Chapter

Sustainable Agricultural Management Practices and Enterprise Development for Coping with Global Climate Change

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Abstract

This book chapter provides an insight into the synthesis of climate change vulnerabilities across various regions of the globe, recent trends, issues and prospects of climate smart agribusiness, the skill, efficiency and sustainable management practices of small and medium enterprises (SMEs) of the globe in the context of climate change, addressing the needs of emerging markets, industries and regional trades through a transformation with development in the areas of technology, value chains, management of environmental and social risk in the supply chains, compliance of food quality and safety regulations, market linkages of smallholders, corporate social responsibility and institutional development. There is a growing concern on food safety regulation and certification as part of sustainable management practices that firms and industries should cope. Sustainable management practices in business prove to be more profitable as they tend to adapt and grow with the changing markets, providing a competitive advantage over other firms. This chapter also focused on the challenges in sustainable business practices as well as suggested a number of development options, institutional and policy issues.

Keywords: agribusiness, enterprise development, sustainable management practices, value chain development, climate change

1. Introduction

There are growing concerns on the impact of climate change on agribusiness. A number of studies assessed such impact at various country levels and food security challenges [1]. An ever increasing amount of evidence suggests that the continual increase in greenhouse gas emissions is affecting the global climate and altering the local precipitation and temperatures [2]. Climate change is expected to produce significant effects on global water resources and freshwater ecosystems [3, 4]. The effects and intensity of climate change will vary from region to region [5]. Impact of climate on global water storage capabilities and hydrologic functions will have significant implications on agricultural production and food processing sector.

The impacts of climate-related extremes include alteration of ecosystems, disruption of food production and water supply, damage to infrastructure and settlements and consequences human well-being. For countries at all levels of development, these impacts are consistent with a significant lack of preparedness for current climate variability in some sectors [6].

Adaptation experience is accumulating across regions in the public and private sector and within communities. Climate variability and extremes have long been important in many decision-making contexts. Monitoring and learning are important components of effective adaptation.

This study was carried out with the objectives to examine and assess climate change vulnerabilities across various regions, climate smart agribusiness, development of small and medium enterprises (SMEs), efficiency of SMEs, sustainable management practices, value chain development, and compliance of food safety regulations of World Trade Organization (WTO). It also identified challenges and development options. The study is completed based on extensive review and analysis of relevant information and literature available across various regions of the globe.

2. Synthesis of climate change vulnerabilities across various regions

Continuous increase in greenhouse gas emissions is affecting the global climate that altering the local precipitation, temperatures and atmospheric composition [7, 8]. According to IPCC World temperature, humidity and precipitation will change significantly by 2030 and 3050 due to climate change [9]. There is already an increase in the frequency and intensity of extreme events, such as drought, heavy rainfall and subsequent flooding and high maximum temperatures. The effects and intensity of climate change will vary from region to region [10].

Climate change vulnerability refers to the state of susceptibility to harm from exposure to climate hazards, and the ability of the sub-national territory or region to cope with, and recover from, such exposure as well as manage incremental and long-term change in climate. Climate change vulnerability encompasses how much the sub-national territory (the environment, society, and economy) will be affected or how sensitive it is to the change. Information on climate change vulnerabilities can be used for investment decisions and prioritization of actions and adoption of sustainable agribusiness management practices. **Table 1** presents information on regional vulnerability and impact of climate change and **Figure 1** illustrates potential impacts associated on the degree of climate change.

Evidence showed that global climate changes found to have considerable impacts on natural resources and livelihoods across different regions of the globe. The observed changes in hydrological systems include changing pattern of precipitation and melting snow. As a result quality and quantity of water resources are changing. The size of the glaciers is reducing due to global warming climate change. It is affecting downstream water resources. The high latitude regions and in high-elevation regions are suffering due to global warming change Productivity and growth of many fresh water and marine species have been affected as a result of climate [6].

A large number of studies covering a wide range of regions and crops identified negative impacts of climate change on crop yields. Climate change has negatively affected wheat and maize yields for many regions. Compared to wheat, the effects of climate change on yield of rice and soybean is less across regions. It is also observed that during occurrence of severe climatic events like flood and drought in major producing regions prices of food grain rises up and thus market also become much sensitive to climate extremes [6].

Regions	Vulnerability and impact of climate change
Africa	• Most vulnerable continents to climate variability and change because of multiple existing stresses like poverty, political conflicts, and ecosystem degradation and low adaptive capacity • By 2050, 350 to 601 million people are projected to experience increased water stress • Climate variability and change is projected to severely affect agricultural production and access to food • Toward the end of the twenty-first century, projected sea level rise will likely affect low-lying coastal areas with large populations • Climate variability and change can negatively impact human health
Asia	• Glaciers in Asia are melting at a faster rate and increasing the risks of flooding and rock avalanches from destabilized slopes • Climate change is projected to decrease freshwater availability in central, south, east and southeast Asia, particularly in large river basins. This decrease could adversely affect more than a billion people by the 2050s • Increased flooding from the sea and, in some cases, from rivers, threatens coastal areas, especially heavily populated delta regions in south, east, and southeast Asia • By the mid-twenty-first century, crop yields could increase up to 20% in east and southeast Asia. In the same period, yields could decrease up to 30% in central and south Asia • Sickness and death due to diarrheal disease are projected to increase in east, south, and southeast Asia due to projected changes in the hydrological cycle associated with climate change
Europe	• Future impacts of climate change are projected to negatively affect nearly all European regions. Many economic sectors, such as agriculture and energy, could face challenges • In southern Europe, higher temperatures and drought may reduce water availability, hydropower potential, summer tourism, and crop productivity • In central and eastern Europe, summer precipitation is projected to decrease, causing higher water stress. Forest productivity is projected to decline. The frequency of peat land fires is projected to increase • In northern Europe, climate change is initially projected to bring mixed effects, including some benefits such as reduced demand for heating, increased crop yields, and increased forest growth. However, as climate change continues, negative impacts are likely to outweigh benefits. These include more frequent winter floods, endangered ecosystems, and increasing ground instability
Latin America	• By mid-century, increases in temperature and decreases in soil moisture are projected to cause savanna to gradually replace tropical forest in the eastern Amazon basin • In drier areas, climate change will likely worsen drought, leading to salinization and desertification (land degradation) of agricultural land. The productivity of livestock and some important crops such as maize and coffee is projected to decrease, with adverse consequences for food security. In temperate zones, soybean yields are projected to increase • Sea level rise is projected to increase risk of flooding, displacement of people, salinization of drinking water resources and coastal erosion in low-lying areas • Changes in precipitation patterns and the melting of glaciers are projected to significantly affect water availability for human consumption, agriculture, and energy generation

Regions	Vulnerability and impact of climate change
North America	• Warming in western mountains is projected to decrease snowpack, increase winter flooding, and reduce summer flows, exacerbating competition for over-allocated water resources • Disturbances from pests, diseases, and fire are projected to increasingly affect forests, with extended periods of high fire risk and large increases in area burned • Crops that are near the warm end of their suitable range or that depend on highly utilized water resources will likely face major challenges • Increases in the number, intensity, and duration of heat waves during the course of the century are projected to further challenge cities that currently experience heat waves, with potential for adverse health impacts. Older populations are most at risk • Climate change will likely increasingly stress coastal communities and habitats, worsening the existing stresses of development and pollution

Source: Synthesis from [11].

Table 1.
Regional vulnerability and impact of climate change.

