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Trade and Investment Policies on Mechanization of Agriculture

Case studies of selected countries: Bangladesh, Indonesia, Pakistan, Philippines, Türkiye

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I. Introduction

Background: The agricultural sector serves as a cornerstone of economic development and food security for many countries, particularly in economies like Bangladesh, Indonesia, Pakistan, the Philippines, and Türkiye. In recent years, the adoption of mechanization has emerged as a pivotal driver of agricultural modernization, promising increased efficiency, productivity, and profitability. However, the extent and pace of mechanization vary significantly across countries, shaped by a complex interplay of trade policies, investment frameworks, technological capabilities, and socio-economic factors. This study delves into manufacturing, trade, and investment in agricultural mechanization technologies. It explores insights from successful national strategies and adapts effective policy frameworks following consultations with key stakeholders. Additionally, the study seeks to promote international trade for agricultural machinery by addressing trade barriers, while also identifying investment opportunities to enhance agricultural productivity in the studied countries.

Anticipated outcomes include contributing to knowledge of agricultural mechanization systems, guiding policy discussions, and facilitating policy formulation to sustainably boost agricultural productivity and ensure food security in line with the 2030 Agenda for Sustainable Development. The study provides an overview of common practices, best practices, and variations in the trade and investment landscape of agricultural mechanization technologies in Bangladesh, Indonesia, Pakistan, the Philippines, and Türkiye.

In the context of globalization and trade liberalization, countries are increasingly interconnected through intricate webs of trade agreements, tariffs, non-tariff measures, and investment flows. These dynamics profoundly influence agricultural production and trade patterns, shaping the competitiveness of domestic producers and the availability of agricultural technologies. Moreover, the imperative to achieve food security amidst growing and ageing populations amplifies the urgency for agricultural modernization.

Bangladesh, Indonesia, Pakistan, the Philippines, and Türkiye stand at unique junctures in their agricultural development trajectories, each facing both common and distinct challenges and opportunities. While some grapple with land constraints and climate vulnerabilities, others confront water scarcity and land fragmentation while aspiring for technological advancement and export competitiveness.

Against this backdrop, examining the trade and investment policies shaping mechanization in agriculture offers valuable insights into the broader socio-economic transformations underway in these countries. By unpacking the policy frameworks, institutional capacities, and stakeholder dynamics, this research aims to inform evidence-based policy interventions to foster sustainable agricultural development and inclusive growth. Through a comparative analysis, it seeks to distill lessons learned and best practices to guide policymakers, researchers, and practitioners in navigating the complex terrain of agricultural transformation in a rapidly changing global landscape.

Among the focus countries, some countries possess wider manufacturing capabilities, while others rely more on agricultural machinery imports. The insights obtained from the study can serve as reference points for other countries undergoing agricultural mechanization, particularly for agricultural machinery associations, policymakers,

and development institutions.

For each country under study, the report systematically addresses the following key aspects:

1. Overview of the agricultural economy and production system, highlighting distinctive features.
2. Examination of agricultural policies and governmental programmes, encompassing the level of mechanization and efforts in agricultural mechanization research, development, and extension (RDE).
3. Analysis of the investment and policy landscape, including insights into public-private partnerships and associations of machinery manufacturers.
4. Evaluation of the trade environment and policies, with a focus on risk management and implications of regional trade agreements.
5. Assessment of infrastructure and financial sector development, with specific emphasis on its impact on agricultural mechanization initiatives.

1.1. Objectives of the study

This study aims to contribute to the dissemination of knowledge regarding agricultural mechanization in the Asia-Pacific region. Conducted across five countries, the study seeks to offer insights into the current landscape of policy, trade and investment in agricultural machinery within the region. Through comprehensive analysis, this research has the following objectives:

1. Profile the current agricultural development trends in each of the five countries.
2. Describe initiatives and advancements in sustainable mechanization of the agricultural sector in each country.
3. Analyze the enabling environment for trade and investment to support sustainable mechanization in agriculture.
4. Outline recommendations for promoting sustainable agricultural mechanization in the Asia-Pacific region.

1.2. Selected countries

The study covers five countries across the Asia-Pacific region: Bangladesh, Indonesia, Pakistan, the Philippines and Türkiye. These countries were chosen based on their commitment and extensive experience in agricultural policy formulation aimed at advancing mechanization within their agricultural sectors.

Each selected country offers a unique perspective and approach to agricultural mechanization, shaped by its distinct socio-economic, geographical, and cultural factors. Through an in-depth examination of their trade and investment policies, this study aims to shed light on the multifaceted strategies employed to promote and sustain agricultural mechanization. By analyzing the successes, challenges, and lessons learned from these diverse contexts, valuable insights can be extracted to inform future policy-making and investment decisions aimed at fostering sustainable agricultural development across the region.

1.3. Study methodology

The methodology employed a mixed-methods approach, combining both primary and secondary data collection. Primary data was gathered through direct engagement with national statistics offices and relevant institutions involved in agricultural mechanization development. Secondary data, sourced from reputable publications and databases, supplemented this information.

For each country, the study methodology involved:

1. Collection and analysis of primary data pertaining to agricultural development trends and mechanization initiatives.
2. Integration of secondary data sources to enrich the analysis and provide a broader contextual understanding.
3. Systematic organization and presentation of findings structured around key themes such as the agricultural economy, policy landscape, investment environment, trade policies, and infrastructure development, with a focus on their implications for agricultural mechanization.

This methodology ensures a comprehensive and robust assessment of agricultural mechanization efforts across the selected countries.

1.4. Report structure

The study is organized into four chapters, each addressing key aspects of sustainable mechanization and its broader impact on trade and investment in the region.

Chapter 1 outlines the significance and objectives of the research. It provides a concise introduction to the study, elucidating the criteria for country selection and detailing the approach and structure of the report.

In Chapter 2, the focus shifts to the enablers of sustainable agricultural mechanization. The chapter examines the roles of governmental policies and private sector engagement in driving mechanization initiatives. Additionally, it evaluates the trade and investment policies influencing the landscape of agricultural machinery and mechanization within each country.

Chapter 3 offers detailed insights into the agricultural development profiles and mechanization initiatives of each country. Through meticulous analysis, it uncovers the diverse strategies employed to foster sustainable mechanization practices and assesses the trade and investment environments conducive to agricultural advancement.

Finally, Chapter 4 synthesizes the findings, draws overarching conclusions, and presents actionable recommendations for stakeholders. The aim is to provide valuable insights to inform policy-making and investment decisions, ultimately contributing to the promotion of sustainable agricultural mechanization across the region.

This structured approach aims to offer a comprehensive analysis that not only elucidates current trends but also lays the groundwork for future advancements in agricultural mechanization within Asia and the Pacific.

II. Enablers of sustainable agricultural mechanization

Agricultural mechanization, once defined by the use of human and animal power alongside hand tools, has evolved into a diverse spectrum of sophisticated equipment powered by mechanical and renewable energy sources. This transformation reflects the growing needs and advancements in the agricultural sector. Today, sustainable agricultural mechanization encompasses a broad range of technologies, from basic hand tools to motorized equipment, all aimed at enhancing efficiency, productivity, and sustainability in farming practices.

The Food and Agriculture Organization (FAO) underscores the significance of sustainable agricultural mechanization in increasing land productivity, mitigating labor shortages, reducing environmental impacts, and improving livelihoods. By facilitating timely cultivation, sustainable mechanization enhances cropping intensity and production while promoting resource conservation through efficient water and input usage. Moreover, it alleviates manual labor burdens, allowing for more diversified livelihood opportunities and educational access for rural households.

One of the key benefits of sustainable mechanization lies in its capacity to add value to farm products and by-products through post-production processing, thereby increasing farmers' incomes. This value addition, coupled with increased labor demand for production and post-harvest operations, contributes to employment generation and economic development in rural areas.

Furthermore, sustainable agricultural mechanization plays a pivotal role in advancing several Sustainable Development Goals (SDGs) outlined in the 2030 Agenda for Sustainable Development. From eradicating extreme poverty and hunger to promoting responsible consumption and production, mechanization aligns with various SDG targets, including those related to climate action and land restoration. By fostering partnerships and collaboration, sustainable mechanization serves as a catalyst for progress towards shared global well-being, particularly in developing countries where agriculture remains a cornerstone of the economy. Nonetheless, various constraints persist in implementing sustainable agricultural mechanization in the Asia-Pacific region, including small land holdings, manufacturing limitations, policy gaps, and institutional capacity constraints (ESCAP-CSAM, 2018). Addressing these challenges is crucial to align progress in agricultural mechanization development with the region's agricultural potential.

The following enablers form a cohesive framework that supports sustainable agricultural mechanization, driving economic growth, food security, and environmental sustainability in rural communities.

2.1. Main enablers for sustainable agricultural mechanization

This section focuses on factors that directly support the adoption and sustainability of mechanized practices in agriculture. Sustainable agricultural mechanization relies on a multifaceted approach that involves various stakeholders working together to create an enabling environment for its adoption and promotion.

Government Policies

At the forefront of this effort are government policies designed to incentivize investment in mechanization equipment and promote sustainable agricultural practices. Governmental initiatives are instrumental in promoting sustainable agricultural mechanization through the formulation and implementation of policies across various sectors of agricultural development. In countries where agriculture holds significant economic importance, governments should implement a range of policies and programmes aimed to prioritize sustained agricultural development to bolster productivity and ensure food security. These measures encompass diverse initiatives such as financial support for agriculture and the development of critical agricultural infrastructure like irrigation systems, processing facilities, and farm-to-market roads. Additionally, governmental interventions should include resource allocation for research and development, establishment of testing procedures for agricultural machinery safety and efficiency, enactment of consumer protection laws, and provision of education, training, and extension services. Research and development drive innovation, leading to the development of new technologies and practices that improve productivity, efficiency, and sustainability. Agricultural research institutions, universities, and international organizations collaborate to adapt and transfer mechanization innovations to local contexts, while demonstration farms and technology hubs showcase these innovations and provide farmers with practical insights and guidance.

Furthermore, government initiatives should be aligned with the needs and priorities of farmers, as well as agricultural machinery manufacturers, retailers, wholesalers, and importers. Collaboration with the manufacturing industry is essential to stimulate increased demand for mechanization by leveraging advanced technologies and innovations. By fostering partnerships and addressing the diverse needs of stakeholders, governments can effectively promote sustainable agricultural mechanization, thereby enhancing agricultural productivity, food security, and rural livelihoods. (Clarke, 2000; ESCAP-CSAM, 2016).

Private Sector

The private sector plays a crucial role in driving sustainable agriculture mechanization by fostering innovation, enhancing productivity, and improving access to technology. Through investment in research and development, private companies could develop advanced machinery that not only increases efficiency but also minimizes environmental impact, aligning with sustainable practices. Additionally, partnerships between the private sector and farmers can facilitate knowledge transfer, ensuring that modern techniques and equipment are effectively integrated into farming operations. This collaborative approach promotes resilience in agricultural systems, enabling farmers to adapt to changing climatic conditions while

meeting the growing demand for food in a sustainable manner.

Technological advancements

Technological advancements are a pivotal enabler for agricultural mechanization, transforming traditional farming practices into more efficient and sustainable operations. Innovations such as precision agriculture, smart machinery, and automated systems allow farmers to optimize resource use, reduce waste, and increase crop yields. By integrating advanced technologies, farmers can monitor and manage their fields with unprecedented accuracy, leading to improved decision-making and reduced environmental impact. Furthermore, these advancements enable better access to data and information, empowering farmers to adapt to changing conditions and market demands. As a result, technological progress not only enhances the efficiency and productivity of agricultural mechanization but also supports the transition toward more sustainable and resilient farming systems, essential for meeting the challenges of food security in the Asia-Pacific region.

Capacity building

Capacity building is essential for driving agricultural mechanization, as it equips farmers with the knowledge and skills necessary to effectively utilize modern machinery and technology. Training programmes focused on operational techniques, maintenance, and management practices enable farmers, particularly smallholders, to adopt mechanization confidently. By fostering a deeper understanding of the benefits and functionalities of agricultural tools, capacity building enhances productivity and efficiency while promoting sustainable practices. Moreover, empowering local communities through workshops and hands-on trainings encourages innovation and collaboration, creating a network of skilled operators who can further advocate for mechanization and share best practices within their regions.

Infrastructure development

Infrastructure development serves as a critical driver for agricultural mechanization, as it creates the necessary foundation for efficient agricultural operations. Adequate roads, storage facilities, and irrigation systems ensure that mechanized equipment can be effectively utilized, allowing farmers to transport their produce and inputs. Improved access to reliable energy sources also facilitates the use of advanced machinery, making it more feasible for farmers to integrate technology into their practices. Furthermore, well-developed agricultural infrastructure supports market access and value chain development, enabling farmers to leverage mechanization not just for production but also for better profitability and sustainability in the agricultural sector across Asia and the Pacific.

2.2 Trade and investment policies for agriculture and agricultural mechanization

This category covers the enablers that facilitate trade, investment, and markets dynamics that support sustainable mechanization.

Trade and investment policies

Trade and investment policies assume paramount importance in facilitating the dissemination of

agricultural mechanization technologies. National policies should promote strategies facilitating the seamless flow of mechanization technologies, fostering economic growth.

Thailand and the Republic of Korea serve as exemplary models, leveraging agricultural policies, trade, and investment measures to propel the agricultural sector forward through modernization and technological innovation. Thailand's transition to an upper-middle income country in 2011, driven by the shift from agrarian to export-oriented manufacturing (ADB, 2015), underscores the transformative power of agricultural modernization. The Thailand 4.0 initiative epitomizes this shift towards smart farming, emphasizing advanced inputs, technologies, and management systems (Kittiyopas and Sapmane, 2015). Concurrently, the Republic of Korea's 2018-2022 agricultural development plan focuses on smart farming and R&D convergence, supported by ICT and big data utilization (Jeongbi Im, 2019). The experiences of Thailand and the Republic of Korea underscore the vital role of advanced agricultural mechanization and investment in boosting agricultural productivity (ESCAP-CSAM, 2018).

Investment

Investments play a pivotal role in sustaining agricultural growth, particularly when directed towards optimizing mechanization, a cornerstone for productivity and self-sufficiency in agriculture. Both public and private investments are essential for the development and adoption of modern technologies that enhance productivity, reduce labor costs, and improve sustainability. Investment in research and development leads to the creation of cutting-edge machinery tailored to the needs of diverse farming systems, particularly in regions like the Asia-Pacific, where agricultural landscapes vary significantly. Additionally, investment in infrastructure, education, and market systems enables broader access to mechanization, empowering farmers, especially smallholders, to improve their operational efficiency and resilience in a competitive and climate-vulnerable environment.