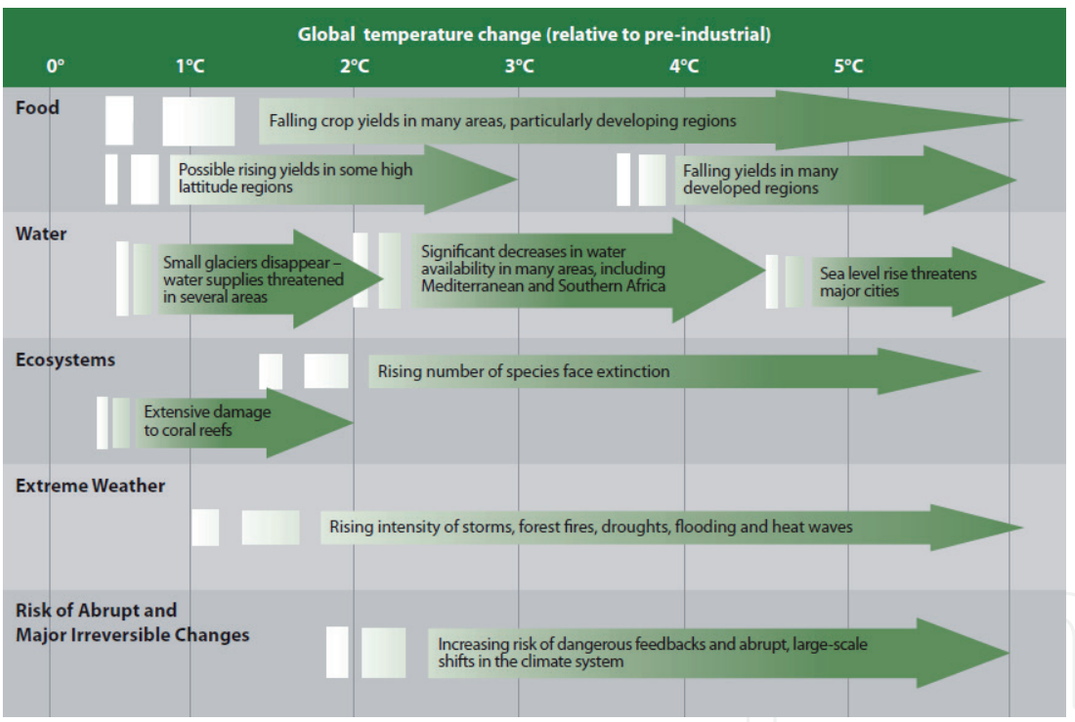

Figure 1.
Potential impacts associated on the degree of climate change. Source: [12].

3. Climate smart agribusiness

There is growing concern on sustainable development of a climate smart agriculture in order to increase its productivity and farmers' resilience to climate change as well as reduce its negative contribution through minimizing greenhouse gas emissions and increasing carbon storage on crop land [13].

An agribusiness could be climate-smart which follows an approach to help guide actions to transform and reorient agricultural systems to effectively and sustainably support development under a changing climate. Agribusiness has a wider field of operations such as production and marketing of crops, livestock, fisheries,

agro-forest, processing of agricultural produces, value chain development, supplies of inputs and machineries. Climate smart agribusiness (CSA) evolves from a process of identifying which production systems and enabling organizations are better suited to respond to the challenges of climate change for specific locations to maintain and enhance the capacity of business in a sustainable way. Three main objectives of CSA are discussed below:

3.1 Developing opportunities to reduce greenhouse gases emissions compared to expected trends

Agribusiness is a major source of greenhouse gas emissions (GHG) in the world. On a global scale, all of the world's agriculture accounts for about one quarter of total anthropogenic GHG emissions of the annual human-caused increase in greenhouse gas emissions, in the form of carbon dioxide, methane and nitrous oxide (**Figure 2**). It contributes to emissions mainly through production of crops, livestock and fisheries, food processing and manufacturing as well as degradation of natural resources.

There is a link with the global climate change with the broad agricultural and energy sectors. Farmers use different forms and amounts of energy to grow food and fibers: transportation fuels, electricity, and industrial chemicals and materials. All of these have some kind of impact on the production of greenhouse gases. Food manufacturing industries also generate carbon dioxide which is around two-third of that generated by agriculture (**Figure 3**). The trend in emission of carbon dioxide from food manufacturing sector is increasing over the past decades (**Figure 4**). Non-CO_2 emissions from agriculture are projected to increase due to expected agricultural growth.

Agriculture's greenhouse gas emissions can be reduced in several ways. Reducing emission intensity (e.g. the CO_2 eq/unit product) through sustainable intensification is one key strategy for agricultural mitigation. The process involves implementation of new practices that enhance the efficiency of input use so that the increase in agricultural output is greater than the increase in emissions [15]. Evidence shows that emission in agriculture can be reduced significantly through adoption of technology of carbon-sequestration. Plants and soils together play a beneficial role for purification air by removing CO_2 from the atmosphere and store it in their biomass.

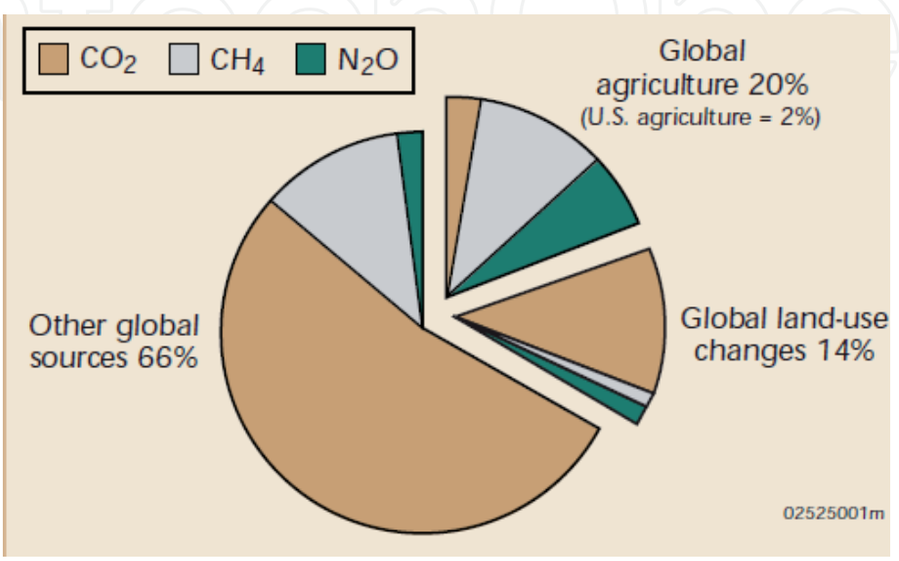

Figure 2.
Source of GHG emissions. Source: [14].

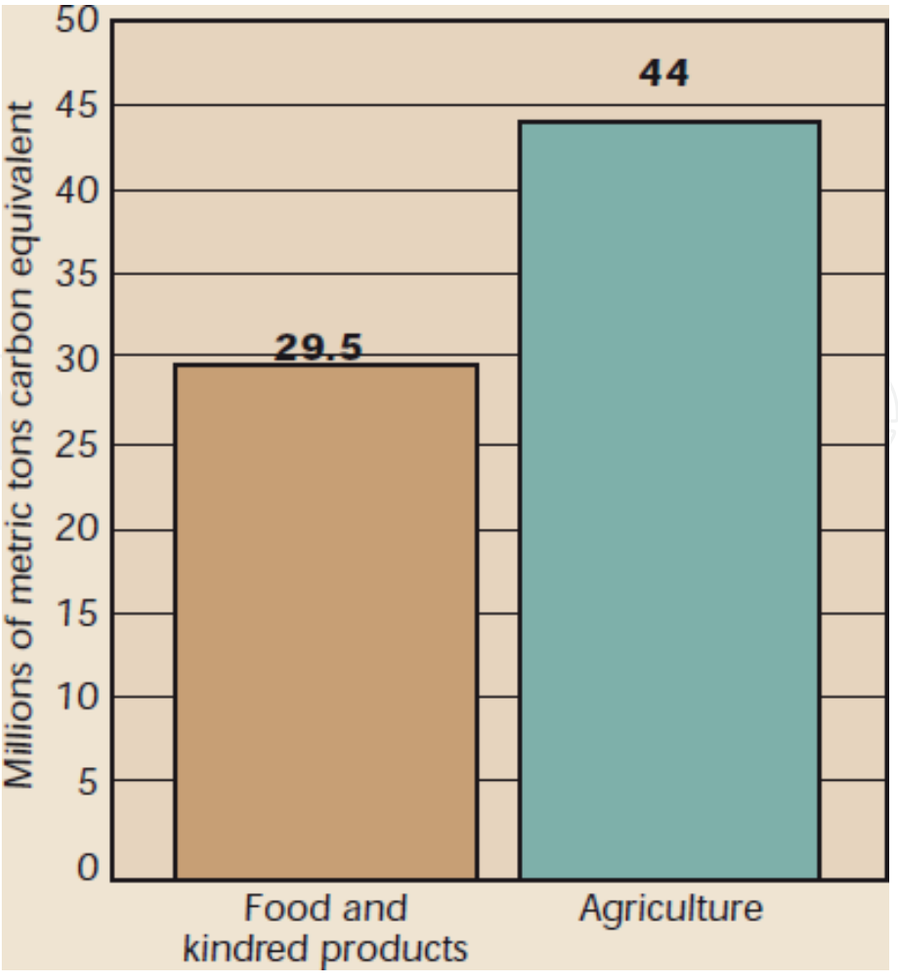

Figure 3.
Emission of GHG from food manufacturing sector. Source: [14].