Financial Services

Accessible financial services are a key enabler of agricultural mechanization, providing farmers with the necessary resources to invest in modern equipment. Through microfinance loans, leasing arrangements, and guarantee schemes, farmers can access the capital needed to purchase or lease machinery and equipment, reducing their upfront costs and financial risks. In regions like the Asia-Pacific, where small-scale farming is prevalent, tailored financial products can help bridge the gap between farmers and new technologies. By improving access to capital and reducing financial barriers, financial services facilitate the adoption of mechanization, enabling farmers to boost productivity, reduce manual labor, and increase profitability.

Public-Private Partnerships

Public-private partnerships (PPPs) serve as a powerful enabler for agricultural mechanization by combining the strengths of both sectors to address shared challenges. Governments can provide policy support, subsidies, and infrastructure, while private companies offer technological innovations and market expertise. In the Asia-Pacific region, PPPs can bridge the gap between public sector goals of sustainability and food security and the private sector’s capacity for technological advancement and investment. These partnerships enable broader access to modern machinery, training programmes, and financial tools, ultimately fostering a more inclusive and resilient agricultural system that benefits smallholder farmers and enhances regional productivity.

III. Case studies from selected countries

3.1. Bangladesh

3.1.1. Full mechanization of grain and oil crops

With a population density of 1,290 people per square kilometer, Bangladesh is one of the most densely populated countries in the world. The country is bounded by India on the west, north and northeast, Myanmar on the southeast and the Bay of Bengal on the south. Bangladesh includes the deltas of the rivers Padma (also known as the Ganga) and Jamuna (also known as the Brahmaputra) flowing down from the northeastern part of the Indian subcontinent. Bangladesh has a total area of 143,998 km2, making it the 24th smallest country in the world with a population of 164.7 million. Agriculture stands as the primary livelihood for the majority of people in the country with more than 70 per cent of the population residing in rural areas. Furthermore, a significant 77 per cent of total workforce is engaged in rural occupations, highlighting the pivotal role of agriculture in sustaining livelihoods across Bangladesh. Rice, wheat, maize, sugarcane, jute, tea, pulses, oilseed, fruits and spices are the major crops, paddy being the staple, accounting for 74.85 per cent of total cropped area and 95 per cent of total cereal production. Bangladesh is nearing self-sufficiency in rice production, but is deficient in wheat, maize, sugarcane, pulses, oilseeds, fruits and spices production. There is a surplus in jute and tea production which are the main export crops. Poverty has declined rapidly from a share of 48.9 per cent of the population in 2000 to 23.2 per cent in 2016, of which 90 per cent was attributed to agriculture growth. However, agriculture's share in economic output is declining while that of industry has seen a sharp increase (see Table 3.1.1.). Agriculture accounts for 14.74 per cent of GDP whereas industry and services produce 85.26 per cent. When sectoral growth is considered, agriculture has the least contribution of 2.97 per cent. Still, agriculture is the backbone of the economy, with nearly 41 per cent of the labour force employed in the agricultural sector.

Table 3.1.1

Bangladesh: economic structure

Year							
	2011	2012	2013	2014	2015	2016	2017
GDP growth (percentage)	6.46	6.52	6.01	6.06	6.55	7.11	7.28
Sectoral share of GDP (percentage)							
Agriculture	18.01	17.38	16.78	16.50	16.00	15.35	14.74
Industry	27.38	28.08	29.00	29.55	30.42	31.54	32.42
Services	54.61	54.54	54.22	53.95	53.58	53.12	52.85
Sectoral growth (percentage)							
Agriculture	4.46	3.0	2.46	4.37	3.33	2.79	2.97
Industry	9.02	9.44	9.64	8.16	9.67	11.09	10.22
Services	6.22	6.58	5.51	5.62	5.8	6.25	6.69

Source: Bangladesh Bureau of Statistics (BBS);

Note: All at constant price and constant price base year: 2005-06

Availability of cultivated land is decreasing at 0.40 per cent annually and the number of farms is increasing at 2 per cent per year with an average farm size of 0.5 ha that is gradually decreasing. Nonetheless, there has not been a decline in productivity. The average farm is divided into 3.2 plots, indicating a high degree of land fragmentation with an average plot size of 0.16 ha (Mandal, 2014).

With the population of Bangladesh projected to reach 215.4 million by 2050, farmers will have to grow more food with the limited land resources to meet the growing demand. Agricultural mechanization can help make sustainable contributions to both GDP and agricultural sector growth (Alam and Khan, 2017).

The average paddy equivalent cost for the five major paddy production operations (tillage, transplanting, weeding, harvesting and threshing) ranges between 37 and 47 per cent of total paddy output (Islam, 2016). Farmers still manually transplant, weed, harvest and carry the crop. Sometimes, farmer profits are negative due to excessive labour use in these time-consuming activities which usually involve both monthly contractual or daily hired labour and family members. Agricultural mechanization is crucial for sustainable crop production and the use of farm machinery rental or custom hire services could be an appropriate way of promoting farm mechanization in Bangladesh (Islam, 2016).

3.1.1.1. The agricultural production system

Of the 8,560,964 ha total cultivated land in the country, 27.5 per cent (2,354,821 ha) is single-cropped, 44.9 per cent (3,847,274 ha) is double-cropped and 20.0 per cent (1,715,430 ha) is triple-cropped with a cropping intensity of 192 per cent. Agricultural production increased between 2011 and 2017 (see Table 3.1.2). Rice, jute, pulses, oilseed and maize production increased by 0.8 per cent, 441 per cent, 67 per cent, 33 and 197 per cent, respectively. Production of milk, meat and eggs increased by 147 per cent, 209 and 96 per cent, respectively, from 2011 to 2016.

Table 3.1.2

Bangladesh: area and production of main crops and livestock products

Production (thousands of tons)							
	2011	2012	2013	2014	2015	2016	2017
Rice	33,542	33,889	33,833	34,357	34,710	34,710	33,804
Jute	1,523	1,452	7,611	7,436	7,501	7,554	8,247
Sugarcane	4,671	4,603	4,469	4,508	4,434	4,208	3,863
Tea	133,380	133,379	139,994	145,728	145,727	142,198	-
Pulses	232	240	265	352	378	378	387
Oilseeds	730	787	804	844	934	934	975
Maize	1,018	1,298	1,548	2,124	2,272	2,446	3,026
Area (thousands of acres)							
	2011	2012	2013	2014	2015	2016	2017
Rice	28,489	28,487	28,228	28,101	28,209	28,123	27,184
Jute	1,751	1,878	1,683	1,645	1,662	1,675	1,823
Sugarcane	287	266	270	265	258	243	227
Tea	140	143	144	148	149	148	133
Pulses	627	667	701	824	885	922	901

Oilseeds	924	972	1,009	1,065	1,124	1,125	1,197
Maize	409	487	580	759	804	827	963
Average yearly livestock production (thousands of tons)							
	2011	2012	2013	2014	2015	2016	2017
Milk	2,950	3,460	5,067	6,090	6,970	7,275	
Meat	1,990	2,330	3,620	4,520	5,860	6,152	
Eggs (Nos)	6,078,500	7,303 ,890	7,617,380	10,168,000	10,995,200	11,912,400	

Source: Bangladesh Bureau of Statistics (BBS)

Consumption of pulses, wheat, fish, meat, egg and fruit increased from 2005 to 2016, with fish and meat consumption increasing significantly by 49 and 203 per cent, respectively (see Table 3.1.3). Per capita daily wheat consumption increased from 12 to 29 g in the same period. However, per capita daily consumption of rice declined from 439 to 367 g and that of milk and milk products, from 32.4 to 27.31 g.

Most farmers are smallholders and not part of farmers' associations or cooperatives that can bargain on their behalf for fair prices for their products, forcing them to sell to intermediaries at low prices. They are also often unable to meet requirements for government procurement at higher prices, such as moisture content of 14 per cent and the absence of foreign material in seeds.

Table 3.1.3

Per capita daily food consumption

(Grams)

Food	*Year*		
	2005	*2010*	*2016*
Rice	439.64	416.00	367.19
Wheat	12.08	26.0	19.83
Pulses	14.2	14.30	15.60
Vegetables	157.0	166.10	167.30
Fruit	32.5	44.7	35.78
Fish	42.1	49.5	62.58
Meat	8.4	19.0	25.42
Egg	5.2	7.20	13.58
Milk and Milk Product	32.4	33.7	27.31

Source: 'Household income and expenditure survey', Bangladesh Bureau of Statistics (BBS)

Harvest time market prices are generally low (see Table 3.1.4.). With no restriction on cereal and oilseed imports at lower prices, farmers are sometimes forced to sell crops at prices lower than production costs.

Table 3.1.4

Bangladesh: harvest time market price of agricultural crops

(Taka per quintal)

				Year		
	cRop	*2010-11*	*2011-12*	*2012-13*	*2013-14*	*2014-15*
1	Paddy Aman Local	2,082	1,650	1,510	1,939	1,736
2	Paddy Aman H Y V	2,201	1,521	1,733	2,113	1,960
3	Wheat	2,056	1,975	2,203	2,248	2,103
4	Mustard	3,618	4,563	4,037	6,015	
5	Masur	4,926	5,471	4,514	7,032	7,028
6	Mung	6,677	5,338	6,877	7,575	7,445
7	*Til*	2,965	3,702	4,300	3,997	4,389
8	Groundnut	4,716	5,260	7,545	5,067	4,791
9	Onion	2,751	1,573	2,819	4,165	6,020
10	Garlic	8,868	2,806	3,949	7,073	2,887
11	Chillies (green)	2,675	5,000	3,448	4,648	14,351
12	Ginger	7,046	3,523	5,494	11,653	3,685
13	Turmeric	19,332	10,038	5,859	7,172	9,573
14	Jute (tossa)	4,314	2,934	2,825	3,942	5,354

Source: Bangladesh Bureau of Statistics (BBS)

Note: 1 USD =80 TK

3.1.2. Agricultural mechanization

3.1.2.1. National policy on agricultural mechanization

After the catastrophic cyclone of 1970, many four- and two-wheel tractors (4WT & 2WT) were donated by international charities for farmers in affected areas. Following the birth of Bangladesh in 1971, the Bangladesh Agricultural Development Corporation (BADC) began distributing low lift pumps (LLP), deep and shallow tubewells to farmers across the country on a rental basis and this increased rapidly. Before 1988, the National Technical Committee (NTC) and Technical Sub Committee (TSC) tested locally made and imported agricultural machines both at field and laboratory levels, ensuring the availability of high-quality standardized machines and equipment suited to local conditions. However, the policy of importing only high quality and high-priced standard agricultural machinery through limited business organizations, restricted the machinery market to limited models, slowing the shift from animal and human to mechanical power. The devastating floods of 1988 killed a large number of draught animals, creating a huge agricultural power shortage, compelling the Government of Bangladesh to resolve to increase agricultural mechanization. This led to removal of restrictions on agricultural machinery imports and the waiving of the mandatory standardization certification requirement. Import duties were withdrawn, restrictions on privatization of minor irrigation removed along with restrictions on irrigation tubewells, and credit facilities liberalized for private importers. There was a huge influx of Chinese-made low-cost agricultural machinery in the country, such as power tillers, diesel engines, motors and spare parts (Ahmed, 1999; Alam, 2005).

This policy change in the 1990s led to a remarkable

diversification in the agricultural machinery sub-sectors of repair, maintenance and manufacturing, benefiting the production of irrigation pumps, engines/motors, power tillers, sprayers, pedal- and engine-operated paddy and wheat threshers, maize-shellers, rice hullers, and poultry and dairy equipment. About 2,000 small- to medium-sized agri-machinery manufacturing enterprises made an immense contribution to this sector in the country. Agri-machinery repair and maintenance were provided by 10,000 small engineering workshops with some 500,000 mechanics (Alam, 2005). However, with no policy guidelines and government support, the subsector's growth was mainly driven by the private sector which also provided repair and maintenance services to farmers.

The Agricultural Mechanization Road Maps for 2021, 2031 and 2041, developed by the Ministry of Agriculture (MoA) mark a key milestone in agricultural mechanization in Bangladesh. Present coverage and targets of mechanization of agricultural operations in the country are listed in Table 3.1.5. prepared by government organizations led by the Bangladesh Agricultural Research Council (BARC). The road map is being implemented by the National Agricultural Research System (NARS) institutes such as the Department of Agricultural Extension (DAE) and others.

Table 3.1.5

Operation-wise mechanization target according to mechanization roadmap

	Agricultural operation	*Coverage (percentage)*	*Mechanization target (percentage)*		
			Short term (2021)	*Medium term (2031)*	*Long term (2041)*
1	Crop planting	<1	20	40	80
2	Seed sowing	3	25	50	80
3	Crop harvesting	2	30	60	80
4	Capacity of irrigation and water management	33	40	50	70
5	Weeding	2	5	15	30
6	Potato planting and harvesting	0.1	10	30	80
7	Jute harvesting and Processing	0	10	30	80
8	Sugar crop plant and harvest	0	10	30	60
9	Crop processing	0	10	30	80
10	Use of renewable energy	1	10	30	50

Source: Agricultural Mechanization Road Map, 2015

The National Agricultural Policy (NAP) approved in 2018 made agricultural mechanization a top priority. Farm mechanization in tillage, spraying and threshing operations has increased significantly but its area should be expanded, while mechanization levels in transplanting, seeding and harvesting are not up to standard.

A government committee was set up in 2017 to prepare guidelines for the National Agricultural Mechanization Policy (NAMP) after thorough discussion with stakeholders, including farmers,

manufacturers, scientists and extensionists.

3.1.2.2. National programmes on agricultural mechanization

The Government of Bangladesh invested in a 30-70 per cent price subsidy incentive in the price of agricultural machinery and distributed 65,329 units of agricultural machinery of various types to farmers.

Farmers in Bangladesh depend mainly on hired, custom or leasing services for machinery used for land preparation, planting, intercultural operations, harvesting, threshing, shelling and transportation (see Table 3.1.6). Seedling preparation, transplanting, weeding, harvesting and winnowing are all done by hired labour. Some entrepreneurs offer machinery rental services for land preparation and threshing. Local service providers in villages are mostly smallholder farmers. There are also service providers who are farmers who invest in equipment for their own use and for hire services (FAO, 2012).

Table 3.1.6

Mode of operation of farm machinery in rice cultivation

Activity	*Method/ machine*	*Mode of operation/ rental system*
Seedlings preparation	Seedlings on seed bed	Hiring labour
	Seedlings on tray	Research trial
Tillage	Tractor	Custom hire
	Power tiller	Custom hire
Levelling	Manual ladder	Ownership
	PT-equipped ladder	Custom hire
Transplanting	Hand transplanting	Hiring labour
	Transplanter	Research trial/ Custom hire
Weeding	Hand weeding	Hiring labour
	Weeding by power weeder	Research trial
Harvesting	Sickle	Hiring labour
	Reaper	Research trial
Threshing	Open drum thresher	Custom hire
	Close drum thresher	Custom hire
Winnowing	Winnowing by *kula**	Hiring labour
	Motor winnower	Research trial

Source: Islam, 2018

* *Kula is a traditional winnowing fan*

3.1.2.3. Current level of agricultural mechanization

Farm mechanization accelerated in Bangladesh with power availability in the farming sector sharply increasing by 8 per cent due to government policy intervention in mechanized cultivation. Government assistance included the introduction and operation of farm machinery at farmers' level, exemption of import tax on some machinery and fund disbursement for machinery research, extension and capacity-building which brought mechanized farm power to the farmers' field (Islam, 2018). At present, 90 per cent of tillage, 75 per cent of threshing, 80 per cent of irrigation, 1 per cent of

harvesting, 5 per cent of fertilizer application, and 3 per cent of seeding and transplanting operations in Bangladesh are mechanized. However, the increasing labour shortage for reaping and transplanting is a great concern, showing the need for appropriate harvesting and planting machinery. There have been a variety of state incentives and policy-related interventions to address the issue.

There has been a significant improvement in the production and marketing of locally made agri-machinery in the country (see Table 3.1.7). Almost all centrifugal pumps are now locally manufactured and used in shallow tube wells (STWs) and LLPs. There are 70 foundries, 800 agri-machinery manufacturing workshops, 1,500 spare parts manufacturing workshops and 20,000 repair and maintenance workshop. The need for production and post-harvest processing machinery has increased significantly. Despite limitations, local production and imports of agri-machinery are increasing at a satisfactory rate.

Table 3.1.7

Bangladesh: farm machinery

	Farm machinery	*Units*
1	Power tiller	700,000
2	Tractor	56,000
3	Seeder	7,500
4	Weeder	250,000
5	Irrigation pump (DTW, STW& LLP)	1,753,453
6	Solar pump	1,100
7	Sprayer	1,300,000
8	Rice transplanter	2,000
9	Combine harvester	1,500
10	Reaper	4,500
11	Open drum thresher	150,000
12	Closed drum thresher	220,000
13	Winnower	2,000
14	USG Applicator	18,000
15	Maize sheller	40,000
16	Sugarcane crusher	50,000

Abbreviations: DTW, deep tubewell; STW, shallow tubewell; LLP, low lift pump.
Source: Hossain, 2019a

However, agricultural machinery use in Bangladesh is still limited and most machines are small. A major reason is the fragmented and small size of farm holdings while their low incomes also make machinery unaffordable for many farmers. A mechanized and energy- efficient conservation agriculture (CA) system is being introduced in many areas of the country, but precision machinery is still to be adopted by farmers. The absence of training programmes for operation, repair and maintenance of agri-machinery has resulted in a scarcity of skilled operators, limiting the adoption of large and advanced machinery like seeder/planter, rice transplanter, reaper and combine harvester.

3.1.2.4. Agricultural mechanization research and development

Sustainable farm mechanization requires the development of machinery suited to local land and socioeconomic conditions. Among the 12 NARS research institutes, coordinated by BARC under the Ministry of Agriculture, the Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural Research Institute (BARI) and Bangladesh Sugar-crop Research Institute (BSRI) are actively involved in the design, development, field-testing, farm-level evaluation, validation, dissemination, feedback collection and modification of farm machinery and technology.

The Farm Machinery and Postharvest Technology Division (FMPE) of BRRI is primarily responsible for the design, development, testing and validation of rice production-related machinery and technology and has developed and disseminated a number of farm technologies and machines to farmers. The FMPE is one of the 16 BARI research divisions and has the main responsibility for developing suitable farm machinery and technology for various agricultural operations, including post-harvest processing for efficient use of limited natural resources. The division has developed 44 farm machines and technologies (Hossain, 2019b). These include the BRRI weeder, BRRI USG applicator, BRRI prilled urea applicator, BRRI rice-wheat reaper, BRRI open drum thresher, BRRI panicle thresher, BRRI rice-wheat thresher, BRRI winnower and the BRRI chopper, which are widely used in the country (Islam, 2018). Scientific research in the division focuses on mechanized production systems suited to maximizing production on decreasing arable land. The division also develops post-harvest processing techniques for different crops, vegetables and fruits, including low-cost post-harvest handling and storage and packaging methods for producers and processors. Replacing fossil fuel with renewable energy in agricultural production is also a research area and the division has developed and successfully tested a solar-powered irrigation pump and the use of non-edible jatropha oil as biodiesel for farm engines. It also regularly tests and evaluates imported and locally-made agricultural machinery and disseminates matured technologies through training, field demonstrations, seminars, workshops, mass media and fairs. Technical training and assistance are provided to local manufacturers to ensure quality and durability (Hossain, 2019b).

The Bangladesh Sugarcrop Research Institute (BSRI) conducts research on sugarcane, palmyra plum, date plum and sugarbeet, the raw material of sugar, jaggery (gur) and cane juice. Its agricultural engineering division has developed an improved power crusher with a juice extraction capacity of 62 per cent and about 50,000 improved power crushers are being used across the country (Ahmed and Karim, 2017).

The Bangladesh Jute Research Institute (BJRI), the oldest mono-crop research institute in Bangladesh has developed a manual and powered double roller jute ribboner and about 30,000 units are being used all over Bangladesh (Ahmed and Karim, 2017).

The Rural Development Academy (RDA) is involved in conducting limited adaptive research on agricultural machinery development and promotion.

The International Rice Research Institute (IRRI), International Maize and Wheat Improvement Center (CIMMYT), CSAM, the United States Agency for International Development (USAID), the South Asian Association for Regional Cooperation (SAARC) Agriculture Centre, FAO, the Department for International Development (DFID) of the UK government and the Korea International Cooperation Agency (KOICA), provide technical and financial support to R&D activities in public institutes in Bangladesh to a limited extent.

Challenges

The lack of a master plan for mechanization of agricultural production and agro-processing activities that is aligned with national food and agricultural policies, irregular and uncertain funding and lack of sustainable inter-institutional collaboration are hindering agricultural mechanization R&D in Bangladesh.

Most NARS institutes have differing roles as autonomous institutes under their own ministries and have differing resource allocations usually made by the controlling ministry with limited research coordination and accountability of cooperation. Research institutes have different research frameworks with no inter-institutional transfer of scientific human resources. The World Bank and FAO recommend raising investment in agricultural R&D in Bangladesh by at least 2 per cent of GDP (Mondal, 2010). Sporadic initiatives by industry to develop and improve agricultural machinery have been hindered by the lack of collaboration with the scientific community and limited financial resources.

3.1.2.5. Import and export of agricultural machinery

All 4WT imports have been from India while 2WT imports mostly come from China with a limited proportion from India and Viet Nam (see Table 3.1.8.). Because of their diversified use, 4WTs are gradually replacing 2WTs.

The early 1990s saw a steady increase in demand for agri-machinery which has grown rapidly in recent years. About 550,000 2WTs are in use in the country of which between 40,000 to 55,000 were imported in 2004-2007, though imports declined afterwards. Importers, wholesalers and retailers are involved in the supply chain of power tillers.

Five large importers based in Dhaka are major suppliers of 2WTs to district wholesale and retail markets. About 95 per cent of 2WTs go to district wholesalers and distributors and only 5 per cent are sold by the importers themselves. District wholesalers and retailers supply 70 per cent stock to the district market and the remaining 30 per cent to other districts and upazila (sub-district) markets (Alam et al., 2017).

Table 3.1.8

Bangladesh: import of tractors

(Units)

Country	*Year*				
	2014	*2015*	*2016*	*2017*	*2018*
Four-wheel tractor					
India	4,515	4,397	6,731	8,800	9,000
Two-wheel tractor					
China	55,568	46,625	31,949	46,201	39,488
India			200	200	
Viet Nam			100	100	

Source: Alam et al., (2017) and MoC import data (2019b)

The increasing demand for harvesting machinery has led to the market becoming more receptive to new machines. All harvesting machinery is imported (see Table 3.1.9). Combine harvesters imported from China hold the major market share because of their relatively low price.

Table 3.1.9

Import of harvesting machinery

(Units)

Country	*Year*				
	2014	*2015*	*2016*	*2017*	*2018*
Combine harvester					
China	5	6	79	1,100	310
India	2	3	7	0	0
Japan	0	0	0	0	52
Republic of Korea	6	10	12	0	0
Others	1	2	2	10	13
Reaper					
China	11	12	4	25	68
India	0	0	0	0	0
Viet Nam	117	586	859	1,056	1866
Taiwan	1	143	88	121	314

Source: Alam et al., (2017) and MoC import data (2019b)

3.1.3. Enabling environment for trade and investment for sustainable mechanization of the agricultural sector

3.1.3.1. Investment environment and policy

Under Bangladesh's liberalized industrial policy and export-oriented, private sector-led growth strategy, all sectors are open for private investment except: (1) arms and ammunition and other defense equipment and machinery, (2) forest plantation and mechanized extraction within reserved forests, (3) nuclear energy and (4) security printing and mining. The Board of Investment (BOI), established by the government for accelerating private investment, provides institutional support services to intending investors.

Foreign investment in Bangladesh is regulated by the Foreign Private Investment (Promotion and Protection) Act 1980 which guarantees non-discriminatory treatment between foreign and local investment, and repatriation of proceeds from sales of shares and profit.

Bangladesh has bilateral agreements to avoid double taxation and investment treaties for promotion and protection of investment with Albania, Algeria, Belarus, Brazil, Bulgaria, Cambodia, China, Democratic People's Republic of Korea, Egypt, Germany, Hungary, Indonesia, Iran (Islamic Republic of), Iraq, Kenya, Kuwait, Malaysia, Mali, Morocco, Poland, Republic of Korea, Romania, Senegal, Sudan, Thailand, Türkiye, Uganda, Ukraine, United Arab Emirates, United States of America, Uzbekistan, Viet Nam and Zimbabwe.

Tax holidays of between 5 and 7 years are offered, depending on the location of the industrial enterprise – 5 years in Dhaka and Chittagong division (excluding Hill Tract Districts) and 7 years in Khulna, Sylhet, Barisal, Rajshahi and 3 Chittagong hill districts. The tax holiday period is calculated from the month of commencement of commercial production. The National Board of Revenue (NBR) issues tax holiday certificates within 90 days of application. Tax exemption is provided on royalties, technical know-how fees received by any foreign collaborator, firm, company and expert. Foreign

technicians working in industries listed in the applicable income tax schedule are eligible for income tax exemption for up to 3 years. Power generation in the private sector is eligible for tax exemption of 15 years from the date of commercial production. Capital gains tax exemption for transfer of public limited companies' shares is listed with the stock exchange.

Industrial businesses not eligible for a tax holiday enjoy an accelerated depreciation allowance at the rate of 100 per cent of the machinery or plant cost if the industry is located within Dhaka, Narayangonj, Chittagong and Khulna and areas within a radius of 16.09 km from the municipal boundaries of these cities. Import duty on capital machinery and spare parts for initial industrial installation is 5 per cent but the cost of spare parts should not exceed 10 per cent of the machinery's total value of cost and freight (C&F). Industries that are 100 per cent export-oriented are exempt from duty for import of machinery and spare parts listed in relevant NBR notifications.

a. Public-private partnership in sustainable agricultural mechanization

Bangladesh pioneered public-private partnerships (PPPs) in South Asia in the 1990s and the Second Country Investment Plan (CIP2) encourages such collaboration through information- and knowledge-sharing between the private sector and the government. The Bangladesh Public Private Partnership Act 2015 enacted as part of the vision 2021 goal offers a conductive legal framework. The government aims to build strong bilateral ties to establish and upgrade large public infrastructure resources through PPPs involving other countries as set out in the Government-to-Government (G2G) Partnership Policy for Implementing PPP projects, 2017.

The PPP approach is used for R&D by BARI to fabricate farm machinery using locally available material. Thus, BARI is working with RK Metal and Faridpur to improve and adopt seeder technology, with Janata Engineering Workshop, Chuadanga, to develop a potato planter/harvester and chopper and combine harvester, with Alam Engineering Workshop, Dhaka, to develop a manual rice transplanter and power weeder, and with Farida Engineering Workshop, Bogra, to develop a panicle thresher. Local manufacturers often modify farm machinery according to farmers' demands with technical assistance from research institutes in the form of design, drawing, technical expertise, suggestions and field testing.

b. Role of agricultural machinery manufacturers', dealers' and distributors' associations

There is a lack of skilled and experienced workers and managers at almost all levels of manufacturing, repair and maintenance of agricultural machinery, including a lack of knowledge and skills on heat treatment, metal casting and fabrication. There are not sufficiently qualified graduate engineers, resulting in a scarcity of design, drawing, manufacturing process and quality control knowledge and skills. Inexperienced small enterprises suffer losses due to low quality production, delayed product delivery and increased raw material waste, among others.

The Agricultural Machinery Manufacturer's Association–Bangladesh (AMMA-B) was established in 2005 to promote standardized production and coordinates with Ministry of Agriculture entities and other organizations for R&D, testing, technical evaluation and promotion of agricultural, plantation and agro-processing machinery and equipment. The Association also explores export possibilities, lobbies for appropriate national policies and helps implement the government's vision for agricultural mechanization, including through demonstrations and road shows for newly developed machinery and technologies. It

also collaborates with the government on agriculture subsidy projects.

c. Sustainable agricultural mechanization technology initiatives

Spanning various sectors and regions, Bangladesh introduced a series of sustainable agricultural mechanization technology initiatives; these endeavors have been pivotal in reshaping and enhancing the agricultural landscape of the country. Here are some notable examples of these initiatives:

From 2009 to 2014, the Farm Machinery Technology Development and Dissemination Project (FMTDDP) implemented by BARI, BRRI, and DAE focused on providing farmers with machinery, training, and subsidies, all manufactured within Bangladesh.