This is known as the process of carbon sequestration. Integrating agro-forestry with crops and livestock farming and reducing soil disturbances by adopting reduced tillage can help sequestering carbon in agribusiness.

Food processing industries in the globe requires a large amount of fossil energy. There is a high energy demand for thermal processes such as heating, cooking freezing, sterilization, etc. This significantly contributes to the cost of the finished product and to the carbon footprint of the industry. Food processing industries need to adopt technology to improve their systems and processes in order to reduce costs, increase productivity and reduce emission of GHG to mitigate negative

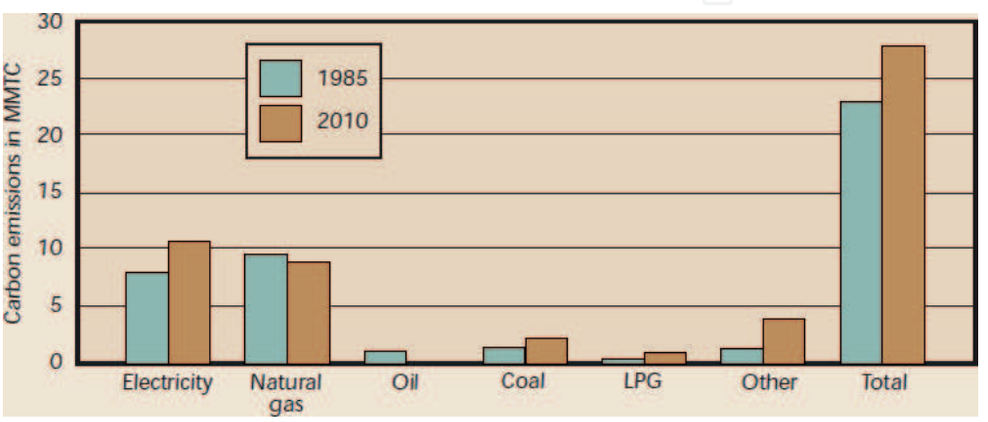

Figure 4.
The trend in emission of carbon dioxide from food manufacturing sector. Source: [14].

impact of climate change. Thus climate resilient technologies are thrust areas of interest for the sector for reducing energy consumption and switching to cleaner, alternative renewable energy sources.

3.2 Building resilience to climate change

Evidence showed that climate change already had negative impact on agricultural productivity and it is projected to further reduce its productivity by 2030. Rising temperature, occurrence of flood and drought due to variability in rainfall will reduce crop yield, as well as productivity of livestock and fisheries [16]. It is possible to reduce or avoid the negative impacts of climate change through formulating and implementing effective adaptation strategies. Given the site-specific effects of climate change, together with the wide variation in agro-ecologies and farming system, the effective adaption strategies will vary within countries and regions. The potential adaptation strategy is enhancing the resilience of agro-ecosystems by increasing ecosystem services through the use of agro-ecology principles and sustainable land management practices, conservation of natural resources and biodiversity. Reducing risk exposure through diversification of production or incomes, and building input supply systems and extension services that support efficient and timely use of inputs and adopting climate resilient stress tolerant crop varieties, livestock breeds and fish and forestry species.

Elements of climate-smart agribusiness	**Sub-system**	**Mitigation options**
1. Management of farms, crops, livestock, aquaculture and capture fisheries	Crops	Switching varieties or species, changing cropping calendars, and nutrient management such as micro-dosing, mulching or organic fertilizers application
	Livestock	Improving the quality of pastures and feed, changing herd management, and specific responses to heat stress
	Fisheries	Changes in locations, species and managing temperature are climate-smart options
2. Landscape or ecosystem management	Ecosystem services	Regulating ecosystem services such as hydrology or biodiversity, including in the soil, can generate production, adaptation and mitigation co-benefits. Multiple objective forest management can generate benefits for food security, development, adaptation to climate change (microclimate), water management, soil protection, agrobiodiversity protection (pollinators) and assist with carbon storage and greenhouse gas emission reduction.
3. Services for farmers, entrepreneurs and managers	Agriculture and food manufacturing	Increasing adaptive capacity of farmers, entrepreneurs and managers requires increasing climate information services, such as seasonal forecasts or early-warning systems, advisory services that link climate information to agribusiness decisions, and financial services such as credit and insurance can increase the ability of smallholders to invest in agribusiness despite increasing climate variability.
4. Changes in the wider food system	Agriculture and food manufacturing	Develop value chain through innovations in harvesting, storage, transport, processing, retail and consumer activities

Source: Authors' synthesis.

Table 2.
Elements of climate-smart agribusiness and mitigation options.

3.3 Increasing agricultural productivity and incomes

Adopting climate resilient technologies and enhancing the productivity of agro-ecosystems and increasing the efficiency of soil, water, fertilizer, livestock feed and other agricultural inputs could offer higher returns to agricultural producers. These measures can often result in lower greenhouse gas emissions compared with past trends. **Table 2** presents the elements of climate-smart agribusiness and mitigation options.

4. Development of SMEs

All over the world, there is growing evidence that SMEs play an important role in the national economic development of a country. SMEs are becoming a subject of high attention in the developing, transition and developed countries. SMEs are considered as the engines of growth and drivers of innovation worldwide due to their private ownership, entrepreneurial spirit, their flexibility and adaptability as well as their potential to accommodate to the challenges of changing environments.

The role of SMEs in global economic and social development has been recognized in a number of studies [17–19]. In fact, SMEs play a key role in the socio-economic development of both developed and developing countries, in terms of not only contribution to GDP but also employment generation and growth [20, 21]. Currently SMEs are dominating the business sector covering 95% of firm worldwide and creating 60% employment of private sector. The important advantage of SMEs is that it can adapt better in response to changing consumers need and markets due to the fact that their organizational structure allows for quicker decision making. Moreover, they are highly flexible to adopt new technology and supporting innovation and promoting competition in the market and better income distribution than the large companies.

SMEs are playing important role toward industrialization and economic development of country due to serving as a starting point. Historically most of the global larger companies originated from SMEs. The industrialized countries could achieve high growth only due to growth of SMEs. It is a growing concern that the market economy started with the born of SMEs and then it progressed with the progress of SMEs. The activities of SMEs are the driving force of an economy and foster employment, economic growth, and poverty alleviation (**Figure 5**). In some of the global companies emerged in USA, Japan, Germany and China, some of the global companies emerged which were established initially as small and medium sized and later they developed into global big companies.

The numbers of SMEs found to have increasing trend over the decades across the globe. The presence of SMEs is more visible in the industrialized countries and developing countries. In Japan, US, Germany, China more than 99% companies are SMEs and proportion of employment generated are 66, 53, 68, and 67% respectively. In the case of Spain, SMEs represent 99% of all companies and generate approximately 66% of jobs [23]. These data show the importance of SMEs to accelerating growth and creating the employment necessary to relaunch the economy in Spain. The food industry[1] is the main manufacturing industry in the European Union, where 95.4% of companies are SMEs with fewer than 50 employees [24]. In Spain, the food industry has been consolidated as the main economic driver, representing 21.7% of the entire industrial sector, 18.3% of employed persons and 15.5% of added value [25].

[1]Europe's food industry means: 4.57 million people employed throughout the EU, a turnover of €1.1 trillion and €230 billion in value added, which make it the largest manufacturing industry in the EU. In half of the EU's 28 Member States, the food industry is the biggest employer within manufacturing.

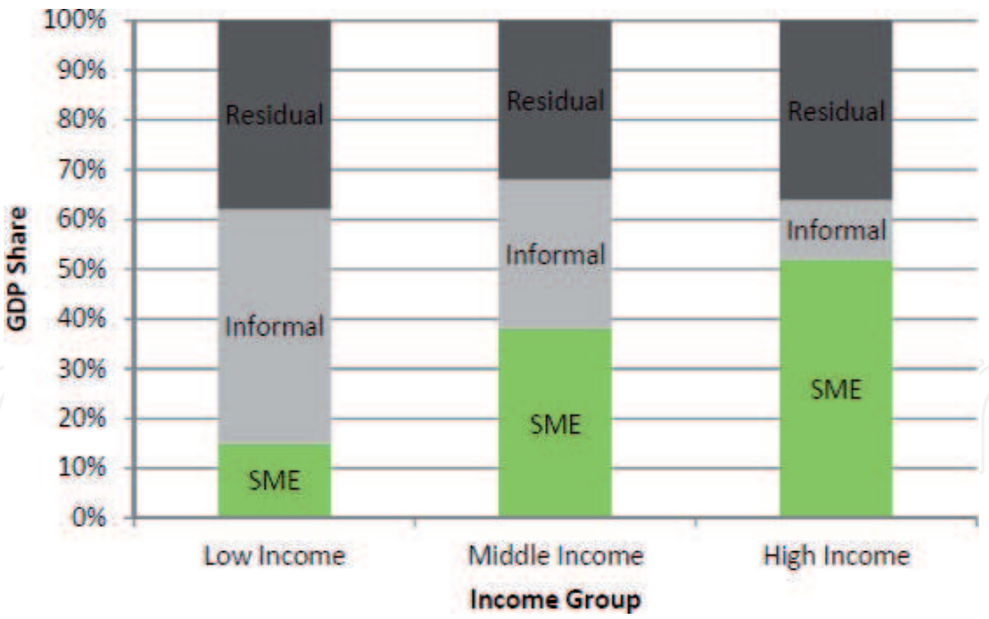

Figure 5.
SME contribution to GDP by countries' income level. Source: [22].

In a developing country like Bangladesh, SMEs are playing an important role toward industrialization and economic development covering 45% of manufacturing value addition, about 80% of industrial employment, about 90% of total industrial units and engaging about 25% of the labor force and contributing to 75–80% export earnings. The industrial sector makes up 31% of the country's gross domestic product (GDP), most of which is coming from SMEs. The total number of SMEs in Bangladesh is estimated to be 79,754. Of them, 93.6% are small and 6.4% are medium. The country's SME sector has created 1.5 million jobs between 2009 and June 2014. Now, private and foreign banks disburse half of all farm loans and a third of these are going to SMEs.

In Thailand, SMEs account for a large proportion of the total establishments in the various sectors. In the manufacturing sector, SMEs comprise 93.8% of all establishments, employing some 868,000 workers or 38.9% of the total. Thai SMEs are increasingly seen as creator of new jobs. Vietnamese SMEs employ 64% of industrial workforce. SMEs in Thailand play an important role in the country's economic development which covered 76.1% of the manufacturing sector in 2007. The largest concentration of Thai SMEs is found in the food sector, textiles, apparels and wood products [26].

Compared to large companies, the SMES are more affected due to change of the environment. They face more risk and uncertainty due to environmental changes and shocks due to having limited resources. As a result their responses to environmental change differ with the large companies. They have usually limited options and opportunities to cope with the adverse situation arising from climate change extremes.

4.1 Efficiency of SMEs

An efficiency estimate allows a company to know its effectiveness in achieving objectives and managing resources. There is growing body of literature on measuring firm specific efficiency of SMEs [27–38]. The main concern of these studies are estimating cost efficiency which is a relative measure of how close is the cost of a company to the costs of a best-practiced one that produces the same output under similar conditions. The cost efficiency approach has two limitations: Firstly, cost efficiency evaluates the efficiency for a given output level only which does not correspond to the optimal level of production. Hence, a firm can be efficient in terms of its cost of production of given level but not for its optimal output level. Secondly,

cost efficiency does not consider the output quality of companies. If differences in output quality between companies are not considered, then the costs of higher quality are incorrectly measured as inefficiency [39].

In order to overcome these limitations profit efficiency is used combining two important economic objectives of cost minimization and revenue maximization. Profit efficiency measures the relative distance of the current profit of a company to its optimal frontier profit. The profit efficiency approach is considered to be better than cost efficiency approach for assessing overall company performance because it considers level of outputs and inputs and as well as prices inputs and outputs [39]. Moreover, profit efficiency can be considered as overall efficiency, such that if a company is efficient in terms of its profits, then it will also be efficient in terms of its costs and its scale of production [40]. Therefore, estimating profit efficiency is far more important for SME managers than the partial view provided by an analysis of cost efficiency [41].

SMEs are strongly influenced by the region in which they operate and therefore, their efficiency level will be conditioned by the economic, social and demographic situation of the region in which their activity is developed [27, 30, 31].

In order to formulate and implement business strategies to improve competitiveness of SMEs, it is important to identify the factors affecting efficiency of SMEs [42]. A number of studies investigated the factors affecting the inefficiency of SMEs. One study pioneered the research on this topic with an empirical study in which they analyzed how size, age and facilities affect cost efficiency in manufacturing SMEs [43]. Subsequently, other authors also studied how the cost efficiency of SMEs is affected by employee qualifications, owner experience, location, type of company, female participation in the workforce, capital-labor ratio, foreign investment, export activity and government support [27, 28, 30, 31, 34, 44].

A recent study found an average profit efficiency of 58% for a sample of 556 small livestock producers in Botswana [45]. The factors that influenced the high degree of inefficiency (42%) were education level of the farmer, distance to the commonly used market, herd size, access to information and income from crop production. The results of another study showed that the mean profit efficiency of smallholder milk producers in Kenya was 60% and it range from 26 to 73% and the factors affecting profit efficiency positively are the level of education, experience, and size of the farm [45].

There are two schools of thoughts on the size and efficiency of company. A number of studies provided evidence that larger firms are more efficient than smaller businesses [35, 36, 43, 46]. The main argument behind this idea is that in a competitive market, the most efficient companies survive and grow, whereas inefficient companies stagnate or exit the industry. On the other hand, some studies supported that small firms are efficient. However, smaller firms are more flexible, have non-hierarchical structures and do not suffer from agency problems owing precisely to their smaller size. These differences could more than offset their size disadvantage and make them more technically efficient than larger companies [31, 47, 48].

The age and efficiency of a company are expected to be positively correlated. First, the oldest organizations in competitive markets will be the most efficient because market inertia will expel inefficient companies [35]. Second, older companies will also be the most experienced in terms of their production and commercial processes and therefore more efficient [33, 46]. Finally, age can also be a significant factor because younger companies have more problems of accessing credit [49]. Alternatively, a negative relationship between age and efficiency is also possible because young companies have more modern infrastructure and the most advanced technologies [43].

We used a panel data set of 10,000 smallholder firms from 64 districts of all over Bangladesh collected for the year 2004 and 2014 for estimating efficiency of rice production using stochastic frontier function model. The results mean

technical efficiency of the sample firms in 2004 and 2014 are presented in **Figure 6**. The mean efficiency of the smallholder firms was 68% in 2004 and it increased to 80% in 2014. It shows that there is a considerable improvement of the mean technical efficiency of the sample firms over the period of 10 years. The main driver of reducing inefficiency in rice production was improvement of the human capital of the firm, i.e., education and experience of the firm operator.

There is positive relationship between labor productivity and efficiency of SMEs because many companies' competitive advantages derive directly or indirectly from human resources [50–52]. There seems to be widespread agreement in the economic literature regarding the positive effect from worker training and skills on the efficiency of companies [30, 31]. The factors positively resource use efficiency are greater employee skills and knowledge. These support adoption of new technologies and stimulate innovation and promote the efficient use of resources. The qualifications and skills of employees found have a positive effect on the supply of goods and services of a company and as well as on its good will [53, 54].

The development of efficient and competitive SMEs is constrained by SMEs' difficulty in accessing financial resources [55, 56]. Study indicated that the structure and costs of financing affect the competitiveness of companies, and difficulties in accessing finance restrict the potential of SMEs to execute projects related to technological innovation and internationalization to improve their efficiency. Gaining greater access to credit could have a positive impact on efficiency among SMEs [19, 28, 57, 58].

Governments of various countries are supporting funding for SMEs in order to promote their competitiveness, innovation and socio-economic development. These strategic actions seems justified on the ground that the difficulties which SMEs are experience in accessing funding besides their importance to economic development and generation of employment. Government assistance could come in the form of credit, reduction/exemption of income tax and import duties on raw materials [30].

Exports found to have a positive impact on efficiency of SMEs because companies that export benefit from access to new information sources and knowledge that are sometimes not available in the local market and they can utilize this acquired knowledge to be more efficient [59].

Profit efficiency of SMEs in the food manufacturing industry found to be an important indicator of assessing the overall performance results of SMEs. The results also identified that there is a positive relationship between labor productivity and profit efficiency. This result reveals the importance of training for employees. Profit efficiency found to improve with increasing SME size. The export activity of SMEs is found to positively relate to profit efficiency [27, 30, 38, 60].