Following this, the FAO-led Emergency Sidr Cyclone Recovery and Restoration Project (ECRRP) operated from 2010 to 2014, funded by the World Bank and implemented in the southern region.

Between 2011 and 2016, the Integrated Productivity Project (IAPP) overseen by MoA targeted both the northern and southern regions, aiming to enhance productivity levels.

Continuing into the present, the Cereal Systems Initiative for South Asia in Bangladesh – Mechanization and Irrigation (CSISA-MI) has been ongoing since 2014, led by CIMMYT alongside International Development Enterprises (IDE) and USAID in the southern region.

From 2013 to 2018, the Enhancement of Crop Production through Farm Mechanization Project (Phase II) was undertaken by DAE throughout Bangladesh, providing substantial subsidies on listed machinery to selected farmers, thus significantly impacting agricultural practices nationwide. A total of 28,787 machine units were distributed, including 13,182 power tillers, 7,351 power threshers, 3,988 reapers, 1,128 combine harvesters, 74 rice transplanters, 1,964 seeders and 1,100 fot pumps. Phase III of this project was under special consideration by the government at the time of finalization of this study.

Lastly, from 2016 to 2018, the Appropriate Scale Machinery Innovation Hub, funded by USAID, was established in the southern region to promote the adoption of suitable mechanization technologies.

3.1.3.2. Trade environment and policy

a. Risk management

Situated in the low-lying delta of Indo-Gangetic plains with more than 300 rivers flowing across it, Bangladesh is highly vulnerable to floods, tidal surges and cyclones which badly affect crop production (Ahmed, 2017). Heavy rainfall, floods, extreme temperature patterns and droughts have been changing cropping patterns in the country, affecting productivity and changing water and land use patterns. Bangladesh could lose up to 15 per cent of its land area to the sea and about 30 million people living in coastal areas could lose their lands with a one-metre rise in sea level due to climate change. Salinity intrusion already affects 100 km of inland area during the dry season (Ahmed, 2017). Bangladesh's vulnerabilities to climate change and sea level rise have been well studied. The World Bank estimates, using the Bay of Bengal in a hydro-dynamic model, that areas and population vulnerable to cyclones in Bangladesh will increase by 26 and 122 per cent, respectively, by 2050 (Ahmed et al., 2015). If either the rain-fed summer rice crop (Aman) or the irrigated winter rice crop (Boro) or both substantially fail in a year, it may cause massive food insecurity leading to economic, social and even political instability.

Government initiatives

Bangladesh was the first South Asian country to set up a separate Disaster Management Bureau (DMB) in the early 1990s and the Comprehensive Disaster Management Programme (CDMP) was launched by the Ministry of Food and Disaster Management. Renamed in 2012 the Ministry of Disaster Management and Relief (MoDMR) as part of reform of the disaster management approach, the ministry and its line agency, Department of Disaster Management, coordinate national disaster management across all agencies. The CDMP is supported by the United Nations Development Programme (UNDP), the European Union (EU), DFID, UKAid, AusAid, the Swedish International Development Agency and the Norwegian Embassy, and also addresses agricultural sector risk management. The Government of Bangladesh is collaborating with FAO in promoting disaster resistant cropping systems (Ahmed et al., 2015) and FAO is also promoting 'climate smart agriculture' in the country.

Various climate change adaptation initiatives of the government have won global recognition and cited as best practices. Climate change adaptation was a priority of the 7th Five Year Plan (2016-2021) and the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) has been synergized with the Plan. A BCCSAP priority area of adaptation is government financial support to the agricultural sector to ensure food security. The National Adaptation Programme of Action (NAPA) implemented with UNDP support was highly successful in promoting agricultural adaptation in the coastal zone through community level horticulture, livestock and forestry-related activities and the project won the United Nations Framework Convention on Climate Change (UNFCCC) Best Practices Award on Adaptation (Ahmed et al., 2015). The government has allocated about Tk 40 million to promote renewable technologies in Bangladesh as part of its low-carbon commitment. Solar-powered irrigation pumps funded by this grant, are being installed to replace diesel-operated irrigation pumps. Part of the fund is also regularly allocated for post-disaster aid and to subsidize fuel, fertilizer and other farm inputs for poor farmers.

Insurance

The insurance sector in Bangladesh emerged after the nation's birth in 1971 with two nationalized insurance companies providing life insurance and general insurance. Private sector companies began entering the industry in the mid-1980s and 62 companies now operate under the Insurance Act 2010, of which 18 deal with life insurance, including a foreign and a state-owned company; and 44 are general insurance companies, including a state-owned company. Insurance companies in Bangladesh also provide reinsurance, micro-insurance and takaful or Islamic insurance. General insurance companies offer coverage for agricultural vehicles and some agricultural machinery. In some cases, cattle and/or dairy and poultry farms take out risk management service. Proposals are under discussion to provide insurance for crop-based agricultural farms.

b. Regional trade agreements

Bangladesh is a member of the World Trade Organization (WTO) since January 1, 1995, and also of the Asia-Pacific Trade Agreement (APTA), a preferential regional trade agreement which aims for mutually beneficial trade liberalization measures that contribute to regional trade expansion and economic cooperation (ESCAP, 2019).

Bangladesh is also a signatory to the Multilateral Investment Guarantee Agency (MIGA), the US Overseas Private Investment Corporation (OPIC), the International Centre for Settlement of Investment Disputes (ICSID) and a member of the World Intellectual Property Organization (WIPO) permanent committee on development cooperation

related to industrial property.

3.1.3.3. Infrastructure and financial development

a. Infrastructure development

A well-developed rural infrastructure, including good irrigation networks, uninterrupted power supply, transport and storage systems, reliable access to energy and information and communication technologies, can attract private investment in agriculture and increase the sector's competitiveness.

An estimated 85 per cent of agricultural land in the country has access to irrigation, powered by diesel engines and electric motors. Irrigation water systems are mostly open channel and plastic irrigation pipes are popular during winter. Most rural roads are underdeveloped and accessibility to agricultural fields is not possible for big machinery like combine harvesters. Despite supply interruptions, about 90 per cent of villages have access to electricity for household use and irrigation power. The government aims to meet 10 per cent of national energy demand with renewable energy by 2020 and 50 per cent by 2050.

The Water Resources Planning Organization (WARPO) estimates that Bangladesh annually receives about 5.5 m of water from surface flow and 2 m from rainfall, of which about 90 per cent is available from June to September and the remaining from October to May. Therefore, while Bangladesh has access to sufficient rainwater for agriculture, it also suffers flooding during the cultivation seasons. Irrigated agriculture is supported by flood-control measures with 64 per cent of cultivable areas under irrigation and this can be increased up to 76 per cent of the country's water potential. About 79 per cent of irrigation uses groundwater due to fluctuation in the availability of surface water and lack of control over it. There is an irrigation development potential of up to 6.55 Mha (megahectare) which can be realized by 2025 and further increased to 7.45 Mha.

Groundwater irrigation, surface water utilization and rural roads development for agricultural mechanization in the country's north-western areas is the responsibility of the Barind Multipurpose Development Authority (BMDA). The Bangladesh Agricultural Development Corporation (BADC) is responsible for supplying inputs to farmers especially seeds, fertilizer, and irrigation and for making suitable arrangements throughout Bangladesh on a commercial basis, for the procurement, transport, storage and distribution of farming inputs, plant protection equipment and agricultural machinery and implements. This involves managing seed multiplication, livestock breeding farms and fruit nurseries and promoting manufacture of improved agricultural machinery and implements.

The Local Government Engineering Department (LGED) develops water distribution infrastructure, working with other government organizations and NGOs and also builds and maintains rural roads, bridges, culverts, union parishad (council) centres and cyclone shelters. Rural roads and bridges are key for agricultural machinery transport and LGED has to design these accordingly.

In 2018, Bangladesh had 30.3 million consumers connected to the grid with an electrification level of almost 90 per cent and the government aimed at full electrification by the end of 2021. Electricity generation is mainly from natural gas (60.89 per cent) while furnace oil, diesel, coal, hydropower and other renewable sources account for 21.58 per cent, 8.65 per cent, 3.28 per cent, 1.44 and 0.02 per cent, respectively. Electricity generation from renewable sources amounted to 288 MW. Electricity is produced by the national Power Development Board (PDB) and distributed in rural areas by the Rural

Electrification Board (REB). There are 0.36 million irrigation pump connections, including 317,351 electric pumps and tubewells of which 10.45 per cent are deep tubewells (DTWs), 86.26 per cent are shallow tubewells (STWs) and 3.29 per cent are LLPs. There are also 1,453,515 diesel STWs. Increased use of solar irrigation pumps is being encouraged to reduce the carbon footprint of agriculture.

b. Financial support to agriculture and sustainable agricultural mechanization

Bangladesh's widespread bank network has improved competition by attracting deposits and providing credit facilities across all sectors. Agricultural credit is offered for both working capital requirements as well as for capital expenditure, and to a limited extent, the bank has included equipment/machinery. Bangladesh Bank, the central bank, set an agricredit target of Tk 21,800 crore (1 crore = 10 million) for the 2018-2019 fiscal year. In 2017-18, all scheduled commercial banks disbursed Tk 21,393.55 crore in agricultural credit (Bangladesh Bank, 2018). Interest on agricultural loan ranges from 4 to 9 per cent for all banks (Ali et al., 2015).

A total of 34 non-bank financial institutions, regulated by the Financial Institution Act, 1993 and controlled by Bangladesh Bank, operate in Bangladesh. The Insurance Development and Regulatory Authority (IDRA) was set up on 26 January 2011 to regulate the insurance industry under the Insurance Development and Regulatory Act, 2010. Non-governmental microfinance institutions (NGO-MFIs) are regulated by the Microcredit Regulatory Authority Act, 2006 which set up the Microcredit Regulatory Authority (MRA) to ensure transparency and accountability of NGO-MFI activities (Bangladesh Bank, 2019d).

The informal sector plays an important role in providing credit to farmers due to the advantages of unregulated money supply, easy accessibility, easy liquidity, low 'administrative' and procedural costs, little or no collateral/mortgage requirements, flexible interest rates and repayment schedules. Cooperative societies and development banks are also important rural credit sources (Srinivas, 2019).

3.1.4. Summary, conclusions and recommendations

Bangladesh is giving a new direction to agricultural development in the face of decreasing land and labour availability and growing climate change risks, by opening up investment opportunities at various stages of the agricultural value chain. Institutional support is being provided to sustainable agricultural mechanization, including through subsidies for the agricultural mechanization business, resulting in prompt adoption of modern agricultural machinery. There is tremendous scope for investment in local agricultural machinery production in Bangladesh, but policy support is needed.

Bangladesh is encouraging foreign investment in a range of sectors including agriculture, with tax holidays ranging from 5 to 7 years for industries and income tax exemptions for up to 3 years for foreign technicians. Free trade facilities with bilateral agreements and international cooperation are creating a better trade environment in Bangladesh for foreign or local investors. Public-private partnerships between stakeholders are being encouraged with a legal framework enacted in the Bangladesh Public Private Partnership Act 2015.

But little interest has been reported in investing in the agriculture machinery sector. Farmers are often reporting a credit shortfall for purchasing quality machinery. Despite much improvement in credit access for farmers including central bank directives to banks to facilitate lending and a Tk 10 bank account for every farmer where government

incentives are credited directly, the system needs to be modernized, requiring fewer visits to government offices. Direct remittance of payment for custom hire services for agricultural machinery into farmers' bank accounts, as with mobile banking, will allow the lending bank to track the use of modern agricultural machinery. This would encourage innovative local entrepreneurship. Non-governmental organizations can also work with farmers to prepare them with knowledge and training to make proper use of the monetary help being extended to them to promote agricultural mechanization and create employment opportunities for youth through the use of modern agri-machinery.

The Agricultural Machinery Manufacturer's Association of Bangladesh also needs to increase collaboration with vendors, especially local artisan-level manufacturers of agricultural machines to promote development of quality and low-cost machines.

The government needs to sustain support for mechanization as with the DAE-implemented Enhancement of Crop Production through Farm Mechanization Project (Phase II) in 2013-2018 which led to significant changes in agricultural mechanization throughout Bangladesh through extensive technology dissemination and 50-70 per cent subsidies.

Recommendations

Considering the current trend of sustainable agricultural mechanization adoption in Bangladesh, the following recommendations can accelerate the process.

a) Development incentives. These have been found to encourage farmers to adopt mechanization and should be continued. Incentives are now limited to the crop sector and should be expanded to livestock and fisheries.

b) Special programmes to promote local agri-machinery manufacture through assistance for capital outlay on machine and technical training.

c) A policy of tax exemptions for local machinery manufacturers for import of critical spare parts and sales.

d) Strengthened R&D for mechanization of all agricultural subsectors and enhanced technical know-how and financial access for the research. Bangladesh lacks a scientific and institutional set-up for mechanization R&D for livestock and fisheries. A national agricultural machinery research institute is needed to address lacunae in agricultural mechanization.

e) Testing and standardization of machinery should resume for quality control of imported and locally produced agri-machinery and the establishment of a standardization and testing centre should be prioritized. The regional testing codes could be adopted, and national testing codes developed at the same time.

f) Establishing an assembly unit for different international agri-machinery brands offers great scope for utilizing low-cost local labour as with the garment industry revolution in Bangladesh. This will also develop backward linkages with light engineering industries to support the assembly process.

g) The after-sales service system should be modernized to ensure the economic life of the machinery.

h) Sophisticated technology like precision agriculture-based machinery should be prioritized.

i) Increased training for farmers, machinery operators and mechanics.

j) Easy credit access for trained farmers, service

providers and traders to increase machinery adoption and its profitable utilization for efficient mechanization of agriculture.

3.2. Indonesia

3.2.1. Overview of the agricultural sector

Indonesia, an archipelagic nation spreading across 9.8 million km^2, has a sea area of 7.9 million km2, including an exclusive economic zone, and a land area of about 1,9 million km². The Indonesian landmass comprises 16,056 islands, including five big islands, namely Sumatera, Java, Kalimantan, Sulawesi and Papua (see Table 3.2.10.) Its neighbours are Malaysia, the Philippines, Singapore, Thailand and Viet Nam. It has the Indian Ocean on the west, Australia and Timor-Leste on the south-west and Papua New Guinea and the Pacific Ocean on the east (Badan Pusat Statistik. Statistik Indonesia 2015, 2018)

The population of Indonesia was 261.89 million in 2017, making it the fourth most populous country (Badan Pusat Statistik. Statistik Indonesia. Statistical Yearbook of Indonesia, 2018).