A cross countries study of World Bank found that the efficient SME firms found to have better access to new technology through joint-ventures agreement with

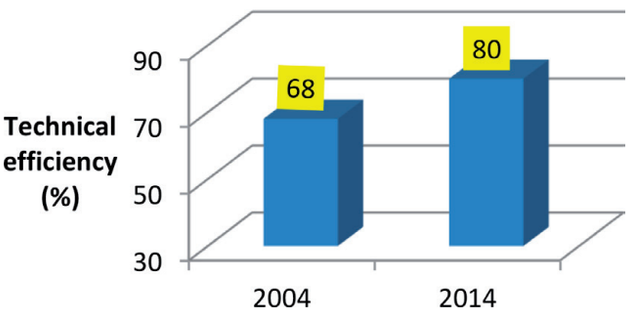

Figure 6.
Firm specific mean technical efficiency of 10,000 smallholder sample firms of 64 districts of Bangladesh in 2004 and 2014. Source: authors estimates.

foreign partners such as buyers and input suppliers [61]. Their efficiency resulted from possessing more educated and well trained work force, adopting greater automation, practicing quality control in production, adopting compensation practices for the employee that supported job stability and skill acquisition.

Products and services, the way of doing business, management know-how and, external environment are most significant factors in determining the business success of SMEs in Bangladesh [62].

A number of studies found that business success of SMEs dependent on characteristic of entrepreneur and SMEs, management and know-how, products and services, the way of doing business and cooperation, resources and finance, and external environment [63–66]. Innovative product, quality, cost, reliability, and services are the key strategic dimension in business success. External environment factor play a very important role as well for firm success. Social network, government support, and legality, are the key strategic dimension in external environment in business success.

4.2 Sustainable management practices

The main concerns about sustainability in agricultural systems and agribusiness are the need to develop technologies and practices that do not have adverse effects on environmental goods and services that are easily accessible and more productive. The global agriculture experienced green revolution with great increase in agricultural productivity through intensive use of HYV seeds, fertilizers, irrigation, pesticides, machinery and improved management practices in the past half-century. Similarly it also experienced a livestock revolution through adoption of improved breed, feed, artificial insemination services, mechanization and improved management practices, etc. Much improvement was found in world food production during the last half century when in aggregate it grew by 145% with some regional variations in its growth. In Africa, Latin America and Asia it increased by 140, 200, and 280%, respectively. The highest fivefold increase was in China during the 1980s–1990s.

Similar results also found in industrialized countries, output doubled in the USA over 40 years while it grew by 68% in Western Europe [67]. Over the same period, world population doubled from 3 billion to more than 6 billion creating more pressure on the demand for food and natural resources [68, 69]. By 2030 and 2050 global population will be 8 billion and 9 billion respectively and will increase demand food at least by 50–60% compared to present situation. The issue is how to sustainably transform global agriculture and agribusiness to meet its future food demand keeping balance with the population growth.

An important change in the world food system will come from the increased consumption of livestock products [70, 71]. Meat demand is expected to rise rapidly with economic growth and this will change many farming systems.

The inefficient use of some of agricultural inputs already led to considerable environmental harm in various regions. Intensive land use contributes substantially to the loss of habitats, associated biodiversity and their valuable environmental services [72]. Irrigation water is often used inefficiently and causes water logging and salinization, as well as diverts water from other domestic and industrial users; and agricultural machinery has increased the consumption of fossil fuels in food production.

Climate change poses an especially serious challenge to many countries and regions of the globe. In the South Asia, Bangladesh would be worst victim of climate change. Bangladesh's agricultural output and its food security will be at high risk. As a low-lying country situated on a delta, Bangladesh experiences salt water intrusion, land erosion, and drought and can expect increased flooding, and more intense natural disasters. In order to mitigate negative impact of climate change the

farmers need to adopt climate-smart technologies such as salt tolerant rice variety, drought-tolerant crops and flood tolerant rice varieties. Similarly, agribusinesses firm will need to resolve increased supply chain problems, decreased productivity, and workforce instability resulting from migration.

Globally some sustainability management practices could be adopted. These are: (i) integration of biological and ecological processes into food production processes such as nutrient cycling, nitrogen fixation, soil conservation, etc., (ii) minimizing the use of those non-renewable resources that cause harm to the environment (iii) utilize indigenous knowledge and skills of farmers for substituting human capital for costly external inputs, and (iv) utilize collective efforts or community based approach to solve common agricultural and natural resource problems like pest infestation, water logging, irrigation, etc. (v) adopt intensification using natural, social and human capital assets, combined with the use of best available technologies and inputs (best genotypes and best ecological management) that minimize or eliminate harm to the environment, can be termed 'sustainable intensification'.

As a more sustainable agriculture seeks to make the best use of nature's goods and services, technologies and practices must be locally adapted and fitted to place. Sustainability has three dimensions. These are (i) protecting the environment, (ii) the needs of present and future generations, and (iii) the economy. Integrating these threes could support economic viability of a system with fulfilling the needs of the present and future generations through minimizing depletion of natural resources.

The sustainable management focuses on a firm's impact on the people, planet, and profit so that these could flourish in the future. It can take many forms including investing in sustainable land management, good agricultural practices, improving food quality and safety, using bio safe packaging materials and improving humane working conditions in the factories, etc.

The boundaries of social accountability are changing over the years. The sustainable management implies that firms should adopt a systems wide approach that links various parts of the business with the greater environment at large. Managers need to apply traditional business principles to environmental problems and corporate social responsibility issues.

5. Value chain development

The global agrifood system is changing rapidly due to structural changes are occurring throughout the system in response to the modernization of agriculture because of globalization, coordination and shifting consumer and societal demands for safer, better-quality and processed food produced in a socially and environmentally responsible sustainable manner.

Markets are growing rapidly across globe due to urbanization and rising income and creating vast opportunities as incomes rise and diets change. It opens new market opportunities for private sector actors all along the value chain. By 2030, the number of people living in urban areas is projected to increase by 68% in low income countries and by 31% in middle income countries. At the same time, rising incomes are driving a dietary change with reduced cereals and increased consumption of animal products, fruits and vegetables and processed foods.

Such consumption changes bring significant new opportunities for farmers, processors and distributors in various regions of the globe. For example, urban food and beverage consumption is projected to grow by about $400 billion by 2030 in Sub-Saharan Africa alone. Africa's food market, valued at about US$ 313 billion per year in 2013 could be tripled by 2030, with investments in infrastructure, smart business and trade policies and a dynamic agribusiness sector linking farmers with

consumers in growing urban areas [73]. In South Asia, the size of food processing sector of Bangladesh is worth US $2.2 billion and grew on an average at 7.7% per annum between FY2004/05 and FY2014/15 [74]. The beverage industry more than doubled during the same period to US dollar 29 million, with an average growth rate exceeding 8%. The food processing sector is thus growing rapidly with prospects for continued growth as Bangladesh's GDP continues to grow. Bangladesh exports over $700 million worth of processed food and beverages, of which over 60% are shrimp and fish products.

Technology and innovations support entrepreneurship in agricultural value chains creating new opportunities to reduce costs and raise incomes. Emerging technologies driven by the Fourth Industrial Revolution include digital database, automation, robotics, and modern manufacturing, new energy technologies and genomics that all offer significant opportunities for the food system.

Agricultural production is a private sector activity comprised of about 450 million private smallholder farmers and many large-scale producers. In low- and lower-middle-income countries, 95% of all farms are smaller than 5 ha. These small farms occupy almost three-quarters of land in low-income countries and two-thirds of land in the lower-middle-income countries. While smallholders include subsistence farmers and commercial producers who sell in unstructured local markets and those who sell in more organized markets often under contract with buyers. Many productive off-farm activities in agricultural value chains in developing countries are undertaken by small and medium scale enterprises (SMEs).

Producers and consumers are connected through a value chain, which include many actors (**Figure 7**) and the performance of one segment is dependent on the performance of other segments. A value chain is the full range of activities that are required to create and add value to a finished product or service. So, a value chain consists of different phases starting from collection of raw material, production, processing, distribution and marketing until the product or service reaches the ultimate consumer. A value chain analysis (VCA) examines the linkages between all actors and their functions. It also considers market demand, quality standards and various influences on the chain [76].

While each segment of the value chain can have unique constraints, there is a set of enabling conditions such as the business climate (including policies, regulations, and market structure) and support services (including finance, information, technology, infrastructure, water, and power) that are common to all segments and all value chains in the sector. Addressing the entire ecosystem is therefore indispensable to creating markets and to improving the performance and transformation of value chains [75].

While some value chains are getting longer with more geographical distance between producers and consumers, some are also getting shorter with fewer

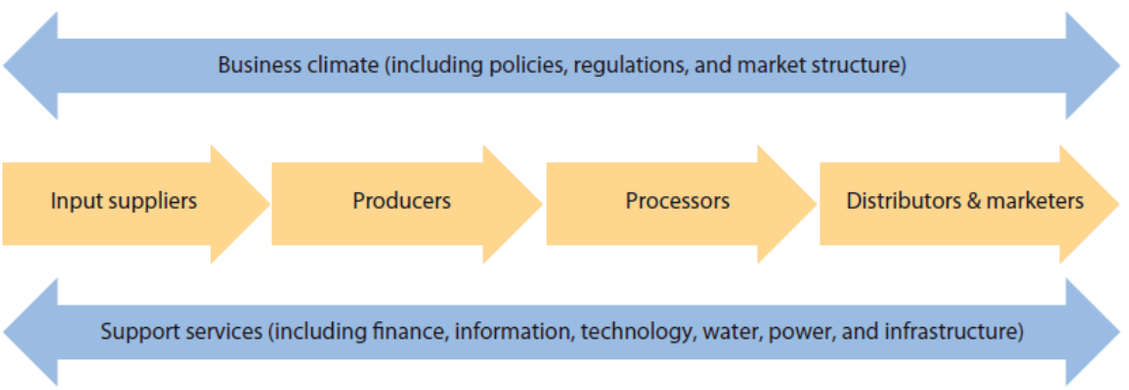

Figure 7.
Agricultural value chain ecosystem. Source: [75].

intermediaries via digital e-commerce platforms that link small entrepreneurs in rural areas with national and global markets.

5.1 Sustainable global value chains (GVC)

Nowadays, agricultural markets are globalizing rapidly. As a result new consumption patterns and new production and distribution systems are occurring in the regions. In the changing market environment, value chains are controlled by emerging corporate firms and supermarkets and their share of the agrifood systems is increasing in developing regions. Small-scale producers provide over 70% of the world's food needs while agribusinesses are important generators of employment and income worldwide. Improving the sustainability of food value chains can benefit hundreds of millions of poor households in developing countries, ensuring access to nutritious food to all. For instance, about 100 types of fruits and vegetables are exported from Bangladesh to more than 40 countries in the world. Export of fresh fruits and vegetables from Bangladesh significantly increased in the past decade (**Table 3**).

Food manufacturing industry being an actor of value chain contributes significantly to a nation's economic development through converting raw agricultural products into finished goods for consumption. Its products are commonly the major exports from a developing country [77]. For instance, frozen foods are the second largest export sector of Bangladesh. The massive natural resources available in Bangladesh make this sector particularly promising for investors looking to supply in international as well as in domestic markets. Bangladesh's export earnings from shrimp and fish export in 2016 were around 348.28 million US$.

There are potentials to transform Bangladesh's export markets of fresh, frozen horticultural crops and processed food. It is projected that Bangladesh's export value could be increased to around $1765 million US $ per year from the export of fresh and processed foods in the year 2034 from the base year level export value of 380 million US$ (**Figure 8** and **Table 4**). This would require capacity development of value chain actors, compliance of certification of food quality and safety and improvement of storage and transportation facilities. The export potential of fruit and vegetables is about 160 thousand metric tons and potatoes would be around 200 thousand metric tons a year. During 2015–2034 total export under business as usual scenario will be 14,773 million US$ and under improved scenario it will be 21,556 million US$ and additional benefit due to improvement will be 6803 million US$. **Table 5** presents information on top 10 vegetables exporters globally.

Fiscal year	Quantity exported (MT)	Export value (in million US$)	Export growth (%)
2008–2009	24,670	50.71	—
2009–2010	29,370	64.21	(+) 26.62
2010–2011	48,428	109.41	(+) 70.39
2011–2012	59,573	134.59	(+) 23.01
2012–2013	80,660	182.23	(+) 35.39
2013–2014	112,924	255.122	(+) 40.00
2014–2015	160,352	362.27	(+) 42.00

Source: Export Promotion Bureau of Bangladesh (EPB) and Hortex Foundation 2013.

Table 3.
Export growth of fresh fruits and vegetables.

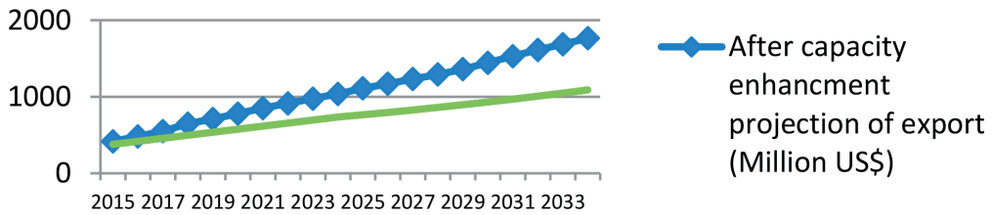

Figure 8.
Projection of export of fresh, frozen horticultural crops and processed food (in million US dollar) under business as usual and enhanced capacity. Source: author's estimation.

It revealed from **Table 5** that similar to Bangladesh's export value of horticultural crops in 2015 the export value of vegetables of Thailand was 562 million USD in 2004 and within a 10 year period it increased to 1797 million USD in 2014. Similar trend in growth of export of horticultural crops was observed in Pakistan, India and Afghanistan. Pakistan's major share of exports (i.e. more than 2/3rd) is from agriculture sector including cotton and cotton based products, rice, fruits, vegetables, etc. During the year 2015, Pakistan exported 1.4 million tons of fruits and vegetables. Export of fresh vegetables of Pakistan increased from 288,200 tons to 751,000 tons and fruits exports increased from 259,900 tons to 682,100 during 2001–2015. During same period export of horticultural crops of India increased from 1092.04 million tons to 2535.57 million tons, it almost doubled during last 15 years. During 2001–2015, the export growth of value of fresh and dried fruits from Afghanistan was around 14%.

The fresh fruit market is recently more globalized than vegetable. About 9% of all fruits grown are traded internationally and it is still growing. The fruits traded worldwide are bananas, apples, citrus fruits and grapes ... Recently Latin America appeared as a dominant global export region and China as a giant increasing import market. A large share of fruit is processed as juice and canned fruit. The markets of processed fruits are expanding in US, Europe, and Oceania. The global demand for frozen and fresh fruits is also increasing mainly in the countries other than US and EU. Around 80% all fruits grown globally are sold as whole fruit. The global demand for frozen fruit has increased by 5% per year. While, global demand for preserved fruit has remained almost stable but it decreased by over 1% a year in Europe, Australia, and the US.

Blueberries, avocados, and other popular year-round fruits found to have boosted trend in global fruit trade during 2006–2016, most countries in the world imported these at least four part of the year. As a result, their trade has increased sharply (**Figure 9**).

Year	Business as usual projection of export (million US$/year)	After capacity enhancement projection of export (million US$/year)	Incremental benefits due to capacity enhancement (million US$)
2015	380		38
2020	578	780	202
2025	766	1110	345
2030	932	1444	512
2034	1090	1765	676
Total	14,773	21,576	6803

Source: Author's estimation.

Table 4.
Projection of export of fresh, frozen horticultural crops and processed food (in million US$) under business as usual and enhanced capacity scenarios.

Year	China	Netherlands	Spain	Mexico	USA	Canada	Belgium	France	Thailand	Italy
2004	2537	4336	4172	2997	2151	1471	1730	1733	562	1003
2005	3052	4258	4308	3122	2421	1714	1829	1812	518	1084
2006	3715	5076	4410	3479	2681	1910	1967	1991	673	1211
2007	4043	6122	5037	3558	3010	2379	2315	2431	789	1416
2008	4222	6630	5528	3869	3468	3039	2508	2452	730	1564
2009	4853	5939	5539	3694	3401	3023	2295	2174	858	1438
2010	7477	6779	5297	4324	3785	3365	2319	2385	1071	1756
2011	8723	7462	5474	4992	3939	3667	2312	2599	1278	1696
2012	6906	6981	5591	4969	4045	3169	2335	2381	1371	1583
2013	7871	7906	6367	5398	4405	4275	2812	2773	1590	1793
2014	8226	7620	6330	5420	4512	4448	2579	2350	1797	1719

Table 5.
Top 10 vegetables exporters globally (value in million US$).