Table 3.2.1

Indonesia: total land area, population and population growth in bigger islands

Islands	*Population*		*Annual population growth (percentage)*	*Area (square kilometre)*	*Percentage of total land area*
	2010	*2017*	*2010-2017*		
Sumatera	50,631 000	56,950 500	1.78	480,773.28	25.08
Java	136,610 700	148,173 100	1.21	129,438.28	6.75
Kalimantan	13,787 800	15,924 100	2.21	544,150.07	28.39
Sulawesi	17,371 800	19,219 200	1.52	188,522.36	9.34
Papua	3,593,800	4,180,600	2.33	421,991.20	22.01
Others islands: (Bali & Nusa Tenggara)	13,074 800	14,489 400	1.55	74,116.01	4.11
Maluku	2,571,600	2,954,000	2.12	77,871	4.32
Total	**237,641 500**	**261,890 900**	**1.34**	**1,916,862.20**	**100.00**

Source: 1. Badan Pusat Statistik. Statistik Indonesia 2015; Luas Lahan Menurut Penggunaan. Land Area by Utilization 2015; 2. Badan Pusat Statistik. Statistik Indonesia; Statistical Yearbook of Indonesia 2018

Java, with a land area of 129,438.28 km² or 6.75 per cent of Indonesia's total land area, is home to 148.17 million people or 57 per cent of the total population.

Table 3.2.2

Indonesia: key social and economic statistics, 2013–2017

		Year				
		2013	*2014*	*2015*	*2016*	*2017*
Social						
Population	*(million)*	248.8	252.2	255.5	258.7	261.9
Population growth	*(percentage)*	1.37	1.35	1.31	1.27	1.34
Economic						
GDP at current price	*(trillion rupiah)*	9,546.1	10,569.7	11,526.3	12,406.8	13,588.8
Growth	*(percentage)*	5.6	5.0	4.9	5.0	5.1
Per capita GDP at current price	*(million rupiah)*	38.4	41.9	45.1	48.0	51.9
Inflation	*(percentage)*	8.4	8.4	3.4	3.0	3.6
Export	*(billions of US dollars)*	182.6	176.0	150.4	145.2	168.8
Import	*(billions of US dollars)*	186.6	178.2	142.7	135.7	157.0

Source: Badan Pusat Statistick. Statistick Indonesia. Statistical Year Book of Indonesia 2018

The annual population growth was 1.34 per cent in 2017 and the economy grew at 5.1 per cent with steady growth in agriculture, forestry, livestock, fishery and agricultural products manufacturing. The gross domestic product (GDP) increased rapidly by about 42.35 per cent from Rp 9,546,134.0 billion in 2013 to Rp 13,588,797.3 billion in 2017. Inflation fell from 8.4 per cent in 2013 to 3.6 per cent in 2017 (see Tables 3.2.2 and 3.2.3). Indonesia has a current account surplus because of higher exports than imports due to increased export of agricultural estate crops.

Table 3.2.3

Gross Domestic Product at current market prices by industry, 2013–2017

(Billions of rupiah)

Business field	*Year*				
	2013	*2014*	*2015*	*2016*	*2017*
A. Agriculture, forestry and fishing	1,275,048.4	1,409,655.7	1,555,207.0	1,671,330.3	1,785,880.7
1. Agriculture, livestock, hunting, and agriculture service	994,778.4	1,089,549.7	1,183,968.6	1,266,848.6	1,344,732.2
a. Food crops	332,111.9	343,252.3	397,408.6	425,179.1	437,803.6
b. Horticulture crops	137,368.8	160,568.6	174,45 3.2	187,402.6	196,131.7
c. Estate plantation crops	358,172.4	398,260.7	405,291.5	428,782.6	471,307.8
d. Livestock	147,981.9	167,008.0	184,151.5	201,085.5	213,468.1
e. Agriculture service and hunting	19,143.4	20.460.1	22,663.8	24,398.8	26,021.0
2. Forestry and logging	69,599.2	74,618.0	82,321.8	87,389.9	91,618.2
3. Fishing	210,670.8	245,488.0	288,916.6	317,091.8	349,530.3
B. Manufacturing of agriculture product	998,352.7	1,135,147.1	1,135,147.1	1,397,468.0	1,527,943.6
1. Manufacture of food products and beverages	491,142.4	562,016.6	647,071.9	740,810.2	834,402.7
2. Manufacture of tobacco products	82,684.3	95,668.1	108,651.6	117,086.3	121,986.2
3. Manufacture of leather and related products	24,810.0	28,600.2	31,440.9	35,214.1	36,988.0

4. Manufacture of wood and wood and cork products, straw articles and plaiting material	66,958.0	76,071.9	77,993.4	80,077.6	81,582.9
5. Manufacture of paper and products; printing and reproduction of recorded media	74,319.0	84,372.5	87,760.4	89,650.0	97,060.0
6. Manufacture of chemicals, Pharmaceutical and botanical products	157,042.1	180,037.2	209,788.2	223,404.7	236,186.4
7. Manufacture of rubber and products and plastic products	76,466.3	80,262.9	85,951.4	79,100.9	85,868.8
8. Manufacture of furniture	24,930.6	28,117.7	31,339.7	32,124.2	33,868.6
C. Mining and quarrying	1,050,745.8	1,039,423.0	881,694.1	890,868.3	1,028,772.2
D. Manufacture of Coal and refined petroleum products, textiles, basic metals and others	1,009,074.1	1,092,436.9	1,138,894.2	1,147,735.5	1,211,471.4
E. Electricity and gas	98,686.8	114,905.1	129,833.7	142,344.4	162,339.9
F. Water supply, sewerage, waste management and remediation	7,209.0	7,840.6	8,546.3	8,942.5	9,720.3
G. Construction	905,990.5	1,041,949.5	1,177,084.1	1,287,659.3	1,409,833.8
H. Wholesale and retail, repair of motor vehicles and motorcycles	1,261,145.6	1,419,239.4	1,532,876.7	1,635,259.0	1,767,718.3
I. Transportation and storage	375,305.9	466,968.9	578,464.3	644,999.5	735,229.6
J. Accommodation and food service activities	289,498.3	321,062.1	341,555.8	353,055.5	387,467.1
K. Information and communications	341,009.4	369,457.3	406,016.5	449,188.9	515,888.9
L. Financial and insurance activities	370,131.9	408,438.8	464,399.9	520,087.5	571,128.5
M. Real estate	264,275.0	294,573.4	327,601.4	350,488.2	379,782.5
N. Business	144,604.1	165,990.6	190,267.9	211,623.6	238,217.0
O. Public administration and defense, compulsory social security	372,195.0	404,629.6	449,382.4	479,793.6	502,238.9
P. Education	307,862.3	341,818.4	387,611.4	418,346.8	446,785.3
Q. Health and social work	96,881.3	109,147.2	123,191.5	132,544.6	144,966.5
R. Other services	140,315.5	163,548.8	190,581.0	211,455.6	239,122.0
Gross value added at basic prices	9,308,331.6	10,306,232.4	11,163,205.7	11,963,191.1	13,064,506.5
Taxes less product subsidies	237,802.4	263,472.9	363,127.1	443,583.0	524,290.8
Gross Domestic Product	9,546,134.0	10,569,705.3	11,526,332.8	12,406,774.1	13,588,797.3

Source: Badan Pusat Statistik. Statistik Indonesia. Statistical Yearbook of Indonesia 2018

3.2.1.1. Agricultural production system

There were 15,416,748 food crop farmers in Indonesia in 2017, who were members of 589,371 farmer groups (FGs) organized in several clusters focused on the production of agricultural commodities and agricultural product processing for agribusiness (Badan Pusat Statistik. BPS Statistics Indonesia, Statistik Indonesia Statistical Yearbook of Indonesia, 2018).

Indonesia's total arable land of 37,052,575 ha (Badan Pusat Statistik BPS-Statistics Indonesia, Statistik Indonesia Statistical Yearbook of Indonesia 2015) comprises 8,087,373 ha of wetland paddy fields and 28,965,182 ha of dryland area for food crops (see Table 3.2.4). Irrigated wetland paddy fields cover 4,751,091 ha and non-irrigated wetland paddy fields cover 3,336,202 ha. The annual food crops harvest is cultivated on 11,846,954 ha of dryland and shifting cultivation for annual food crops covers 5,172,502 ha.

Table 3.2.4

Indonesia: arable wetland and dryland, 2015

(Hectares)

Wetland paddy field (area)				*Dryland for food crops (area)*			
Island	*Irrigated*	*Non-irrigated*	*Total wetland*	*Dryland*	*Shifting cultivation*	*Bareland (temporary unused)*	*Total*
Sumatera	1,057,473	1,143,477	2,200,950	3,571,076	1,487,775	2,361,979	7,420,830
Java	2,418,162	805,341	3,223,503	2,683,582	321,391	40,586	3,045,559
Kalimantan	164,954	890,923	1,055,877	897,250	429,265	846,076	2,172,591
Sulawesi	690,825	318,628	1,009,453	1,671,874	692,282	3,845,549	6,209,705
Papua	9,221	45,367	54,588	1,621,011	736,380	878,294	3,235,685
Bali, Nusa Tenggara	388,884	128,942	517,851	996,202	484,613	911,143	2,388,958
Maluku	21,572	3,624	25,196	405,959	1,020,796	3,062,099	4,488,854
Total	4,751,091	3,336,302	8,087,393	11,846,954	5,172,502	11,945,726	28,965,182

Source: 1. Badan Pusat Statistik. Statistik Indonesia 2015. Luas Lahan Menurut Penggunaan. Land Area by. Utilization 2015; 2. Badan Pusat Statistik. Statistik Indonesia. Statistical Year Book of Indonesia. 2018

Indonesia has constructed several large dams to irrigate 3,336,302 ha of rainfed lowland area of the 11,846,954 ha dryland. This will help in land development, including construction of terraces, contour farming and building small dams or ponds as water reservoirs for the dry season.

The total rice harvest area increased from 12,496,000 ha in 2009 to 15,157,000 ha in 2016 (see Table 3.2.5). Although total rice production increased significantly from 34,808,000 tons in 2009 to 49,169,000 tons in 2016, Indonesia had to import 2,500,000 tons rice to fill the supply-demand gap. Rice field data for 2008 (Alsin Road Map 2009-2013, 2008 Ministry of Agriculture), shows that rice fields covered an area of 2,985,819 ha in Sumatera, 1,093,080 ha in Kalimantan, 3,519,115 ha in Java, 743,874 ha in Sulawesi, 139,997 ha in Bali, 35,196 ha in Nusa Tenggara, 14,906 ha in Maluku and 29,148 ha in Papua, and a total of 8,961,135 ha in Indonesia.

Since 2014, Indonesia has built several new dams for electricity and irrigation in Java, Sulawesi and East of Nusa Tenggara. Agricultural infrastructure has also been provided, including village roads and irrigation and drainage systems, while the government has subsidized fertilizers, seeds, pesticides and irrigation. The harvested area of rice changed from 11,790,000 ha in 2000 to 11,430,000 ha in 2007 and then increased to 12,327,400 ha in 2008 and 12,955,000 ha in 2013.

Table 3.2.5

Indonesia: harvested rice area and rice and grain production and imports

(Thousands of hectares, thousands of tons)

Year	*Rice harvest area*	*Paddy yield (tons per hectare)*	*Total grain production*	*Total rice production*	*Imports*
2000	11,790	4.40	51,876	32,130	1,512
2001	11,500	4.39	50,485	31,891	1,404
2002	11,520	4.47	51,494	32,130	3,703
2003	11,480	4.54	52,119	32,535	1,620
2004	11,920	4.53	53,998	33,690	237
2005	11,840	4.57	54,109	33,765	180
2006	11,870	4.61	54,721	34,145	208
2007	11,430	4.65	53,150	33,153	1,000
2008	12,327	4.81	59,330	38,310	-
2009	12,496	4.46	55,780	34,808	-
2010	12,611	4.46	56,229	35,088	-
2011	12,726	4.45	56,682	35,371	2,750
2012	12,840	4.45	57,138	35,656	-
2013	12,955	4.45	57,598	35,943	-
2014	13,797	5.14	70,846	43,895	-
2015	14,117	5.34	75,398	46,715	-
2016	15,157	5.24	79,358	49,169	2,500

Source: Badan Pusat Statistik. Statistik Indonesia. Statistical Year Book of Indonesia 2004; 2009; 2013; 2018

Rice production gradually increased from 32,130,000 tons in 2000 to 33,153,000 tons in 2007. Production increased significantly to 38,310,000 tons in 2008 due to highly favorable climate conditions and water optimization for irrigating wetland paddy fields, enabling Indonesia to produce a surplus of rice again since 1984. Harvested area and production of rice has increased steadily because of new irrigation dams. Rice cropping area increased from 13,797,000 ha in 2014 to 14,117,000 ha in 2015 and to 15,157,000 ha in 2016 while production grew significantly from 43,895,000 tons in 2014 (35,943,000 tons in 2013) to 46,715,000 tons in 2015 and 49,169,000 tons in 2016. Although it is the world's fourth largest rice producer, Indonesia still imports about 2,500,000 tons of rice annually because of increasing domestic consumption. In several districts, consumption of traditional local staple food has been replaced by rice consumption. Thus, it is important to increase the net income of the Indonesian people to diversify diets and to maintain a rice buffer stock.

Table 3.2.6

Indonesia: production, area and yield of food crops

(Thousands of tons, thousands of hectares, tons per hectare)

Crop	*Year*					*2012-2016 growth (percentage)*
	2012	2013	2014	2015	2016	
Paddy						
Production	57,138.00	57,598.00	70,846.00	75,389.00	79,358.00	14.92
Area	12,840.00	13,835.00	13,797.00	14,117.00	15,157.00	12.72
Productivity	4.45	4.45	5.14	5.34	5.24	1.95
Corn						
Production	19,387.00	18,512.00	19,008.00	19,612.00	23,578.00	21.62
Area	3,958.00	3,822.00	3,837.00	3,787.00	4,444.00	12.28

Productivity	4.90	4.84	4.95	5.18	5.31	8.32
Soybean						
Production	843.00	780.00	955.00	963.00	675.00	-19.93
Area	568.00	551,00	616.00	614.00	446.00	-21.48
Productivity	1.48	1.42	1.55	1.57	1.51	1.97
Peanut						
Production	713.00	702.00	639.00	605.00	510.00	-28.47
Area	560.00	519.00	499.00	454.00	393.00	-29.82
Productivity	1.27	1.35	1.28	1.33	1.30	1.92
Mung bean						
Production	284.00	205.00	245.00	271.00	190.00	-33.10
Area	245.00	182.00	208.00	229.00	162.00	-33.88
Productivity	1.16	1.13	1.18	1.18	1.17	1.18
Cassava						
Production	24,177.00	23,937.00	23,436.00	21,801.00	20,400.00	-15.62
Area	1,130.00	1,066.00	1,003.00	950.00	840.00	-25.66
Productivity	21.40	22.45	23.37	22.95	24.29	13.51
Sweet potato						
Production	2,483.00	2,387.00	2,383.00	2,298.00	2,136.00	-13.98
Area	178.00	162.00	157.00	143.00	122.00	-31.46
Productivity	13.95	14.73	15.18	16.07	17.51	25.51

Source: 1. Food Crop Statistics, Ministry of Agriculture, 2012–2017; 2. Badan Pusat Statistik. Statistik Indonesia. Statistical Yearbook of Indonesia 2018

Although rice and corn production has been increasing (see Table 3.2.6), Indonesia faces increasing demand for rice as the main staple food and for corn as poultry feed.

The main seasonal vegetables and fruits are whole onion, shallot, spinach, chili, string bean, kangkong, potato, cucumber, cabbage, eggplant, tomato, Chinese cabbage, carrot, watermelon and melon. In 2017, shallots were planted on 158,172 ha, producing 1,470,154 tons; chili on 620,294 ha, producing 4,718,882 tons; potato on 75,611 ha, producing 1,164,743 tons; cabbage on 90,838 ha, producing 1,442,631 tons; tomato on 43,905 ha, producing 962,856 tons and watermelon on 32,558 ha, producing 499,475 tons. (Badan Pusat Statistik. Statistik Indonesia 2018).

The main fruits and vegetables harvested in 2017 were durian (795,211 tons), orange (4,590,650 tons), mango (2,203,793 tons), jackfruit (656,583 tons), pineapple (1,795,983 tons), papaya (875,112 tons), banana (7,162,685 tons), rambutan (523,704 tons) and salak (953,853 tons) (Badan Pusat Statistik. Statistik Indonesia, 2018).

Table 3.2.7

Number of large state crop companies, 2013-2017

Crop	*2013*	*2014*	*2015*	*2016*	*2017*
Perennial					
Rubber	315	315	316	315	320
Coconut	107	107	107	107	107
Oil palm	1,601	1,601	1,600	1,592	1,694
Coffee	89	89	91	89	92
Cocoa	86	86	85	80	78
Tea	96	96	98	97	94
Clove	52	52	52	52	52

Kapok	1	1	1	1	1
Cinchona	2	2	2	1	1
Seasonal					
Sugar cane	97	97	98	98	98
Tobacco	6	6	8	7	7

Source: Badan Pusat Statistik. Statistik Indonesia. Statistical Yearbook of Indonesia 2018

In 2017, a total of 1,694 large estate crop companies actively managed palm plantations over a total area of 8,417,300 ha with a production of 30,112,100 tons of bunch palm fruits (see Tables 3.2.7 and 3.2.8). Indonesia has both the world's largest area under palm plantations and palm fruit production. Together with smallholder estate crops, Indonesia had a total of 14,030,600 ha of estates, producing 45,385,100 tons of bunch palm fruit. The second important perennial estate crop is rubber. In 2017, there were 320 large estate crop companies cultivating 555,800 ha, which produced 630,200 tons of rubber. When combined with smallholder rubber production, Indonesia is the world's third largest rubber producer.

In 2017, a total of 107 large estate crop companies had coconut plantations over 36,200 ha, producing 32,300 tons (Statistical Yearbook of Indonesia 2018). Large estate crop companies are also cultivating coffee, cocoa, tea, clove, sugarcane and tobacco. In 2017, there were 92 companies which produced 32,000 tons of coffee grain over an area of 48,900 ha. Another 78 companies produced 29,200 tons of cocoa grain on 42,800 ha, while 94 companies produced 90,900 tons of tea leaves on 61,300 ha, another 52 companies produced 2,000 tons of clove on 9,200 ha, some 98 companies produced 837,000 ton of sugarcane on 158,500 ha and 7 companies produced 500 tons of tobacco leaves on 700 ha of plantations that year. All agricultural product processing factories in Indonesia are run by big private companies and state-owned national companies (see Tables 3.2.7 and 3.2.8). Indonesia is the world's largest producer of nutmeg, clove and pepper and ranks number three and four, respectively, in the production of cocoa and coffee.

Table 3.2.8

Area and production of large estate crops, 2013–2017

(Thousands)

Crop	*2013*		*2014*		*2015*		*2016*		*2017*	
Perennial	*Hectare*	*Ton*	*Hectare*	*Ton*	*Hectare*	*Ton*	*Hectare*	*Ton*	*Hectare*	*Ton*
Rubber	529.9	581.5	538.9	569.7	545.5	576.8	544.9	552.4	555.8	630.2
Coconut	39.8	39.1	38.9	37.3	36.7	32.7	36.2	32.1	36.2	32.3
Oil palm	6,108.9	21,325.6	6,332.4	22,887.4	6,724.9	24,513.8	6,462.1	24,186.5	8,417.3	30,112.1
Coffee	47.6	30.5	46.8	31.0	46.8	37.0	47.8	31.9	48.9	32.0
Cocoa	79.8	55.5	41.3	30.0	41.9	31.0	42.1	28.6	42.8	29.2
Tea	66.4	94.1	65.5	103.5	61.3	83.1	48.2	74.8	61.3	90.9
Clove	8.1	2.0	9.1	2.0	9.1	1.9	9.2	2.0	9.2	2.0
Kapok	4.4	2.2	4.5	1.8	NA	NA	NA	NA	NA	NA
Cinchona	0.5	0.2	0.5	0.1	NA	NA	NA	NA	NA	NA
Seasonal										
Sugarcane	208.7	1.185.3	209.7	1 196.3	217.3	1 212.4	218.0	1 093.7	158.5	837.0
Tobacco	3.1	3.1	2.5	2.0	0.6	0.9	0.4	0.3	0.7	0.5

Source: Badan Pusat Statistik. Statistik Indonesia. Statistical Yearbook of Indonesia 2018

Smallholder estates covering 5,613,300 ha produced 15,263,000 tons of bunch palm fruit. Smallholder farmers also planted rubber on 3,103,300 ha, producing 2,999,300 tons, harvested 2,838,400 tons of coconut on 3,617,500 ha, grew 636,700 tons of coffee on 1,204,900 ha and 630,600 tons of cocoa on 1,687,200 ha. Smallholder farmers still grow tea, cashew nut, nutmeg, cinnamon, candlenut, areca nut, pepper, clove, sugarcane, tobacco and patchouli. Smallholder estate crop farmers still have a big role in maintaining the area and production of estate crops in Indonesia. The government supports smallholder estate farmers in improving production and quality.

Table 3.2.9

Area and production of smallholder estate crops, 2013–2017

(Thousands)

Type of crops	*2013*		*2014*		*2015*		*2016*		*2017*	
Perennial	*Hectare*	*Ton*	*Hectare*	*Ton*	*Hectare*	*Ton*	*Hectare*	*Ton*	*Hectare*	*Ton*
Rubber	3,026.0	2,655.9	3,067.4	2,583.4	3,075	2,568.6	3,092.4	2,754.7	3,103.3	2,999.3
Coconut	3,614.7	3,012.5	3,570.9	2,968.6	3,548.9	2,888.0	3,617.5	2,872.1	3,617.5	2,838.4
Oil palm	4,356.1	12,012,8	4,422.4	12,246.5	4,535.4	12,633.4	4,739.4	13,890.7	5,613.3	15,263
Coffee	1,194.1	654.3	1,183.7	612.9	1,183.0	602.4	1,198.9	632.0	1,204.9	636.7
Cocoa	1,686.2	665.4	1,686.2	698.4	1,667.3	562.3	1,678.7	629.8	1,687.2	630.6
Tea	56.1	51.7	53.4	50.9	53.5	49.5	52.4	47.7	52.4	48.5
Kapok	152.9	59.0	144.3	55.3	NA	NA	NA	NA	NA	NA
Cashew nut	553.2	116.0	529.8	131.2	521.7	137.5	513.4	137.0	510.1	131.5
Nutmeg	139.9	28.1	157.8	32.7	168.4	33.6	177.8	33.2	179.7	34.3
Cinnamon	105.5	92.0	109.6	91.4	NA	NA	NA	NA	NA	NA
Candlenut	215.4	107.2	210.1	100.6	NA	NA	NA	NA	NA	NA
Areca nut	143.1	42.8	137.0	47.0	NA	NA	NA	NA	NA	NA
Pepper	171.9	91.0	162.7	87.4	167.6	81.5	174.5	82.8	175.1	83.5
Vanilla	16.6	2.6	13.6	2.0	NA	NA	NA	NA	NA	NA
Clove	493.3	107.6	501.0	120.2	526.6	197.7	535.9	137.6	538.9	121.8
Seasonal										
Sugar cane	263.3	1,368.2	263.0	1,379.1	238.5	1,322.5	240.3	1,238.8	267.5	1,284.3
Tobacco	189.7	161.3	213.3	196.1	208.3	192.9	155.6	126.4	185.0	151.8
Citronella	18.6	2.7	19.3	3.1	NA	NA	NA	NA	NA	NA
Castor oil seeds	4.3	1.4	3.2	1.3	NA	NA	NA	NA	NA	NA
Patchouli	28.2	2.1	20.7	2.1	18.6	2.0	19.6	2.2	18.8	2.1

Source: Badan Pusat Statistik. Statistik Indonesia. Statistical Yearbook of Indonesia 2018

3.2.2 Agricultural mechanization

3.2.2.1. National policy on agricultural mechanization

By the end of the 21st century, Indonesia aims to have achieved all four industrial revolutions:

• The primary industrial revolution (1.0) focused on agriculture, forestry, animal husbandry, fisheries, farm power and agriculture machinery.

• The secondary industrial revolution (2.0) focused on mining, construction, roads, dams and railways, and manufacturing.

• The tertiary industrial revolution (3.0) focused on electric power, transport and communications, wholesale and retail trade, finance, insurance and banking, real estate, services, state-owned companies and private companies.

• The fourth industrial revolution (4.0) focused on digitalization, automation, robotics, globalization, mobility and ethical codes. The fourth revolution (4.0) will also influence the primary revolution (1.0) using advanced technology-based machines to promote agricultural development.

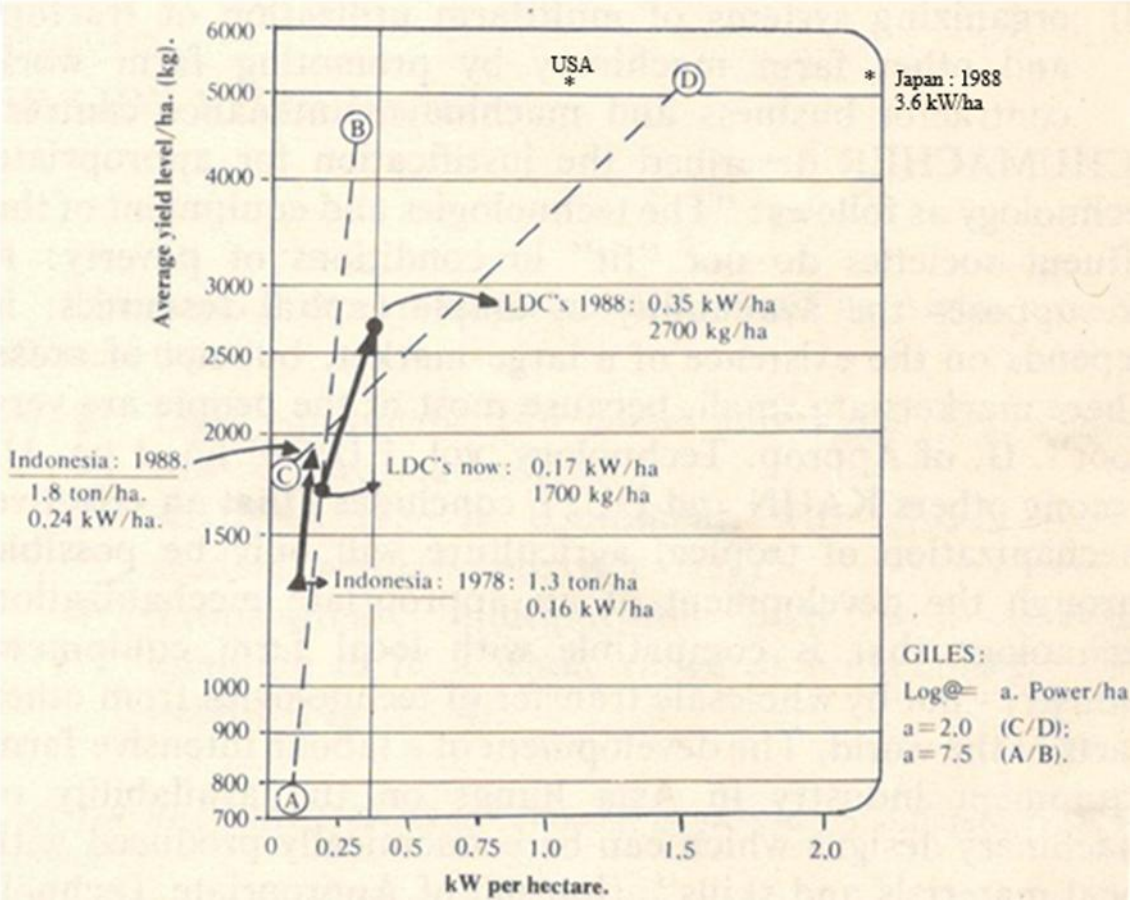
Across Asia, the share of population employed in the primary sector has decreased as economic growth moves workers from agriculture to the secondary, tertiary and quaternary industries (Sakai, 1997). Mechanized farming can play an important role in freeing labour used in agriculture for other industries. Indonesia's experience with agricultural mechanization began during the colonial period when machinery was used for land tillage, drainage (with the mole drain in the PG Jatiroto Sugar Factory and Besuki Tobacco Plantation in east Java), for transporting agricultural products (with the permanent and semi-permanent sugarcane plantation railways) as well as for tobacco processing at the Deli Tobacco My. North in Sumatera. In 1962, an Indonesian state company was set up to produce dryland rice in six locations, two of them in Jabung, Lampung in Sumatera and Pinrang in south Sulawesi, using four-wheel tractors, tillage, seeder and fertilizer equipment, harvester machinery and trailers for transportation. Farm power and machinery imported from Eastern Europe as loan, did not prosper (Daywin, 1966).