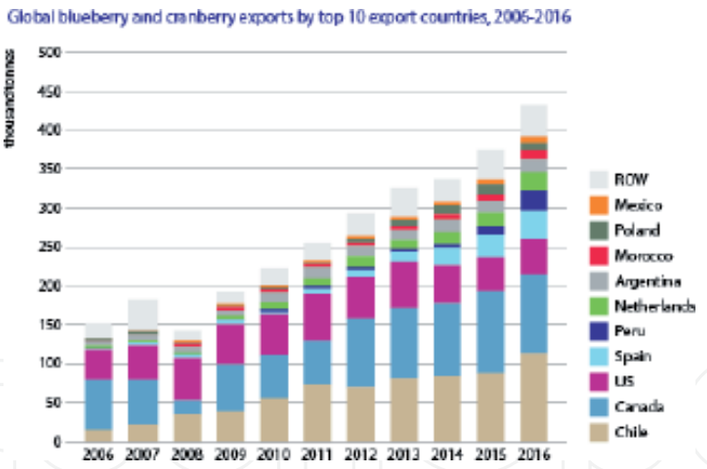

Figure 9.
Rising trade in global export of 'supermarket foods': Export by top 10 countries, 2005–2016. Source: UN Comtrade, 2018.

Over the last decade the international fresh fruit exports is increasing almost by 7% and most of such increase is consumed by import markets of the US, China, and Germany (**Figure 10**). The emerging markets like China and India are becoming more important in the global fruit market. The important driving factors of growth in fresh fruit trade are improved market access, changing consumer preferences, increasing purchasing power, improved logistics, and storage and cold-chain facilities. Many fruits can be shipped over long distances by transportation by sea. For Latin American countries like Chile, Peru, Ecuador, and Brazil has opened up a world of opportunities.

The GVC are generated from globalized markets. It motivates firms to operate internationally through outsourcing of activities like design, production, marketing, distribution, etc. [78]. The smallholder farmers form a key part of the GVC and agro-industry, by providing over 80% of the food consumed in a large section of the developing world [79]. Linking smallholder farmers to global value chain and developing their capacity could transform world agriculture with sustainable growth to feed the future generation. They hold many practical solutions that can help place agriculture on a more sustainable and equitable balance.

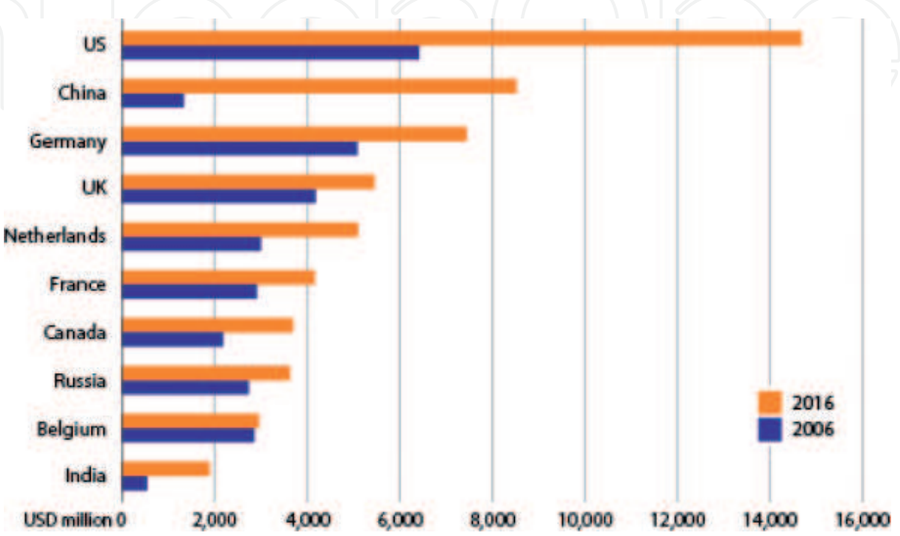

Figure 10.
Top 10 fresh fruit import countries, 2006 vs. 2016. Source: UN Comtrade, 2018.

6. Compliance of food safety regulations of WTO

Export of fresh agricultural produces and food products require compliance of food quality and safety regulation of WTO and meet required standards of importing country. Traceability is an important market requirement for most commodities in high value markets. Often the exportability of food products is limited by non-compliance of the traceability requirement in developing countries. Traceability is an important market requirement for most commodities in high value markets. Often the exportability of food products is limited by non-compliance of the traceability requirement in developing countries. Electronic traceability systems are becoming the norm in developed countries and increasingly in developing countries.

Food safety in developed and developing countries increasingly relies on traceability related information derived from food production history. Furthermore, in order to control diseases, the government need information on sanitary and phyto-sanitary (SPS) condition to ensure safety of imported food. Traceability related information allows compliance with the food quality standards. It thus helps to increase the speed of trading of food companies that comply with it. Consumers of importing country also demand more information on the origin of the food and its traceability information. Traceability related information has experienced a high increase in demand as customs, food safety agencies and consumers increasingly require traceability related information.

Due to emerging markets of quality and safe food across various regions of the globe an investment on improving quality management system could have better payoffs through expanding satisfaction of the consumers and market opportunities. However, there is a challenge for the management of a company to understand the regulatory standards and their adoption in the context of a developing country having imperfect market information.

The globalization of food trade and supply chains requires pre- and post-harvest management to comply with required standard by all participants wishing to supply products to international markets. Current world food trade is valued at $300–400 billion according to Food and Agriculture Organization of United Nations. With the demand for food rising to meet the ever growing world population, food safety is becoming more important and growing concern.

The issue of food safety and sustainability of business is interlinked. There are several prominent sustainability challenges that can be tackled in cycle with food safety issues, most of which can be boiled down to the importance of transparency and traceability. More specifically, the most pressing issues are risk reduction and monitoring, brand reputation, food fraud, supply instability and flexibility, meeting consumer demands and addressing climate change impacts.

Traceability challenges exist both within a company's and throughout its supply chain. Having full visibility into the inputs and outputs from each process—from farm to fork, which is not an easy task, nor is it easy to identify risks and opportunities with food safety and sustainability in these areas. The companies need to analyze the risk in the supply chain, prioritize issues that are important to stakeholders and for the environment, and identify technically feasible solutions that are financially viable. The consequences of poorly managing either issue are costly and include damages to a company's reputation, as well as to consumer and investor confidence, Organizations that address these issues together will maximize their returns on investment in joint solutions.

According to FAO the value of global agricultural trade almost tripled during the period 2000–2012 with the result of high food prices and increased demand for high value produces. But the less developing countries (LDCs) could not keep space with

this high growth as a result their share of global agricultural exports declined during the same period according to WTO. Although tariffs have fallen but non-tariff barriers such as SPS measures have created hurdle to the agricultural exports of LDCs.

The SPS measures are also increasingly addressed in regional and bilateral trade agreements. These agreements focus on the rules and requirements for food safety standards and issues like import licenses, requirements for inspection, testing, certification, labeling, packaging and quarantines. The SPS measures play a critical role in determining a company's ability to access global markets. **Table 6** presents food safety standards applicable to African fruit exporters. In order to get access to global markets the exporters require complying with these standards.

Aquaculture provides almost half of the world's supply of seafood, with a value of U.S. $125 billion. It employs 24 million people and contributes 13% of the world's animal-source protein (excluding eggs and dairy) [81]. While capture fisheries

Type of standard	Institution	Standards
International agreements related to trade and standards	World Trade Organization	Agreement on SPS Agreement on TBT
	Codex Alimentarius Commission Regional Coordination Committee for Africa	Codex standards, guidelines and codes of practice Maximum residue levels of pesticides
	International Plant Protection Convention	International standards for phytosanitary measures (ISPM)
	International Standardization Organization (ISO)	ISO Standards on: agriculture environment, health protection and safety food technology packaging and distribution of goods
	Southern Africa Development Community	SADC trade protocol SPS/food safety annex
Importing country rules	European Union	Legislation on food safety legislation on crop protection products legislation on phytosanitary requirements
Producer protocols	COLEACP (EU-ACP stakeholders in the horticultural trade)	COLEACP harmonized framework
Importing firms' requirements (key protocols applied)	EurepGap Euro-Retailer Produce Working Group British Retail Consortium (BRC)	EurepGap (European retailers protocol for good agricultural practice) BRC protocol
	Other retailer protocols	Global foods safety initiative (GFSI), Assured produce scheme (APS) Marks & Spencer Farm to Fork Tesco's Nature's Choice Shoprite
Consumers' preferences	Fair trade labeling	Fair trade labeling organizations international (FLO) standards
	Organic agriculture	International federation of organic agricultural movements (IFOAM)—IFOAM basic standards (IBS) EU organic standards
International Conventions, "codes of conduct" or guidelines	EU/USA/FAO/Codex	Hazard analysis and critical control point (HACCP)

Source: [80].