In 1971, Indonesia launched a land consolidation project in Tjihea Tani Makmur to increase wetland rice production for food self-sufficiency through intensive agricultural extension and use of fertilizer and chemicals. In 1972, Japan provided a soft loan to Indonesia to promote use of farm machinery, including power tillers, two-wheel tractors with rotary plows for tillage, plant protection machines, transport trailers, threshers, dryers and rice processing machines on the pilot project. However, the Indonesian government did not continue the land consolidation projects at other locations.

Agricultural mechanization, starting in the 1960s and continuing into the 1970s, increased energy use for food crops production (see Figure 3.2.2). By 1978, human power usage in agriculture totaled 140 x 10,000 kW (47 per cent), animal power, 150 x 10,000 kW (50 per cent), two- and four-wheel tractors accounted for 3000 x 20 kW and other farm machines for 2000 x 10 kW (together 3 per cent), adding to a total energy use of 2,980,000 kW (100 per cent) (Muns. A, 1978). The total cultivated area and crop yield in 1978 were estimated at 18,000,000 ha and 1.3 ton/ha, respectively (Muns. A, 1978). Power availability in 1978 was 0.16 kW/ha which increased to 0.24 kW/ha in 1988 with an estimated cultivated area of 25,350,000 ha and crop yield was 1.8 ton/ha (Muns. A, 1978). Statistical studies by Giles and Moens (1978) show a positive correlation between power availability and crop yield in countries where agricultural mechanization was introduced (see Figure 3.2.1).

Figure 3.2.1

Growth lines for agricultural mechanization



Source: (Moens after Giles, 1978)

Compared to some other countries in the region, agricultural energy use for food crops production in Indonesia in 1995 was as follows: human power, 48,343,000 x 0.04 kW (1,933,720 kW); animal power, 14,950,000 x 0.5 kW (7,475,000 kW); 2-wheel tractor, 53,867 x 6 kW (323,202 kW); 4-wheel tractor, 6,124 x 30 kW (183,720 kW); and other farm machines, 45,000 x 10 kW (450,000 kW), giving a total energy use of 10,365,642 kW (see Table 3.2.10). Total cultivated area and yield were around 30,171,000 ha and 2.45 ton/ha, respectively while power availability was 0.34 kW/ha in 1995 (Badan Pusat Statistik, 2018).

Table 3.2.10

Population, agricultural land area and tractor use in some Asian countries, 1995

(Millions, millions of hectares, thousands of units)

	Population				*Agricultural land*			*Number of tractors*	
	Total	*Worker household (a)*	*Farmer households (b)*	*percentage b/a*	*Paddy*		*Total arable land*	*2-Wheel tractor*	*4-Wheel tractor*
					Irrigated	*Non-irrigated*			
Philippines	70.267	28.039	11.768	41.97	4.550		9.190	53.710	-
Indonesia	193.750	83.689	48.343	57.77	4.688	3.797	30.171	53.867	6.124
Korea	44.851	20.798	2.927	14.07	1.020		2.005	1,231.830	-
China	1,221.462	624.000	517.223	82.89	32.384		95.782	10,922.667	-

Bangladesh	118.230	45.397	37.183	81.91	10.111	9.694	16.667	-
Japan	125.197	66.670	3.644	5.47	2.127	4.424	1.344	2.123

Note: the number of tractors was estimated data from. 1992, except Japan and Indonesia estimated number of tractors data from 1995. Japan used 1,650,000 units rice transplanter and 1,120,000 combine harvester in 1995 (Daywin, 1999).

Since 1990, Indonesia has intensified mechanization in lowland irrigated paddy production without developing and consolidating complementary infrastructure of lowland paddy fields.

Policies, laws and regulations in support of agricultural mechanization include the plant cultivation system law (Law No. 12, 1992), the food security law (Law No. 18, 2012), consumer protection law (Law No. 8, 1999) and the national standardization law (Law No. 102, 2000).

The Ministry of Agriculture and the Ministry of Industry have established regulations about the following institutional arrangements in this regard, including No. 42/Permentan/OT.010/8/2005 and No. 107/M-IND/PER/11/2015:

• The Directorate General of Agricultural Infrastructure and Facilities comprising the Secretariat of the Directorate General; the Directorate of Land Extension and Protection; the Directorate of Agricultural Irrigation; the Directorate of Agricultural Financing; the Directorate of Fertilizers and Pesticides; and the Directorate of Agricultural Equipment and Machinery.

• The Directorate of Agricultural Equipment and Machinery is tasked with formulating and implementing policies related to the provision of pre-harvest agricultural tools and machinery.

• The Directorate General of Metal, Machinery, Transportation Equipment and Electronics Industry comprises the Secretariat of the Directorate General; the Directorate of Metal Industry; the Directorate of Machinery Industry and Agricultural Machinery; the Directorate of Maritime Industry, Transportation Equipment and Defense Equipment; and the Directorate of Electronics and Telematics Industry.

• The Directorate of Machinery Industry and Agricultural Machinery is tasked with formulating and implementing the master plan for national industrial development, national industrial policy, industry dissemination, industrial resource development, industrial infrastructure and development, empowerment, safeguarding industries, industrial licensing, investment and industrial facilities, as well as technical policies for industrial development in the industrial machinery and agricultural machinery sectors.

The Ministry of Agriculture regulates the testing and certification of agricultural hand tools and machinery (Law No. 25/Kpts/OT.210/3/2003) and issues guidelines for supervising the procurement, distribution and use of agricultural machinery and hand tools (Law No. 253/Kpts/OT.140/4/2004 and Law No. 65/Permentan/OT.140/12/2006). It is also responsible for the implementation of the national standardization system in agriculture (Law No. 58/Permentan/OT.140/8/2007).

3.2.2.2. National programmes on agricultural mechanization

Since the introduction of farm mechanization for food production, especially rice, corn, and soybean, Indonesia has provided power, machinery and donations of machinery to selected farmers. Agricultural mechanization development programmes in Indonesia have achieved four objectives, namely (a) food self-sufficiency, (b) sustainable natural resource use, (c) agriculture-industry synergy and (d) enhanced farmer welfare.

Government supports to agricultural mechanization focuses on machinery procurement, encouragement of agricultural machinery use and imparting machine operation skills to farmers.

The Ministry of Agriculture's 2008 Decree Number 25/ Permentan/PL.130/ 5/2008 introduced the Custom Hiring for Rental Services of Agricultural Machineries (CHRSAM) system which has increased agricultural machinery use by addressing the issue of farmers' lack of access to capital to purchase machinery. Rural economic institutions have played a key role in financing the programme.

Machines are provided as donations (grants) to food crop farmers' groups, such as a donation of 752 two-wheel tractors in 2011 which increased to 25,000 units in 2017 and a donation of 410 irrigation water pump in 2011 which increased to 21,000 units in 2017 (see Table 3.2.11). Donations of four-wheel tractors during the same period increased from 10 to 3,000 units of rice transplanters from 174 units in 2011 to 11,454 units in 2015 before decreasing to 3,000 units in 2017. Excavator donations increased from 30 units in 2015 to 200 units in 2016 and then decreased to 150 units in 2017.

Table 3.2.11

Indonesia: agricultural machinery donated by government to farmers' groups, 2011–2017

(Units)

	Machinery	*Year*							*Total*
		2011	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	
1	2-wheel tractor	752	1,567	3,996	15,435	26,724	46,982	25,000	120,456
2	Water pump	410	600	2,002	7,122	20,970	19,518	21,000	71,622
3	4-wheel tractor (TP*)	10	40	-	-	1,339	2,250	3,000	6,639
4	4-wheel tractor (BUN*)	-	10	-	-	-	-	-	10
5	Rice transplanter	174	-	153	379	11,454	7,854	3,000	23,014
6	Chopper	-	-	154	225	-	-	-	379
7	Cultivator	-	-	200	240	-	-	2,000	2,440
8	Excavator	-	-	-	-	30	200	150	380
9	Seeding tray	-	-	-	-	-	623,100	200,000	823,100
10	Hand sprayer	-	-	-	-	-	72,000	25,000	97,000
11	Corn Planter tools	-	-	-	-	-	-	2,410	2,410
Total		**1346**	**2217**	**6505**	**23401**	**60517**	**771904**	**282560**	**1148450**

Source: Direktorat Alsintan, Kementerian Pertanian 2017. Pembangunan Pertanian Berkelanjutan Menuju Kedaulatan。Pangan. Focus group Discussion Penyusunan Roadmap Pengembangan Teknologi Sektor Industri Alat Mesin Pertanian dan Mesin Perkakas, Hotel Pomelotel Jakarta, 15 Desember 2017, Direktorat Industri Permesinan dan Alat Mesin Pertanian. Kementrian Perindustrian Republik Indonesia.

In fiscal year 2018, the Ministry of Agriculture allocated a budget to purchase agricultural machinery for farmer groups as donations (grants) to accelerate mechanization in food crops production, especially rice (see Table 3.2.12).

Table 3.2.12

Indonesia: government's agricultural machinery donation plan, Fiscal Year 2018

(Units)

	Machinery	
1	2-wheel tractor	30,000
2	4-wheel tractor	3,400
3	Water pump	35,000

4	Rice transplanter	3,000
5	Cultivator	4,250
6	Excavator	75
7	Hand sprayer	27,800
8	Push type corn planter	8,000
9	Corn planter (Implement of 4-wheel tractor)	1,000
	Total	112,525

Source: Direktorat Alsintan, Kementerian Pertanian 2017. Pembangunan Pertanian Berkelanjutan Menuju Kedaulatan Pangan. Focus group Discussion Penyusunan Roadmap Pengembangan Teknologi Sektor Industri Alat Mesin Pertanian dan Mesin Perkakas, Hotel Pomelotel Jakarta, 15 Desember 2017, Direktorat Industri Permesinan dan Alat Mesin Pertanian. Kementrian Perindustrian Republik Indonesia.

3.2.2.3. Current level of agricultural mechanization

The nationwide use of mechanized agricultural farm power and machinery is increasing rapidly. Indonesia is dedicated to improving food productivity and production and replace fossil fuels with cassava, sugarcane and palm oil-based biofuels. Besides two- and four-wheel tractors, the crawler rubber track has been introduced for soil tillage, excavators for rehabilitation of irrigation and drainage canals, irrigation water pumps, rice-transplanters, insecticide power sprayers, electric semi-manual hand sprayers, combine harvesters, power threshers and post-harvest machinery like rice milling units and dryers (see Table 3.2.13).

Table 3.2.13

Agricultural machinery use for food crops production, 2012-2017

(Units)

Machinery	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*
2-wheel tractor	122,149	194,472	198,468	213,903	240,627	265,627	295,627
4-wheel tractor	3,163	3,358	3,358	4,697	6,947	9,197	12,597
Irrigation water pump	108,286	140,833	142,835	163,805	183,323	204,323	239,323
Rice transplanter	534	636	789	12,243	20,097	23,097	26,097
Combined harvester	221	754	754	754	754	11,209	11,209
Power thresher						70,678	70,678
Rice milling unit						98,219	98,223
Dryer				3,311	2,943	2,323	2,323
Excavator	0	0	0	30	230	380	455
Insecticide sprayer					72,000	97,000	124,800
Cultivator	0	200	440	440	440	2,440	6,690
Corn planter	0	0	0	0	0	2,410	3,410

Source: Astu Unadi, 2014. Current Status of Agricultural Mechanization in Indonesia. Indonesia Center for Agricultural Engineering Research and Development, IAARD. Ministry of Agriculture Republic of Indonesia. Direktorat Alsintan, Kementerian Pertanian 2017. Pembangunan Pertanian Berkelanjutan Menuju Kedaulatan Pangan. Focus group Discussion Penyusunan Roadmap Pengembangan Teknologi Sektor Industri Alat Mesin Pertanian dan Mesin Perkakas, Hotel Pomelotel Jakarta, 15 December 2017, Direktorat Industri Permesinan dan Alat Mesin Pertanian. Kementrian Perindustrian Republik Indonesia.

The Supply Index of agricultural machinery has increased annually because of increasing domestic manufacturing capacity to meet both local and export demand (see Table 3.2.14). The total energy supply was 16,201,240,42 kW and power availability was 0.44 kW/ha in 2018. Total cultivated area and the yield of rice in Indonesia was estimated at about 37,052,575 ha and 4.04 ton/ha.

Table 3.2.14

Agricultural machinery supply index for rice crop production

(Percentage)

Activity	*Year*							
	2004	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2020*
Tillage	48	55	60	65	70	75	80	90
Irrigation	100	100	100	100	100	100	100	100
Nursery	0	1	2	4	6	8	10	50
Planting	04	5	6	7	8	9	10	50
Weeding	02	5	8	12	15	18	20	80
Eradication of pests	100	100	100	100	100	100	100	100
Harvesting	5	10	18	26	34	42	50	90
Threshing	45	55	60	65	70	75	80	100
Drying	25	30	34	38	42	46	50	100
Milling	100	100	100	100	100	100	100	100

Source: Direktorat Jenderal Tanaman Pangan. Direktorat Sarana Produksi 2008. Road Map Pengembangan Alat dan Mesin Pertanian 2009 – 2013. Kementerian Pertanian Republik Indonesia.

Agricultural mechanization development in Indonesia went through four phases corresponding to the four development stages of agriculture:

1. 1968 to 1994: Mechanization on 939,844.4 ha (see Table 3.2.15) of new cleared land.

Table 3.2.15

New land area for transmigration

(Hectares)

Type of land	*1968*	*Pelita I 1969/1974*	*Pelita ii 1974/1979*	*Pelita iii 1979/1984*	*Pelita iv 1984/1989*	*Pelita v 1989/1994*	*Total*
Household yard food crops	843.3	11,567.0	20,738.5	86,713.5	37,523.0	84,04.9	241,434.2
Business Land I	3,373.0	34,701.0	62,215.5	361,983.0	151,690.0	84,447.7	698,410.2
Total	4,216.3	46,268.0	82,954.0	448,696.5	189,213.0	168,496.6	939,844.4

Source: President of the Republic of Indonesia State Speech in Indonesian Parliament, August 16, 1996.