Table 6.
Food safety standards applicable to African fruit exporters.

production is stagnating, aquaculture could reduce global deficit in fish protein by 2020 [82]. This requires coping with a number of environmental and social problems, such as water pollution and degradation of ecosystems. One response to these problems has been the rise of sustainability certification launched by the Aquaculture Stewardship Council (ASC). This certification requires setting standards for ecological and social interactions, auditing compliance with labeling products and enterprises that meet the standards, and establishing institutions performing these functions.

The greatest demand for certified aquaculture products comes from North America and Europe, where large supermarket and restaurant chains have committed to selling only certified sustainable seafood by 2015 [83]. Global and regional buyers are turning to certified seafood. But only a small proportion of world aquaculture production (4.6%) is currently certified. Certification is complex and expensive and assumes a level of managerial capability that most aquaculture producers in the Global South do not have. Smallholders are often excluded from markets that require certification [84–86]. Not only producers are excluded, but also up- and downstream supply chain actors also excluded such as collectors, small-scale traders, brokers, and input suppliers.

7. Challenges

7.1 Sustainability of productivity growth

Demand for food and other agricultural products are projected to increase by 50% between 2012 and 2050. The main challenge of global agriculture is meeting the rising demand of the growing population which is projected to increase from 7 billion people today to approximately 9 billion in 2050. However, the expansion of productive agricultural land is limited and in addition climate change may pose further constraint. Climate change will pose a serious challenge to the projections of rising global demand for foods and declining per capita arable land. Intensive farming is often degrading world's natural resources. The farmers would have to increase productivity while also positively supporting the provision of various vital ecosystem services otherwise it will cause degradation of natural resources but also exhaust the ability to produce enough food.

Water scarcity will also become a growing constraint, particularly in areas that use a high proportion of their water resources and where production systems will be exposed to high environmental and social stress.

Climate change and natural and human-induced disasters pose multiple concerns, specifically damage and losses to production, degradation of land, forests, water, fish stocks and other natural resources, declining productivity growth and pressures on fragile agricultural livelihoods and ecosystems.

7.2 Value chains challenge of small-scale operators

Transformation of agrifood chains in low- and middle-income countries has created serious barriers to the participation of smallholder producers and small scale agro-processors in local, national and global markets. Barriers to smallholder access to supermarket channels, combined with reduced labor requirements, may undermine farmers' livelihoods if they cannot diversify into other rural off-farm activities. The issues of financing, market accessibility and transport, requirement of compliance to standards related to quality, traceability and certification making participation in the global value chains difficult for many small-scale operators.

7.3 Postharvest loss

Around one-third of all food produced globally each year amounting 1.6 billion tons of food worth about $1.2 trillion is wasted along the value chain from production to consumption [85, 86]. Reducing food losses and waste would increase the supply of available food and strengthen global food security. Food losses and waste are also causing negative impact to environmentally sustainable food systems. They are contributing toward considerable waste of land, water, energy and agricultural inputs and cause the emission of millions of tons of greenhouse gases.

7.4 Compliance of food safety regulations

We have already discussed in previous section that food and agricultural exports often create SPS compliance challenges. The LDCs have inadequate capacity to comply with SPS requirement for which they struggle to get access to foreign markets. Repeatedly there are happening rejections of shipments due to non-compliance with SPS requirements. As a result the importing countries are putting stricter scrutiny that increases transaction costs, damage reputation and confidence of the exporters.

8. Development options

A number of development options can be suggested: (i) promote good agricultural practices and conservation agriculture, (ii) promote mechanization using robotics and ICT, (iii) developing value chains and agro processing, (iv) improving food quality and safety compliance through institutional development and global cooperation for capacity development for addressing compliance of SPS standard and certification, (v) knowledge generation and technology development. Climate smart agro-technology need to be developed with the focus on improvements in productivity and resource-use efficiency.

9. Policy issues

A range of technical and institutional solutions might be available to increase food production by at least 50% by 2050 in order to feed the increased population, reduce poverty and to minimize degradation natural resources and ecosystems of the globe. Policies, institutions and implementation strategies should be adjusted at global, national and local levels to develop capacities of organizations and farmers with the knowledge and financial resources. Knowledge sharing at local, national and global levels focusing on land and water systems development will foster socio-economic growth across the globes reducing food insecurity and poverty.

The policy and strategies should consider environmental impacts and social consequences of global evolving agrifood systems. Rather considering quantitative increase in production we should also emphasize on better quality.

Policies should be designed to provide SMEs with a package of integrated proactive services such as training, investments in technology and sustainable management practices.

10. Conclusions

World's humidity and precipitation will change significantly by 2030 and 3050 due to climate change. Information on climate change vulnerabilities can be used

for investment decisions and prioritization of actions and adoption of sustainable agribusiness management practices.

A climate-smart agribusiness could achieve three fold objectives: (1) developing opportunities to reduce greenhouse gases emissions compared to expected trends, (2) building resilience to climate change, and (3) increasing agricultural productivity and incomes.

SMEs are considered as the engines of growth and drivers of innovation worldwide due to their private ownership, flexibility and adaptability as well as their potential to accommodate to the challenges of changing environments. The numbers of SMEs found to have increasing trend over the decades across the globe.

Either cost efficiency or profit efficiency approach could be used for measuring efficiency of SMEs. Profit efficiency can be considered to be overall efficiency, such that if a company is efficient in terms of its profits, it will also be efficient in terms of its costs and its scale of production. Therefore, estimating profit efficiency is more important for SME managers than the partial view provided by an analysis of cost efficiency.

Factors affecting efficiency of SMEs are size, age, employee qualifications, owner experience, location, and type of company, female participation in the workforce, capital-labor ratio, foreign investment, export activity, government support and access to information. Evidence from Bangladesh showed that mean efficiency of the smallholder rice firms increased from 68% in 2004 to 80% in 2014 due to improvement of the human capital of the firm, i.e., education and experience of the firm operators. There is widespread evidence in the economic literature regarding the positive effect from worker training and skills on the efficiency of companies.

A number of studies found that business success of SMEs dependent on characteristic of entrepreneur, management and know-how, products and services, the way of doing business, resources and finance and external environment.

The global agrifood system is changing rapidly due to structural changes are occurring throughout the system in response to the modernization of agriculture because of globalization, consumer and societal demands for safer, better-quality and processed food produced in a socially and environmentally responsible sustainable manner. Producers and consumers are connected through a value chain, which include many actors and the performance of one segment is dependent on the performance of other segments.

Small-scale producers form a key part of the global value chain and provide over 70% of the world's food needs while agribusinesses are important generators of employment and income worldwide. Food manufacturing industry being an actor of value chain contributes significantly to a nation's economic development through converting raw agricultural products into finished goods for consumption. For instance, Bangladesh's export earnings from shrimp and fish export in 2016 was around 348.28 million US$ in 2015. It is projected that earning of Bangladesh from the export of fresh and processed foods could be raised to more than $1800 million USD per year in 2034 from the base year export level of 380 million USD. Linking smallholder farmers to global value chain and developing their capacity could transform world agriculture with sustainable growth to feed the future generation.

Export of fresh agricultural produces and food products require compliance of food quality and safety regulation of WTO and meet required standards of importing country. The globalization of food trade and supply chains requires pre- and post-harvest management to comply with required standard by all participants wishing to supply products to international markets. The exports from LDCs are often constrained by sanitary and phytosanitary (SPS) measures of WTO.

The SPS measures are increasingly addressed in regional and bilateral trade agreements. As a result there are needs to develop capacity of LDCs for requirements of inspection, testing and certification, labeling, packaging and quarantines.

The challenges identified are (1) sustainability of productivity growth, (2) value chains challenge of small-scale operators, (3) high postharvest loss, and (4) compliance requirement of food safety regulations. A number of development options are also suggested.

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