2. Mechanization for intensive agriculture in the form of a Green Revolution-like pattern in dryland food crops area with physical constraints not easily controlled by available technological infrastructure.

3. The third stage was mechanization of lowland irrigated paddy. This innovative farming pattern is used in general and special intensification fields with good irrigation systems where a variety of new sustainable agricultural technologies can be applied.

4. The fourth stage was that of introduction of industrial agriculture in a relatively controlled physical environment and where the farming community is organized and has the capability to adapt to working in an agricultural industrial system. The pattern of thinking that agricultural mechanization is only limited to on-farm activities for food crops must be changed. Agricultural mechanization has a strategic role in increasing the competitiveness of food crop production and the development of independent agricultural and rural industries, supported by appropriate agricultural mechanization technologies, is the basis of an efficient, competitive and sustainable food crop

agriculture industry.

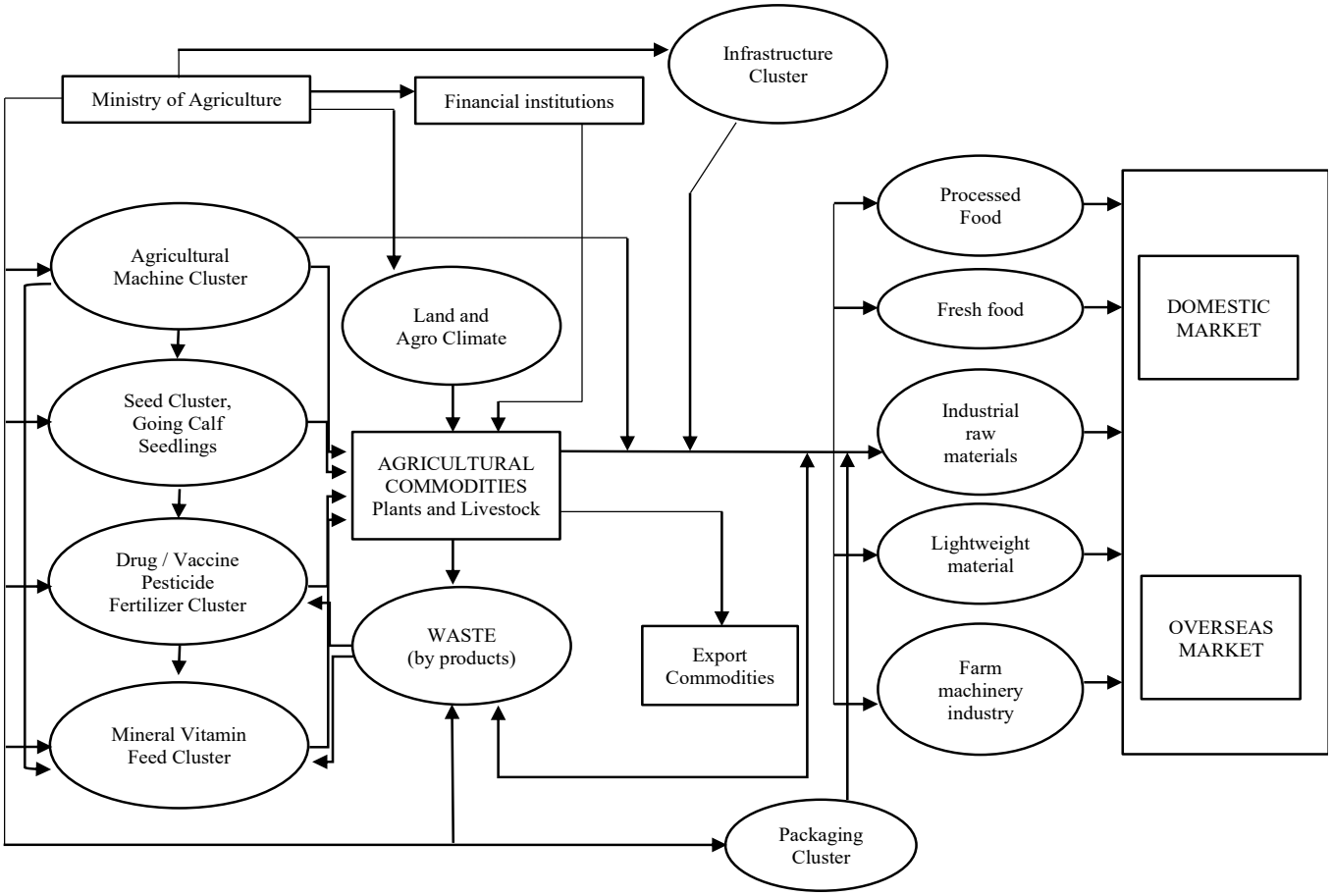
3.2.2.4. Agricultural mechanization research and development

Indonesia's technology roadmap is a guide for R&D institutions and agriculture machinery manufacturers for the development of strategic agribusiness-oriented technologies, mobilizing cooperation with the national research system (Law No. 18/2002), etc.

In 2017, the Indonesia Center for Agricultural Engineering Research and Development (IAARD), in collaboration CV. Adi Setia Utama Jaya and PT. Pindad (National State Agriculture Machinery Manufacturer), initiated an agricultural mechanization research programme to develop and produce a crawler rubber track rotovator tractor combined with a seed planter.

Figure 3.2.2

Agribusiness nodes in the agricultural system roadmap



Source: Achmad M. Fagi (2003)

In 2018, the Ministry of Agriculture, the Directorate General of Agricultural Infrastructure and Facilities and the Agricultural Engineering Associations launched a pilot programme of mechanization-based corporate agriculture development (digital farming). In 2019, pilot activities were conducted in five regions: Tuban Regency (East Java), Sukoharjo Regency (Central Java), Ogan Komering Ilir Regency (South Sumatera), Barito Kuala Regency (South Kalimantan) and Konawe Selatan Regency (South-east Sulawesi). Research collaboration was also initiated with the private manufacturering company and the National Private Agricultural Machinery Association ALSINTANI.

3.2.2.5. Import and export of agricultural machinery

a. Import of two-wheel and four-wheel tractors

The Indonesian government through the Ministry of Agriculture is allocating state budget funds and preparing the national tender programme for procurement and distribution of farm power and farm machinery since 2011. The government encourages domestic manufacturers to distribute agricultural machinery to farmers' groups with a local component content of above 40 per cent. Domestic agricultural machinery manufacturers and ALSINTANI produce high-quality agricultural machinery with a local component content of up to 90 per cent which is also exported (see Table 3.2.17).

The import value of two-wheel tractors of less than 22.5 kW power decreased from USD 579,541 in 2012 to USD 546,052 in 2016 (see Table 3.2.16) and that of four-wheel tractors from USD 54,907,153 in 2012 to USD 47,717,178 in 2016. Except for hand tractors of more 22.5 kW, imports increased significantly because of the tender project for agricultural machinery imports. Farmers use power tillers with rotary plows on upland paddy fields and two-wheel tractors with trailers for transport in the villages.

Table 3.2.16

Import value of two-wheel and four-wheel tractors, 2012-2016

(United States dollars, (USD))

Type	*2012*	*2013*	*2014*	*2015*	*2016*	*Total 2012-2016*
Hand tractor power not over 22.5 kW	579,541	543,662	405,810	526,958	546,052	2,602,023
Hand tractor power over 22.5 kW	24,366	216,880	296,088	386,624	409,864	1,333,822
Four-wheeled tractor	54,907,153	37,562,725	32,701,859	52,200,434	47,717,178	225,089,349
Total	55,511,060	38,323,267	33,403,757	53,114,016	48,673,094	229,025,194

Source: Foreign Trade Statistical Bulletin Import/Imports. December 2018. Badan Pusat Statistik BPS-Statistik Indonesia

b. Export of two-wheel and four-wheel tractors

The export value of four-wheel tractors made in Indonesia increased rapidly from USD 341,751 in 2012 to USD 59,434,197 in 2016 (see Table 3.2.17). Exports to the United States of America totaled USD 46,286,867, followed by sales worth USD 9,010,783 to Thailand and USD 1,676,751 to Viet Nam.

Table 3.2.17

Export value of two-wheel and four-wheel tractors, 2012-2016

(USD)

Type of tractor	*2012*	*2013*	*2014*	*2015*	*2016*	*Total 2012-2016*
Hand tractor power not over 22.5 kW	173,494	179,998	212,428	170,087	531,207	1,267,214

Hand tractor power over 22.5 kW	1,100	776	119	0	66	2,058
Four-wheel tractor	341,751	518,280	11,821,088	32,845,089	59,434,197	104,960,405
Total	516,345	699,054	12,033,635	33,015,176	59,965,470	106,229,680

Source: Foreign Trade Statistics Bulletin. Export Bulletin. According to Commodity Group and Country. Badan Pusat Statistik. Statistik Indonesia, 2018

The dominant agricultural machine imports were harvesting and threshing machines, post-harvest machines and tractors (see Table 3.2.18). The import value of harvesting and threshing machines grew steadily from USD 27,652,354 in 2012 to USD 92,581,165 in 2016 although that of post-harvest machine imports decreased from USD 58,450,923 to USD 35,782,104 over the same period. In 2016, for the first time, the value of Indonesian export of four-wheel tractors at USD 59,434,197 (see Table 3.2.17), exceeded that of imported four-wheel tractors at USD 47,717,178 (see Table 3.2.16) (BPS-Statistik Indonesia. Buletin Statistik Perdagangan Luar Negeri. Ekspor. 2017, 2018).

Table 3.2.18

Value of agricultural machinery export and import, 2012–2016

(USD)

EXPORT							*TOTAL 2012-2016*
HS	*Type*	*2012*	*2013*	*2014*	*2015*	*2016*	
8201	Hand tools	442,620	472,891	639,936	545,574	253,770	2,354,791
8424	Spraying and irrigation machines	6,152,889	5,628,355	5,210,466	4,780,296	4,952,107	26,724,113
8432	Soil preparation and cultivation machines	195,549	15,204	159,435	118,434	52,761	541,383
8437	Post-harvesting machines	1,889,876	1,220,536	1,999,028	783,209	744,419	6,637,068
8701	Tractors	516,345	699,054	12,033,635	33,015,175	59,965,470	106,229,679
Total		9,197,279	8,036,040	20,042,500	39,136,097	65,968,527	142,487,034
	Import Type						
8201	Hand tools	584,778	554,531	1,029,827	1,002,717	873,808	4,045,661
8424	Spraying and irrigation machines	18,812,818	19,425,145	13,668,251	14,642,090	20,665,775	87,214,059
8432	Soil preparation and cultivation machines	8,699,802	8,923,050	11,878,823	29,348,420	38,843,248	97,693,343
8433	Harvesting and threshing machines	27,652,354	31,110,211	37,880,587	56,093,508	92,581,165	245,317,825
8437	Post-harvesting machines	58,450,923	62,698,005	75,209,873	65,407,330	35,782,104	297,548,235
8701	Tractors	55,511,060	38,323,267	33,403,757	53,114,016	48,673,094	229,025,194
Total		169,711,735	161,034,209	173,071,118	219,608,081	237,419,194	960,844,337

Source: Foreign Trade Statistics Bulletin. Export Bulletin. According to Commodity Group and Country. October 2018. Badan Pusat Statistik BPS-Statstics Indonesia; Foreign Trade Statistical Bulletin Impor/Imports.

Desember 2018. Badan Pusat Statistik. Statistik Indonesia, 2018.

Indonesia imports rice transplanters and rice combine harvesters because of the high quality of steel alloy used in the planting mechanism of the former and the cutting mechanism of the latter.

Table 3.2.19

Export of agricultural machinery, 2012–2016

(United States dollars)

TYPE	*2012*	*2013*	*2014*	*2015*	*2016*	*TOTAL 2012-2016*
Spades and shovels	16,451.00	8,951.00	32,554.00	24,250.56	1,436.57	11,729
Hoes (mamooties) and rakes	-	29,300	4900	19,560	47,500	203
Mattocks and picks	145,862.00	45,493.00	170,144.00	26,144,592	5,685,13	125,726
Axes, bill hooks and hewing tools	35,841.00	3,432.00	1,630.00	21,918.81	29,769.21	18,518
Secateurs and one-handed pruners and shears (including poultry shears)	1,331.00	705.00	2,195.00	1,094.49	12,290	1,090
Hedge shears, two-handed pruning shears and two-handed shears	386.00	1,421.00	127.00	555,19	483,89	591
Hand tools for agriculture, horticulture and forestry	242,767.00	412,596.00	433,237.00	236,113.56	215,797.06	308,102
Electric spray gun	25,584	15	5,579	4,841	1,540	7,512
Non-electric spray gun	11,684	-	765	4,882	917	3,650
Insecticide sprayers	6,107,010	5,599,063	4,796,127	4,428,510	4,780,780	5,142,298
Drip irrigation system	-	250	-	-	870	224
Electric sprayer	2,883	9,638	173,988	1,168	-	37,535
Non-electric sprayer and irrigation system	5,728	19,389	234,007	340,895	168,000	153,604
Plough	62,342	8,575	75,784	40,841	6,920	38,892
Disc harrows	9,347	33	5,622	4,558	760	4,064
Scarifiers, cultivators, weeders, hoes and harrows	0	4,520	0	0	0	904
Seeders, planters and transplanters	15,257	0	48,714	50,462	5,401	23,967
Soil preparation/cultivation machinery	1,505	0	510	0	1,728	749
Machine parts for soil preparation/ cultivation	107,098	2,076	28,805	22,573	37,952	39,701
Mower using powered, horizontally rotating cutting device	3,358	715	21,616	2,059	2,325	6,015
Mower using powered, other than horizontally rotating cutting device	44,714	167,714	259,954	8,871	10,874	98,425
Other type of mower, including cutter bar for tractor mounting	35,017	10,288	5,760	6,276	121,521	35,772

Combine harvester-thresher	709	24,085	54,000	161,000	453,758	138,710
Other threshing machinery	0	775	0	200	21,007	4,396
Root or tuber harvesting machine	0	391	0	0	6,636	1,405
Other parts machine of mowers	0		5,332	75	237	1,411
Other parts harvesting or threshing machine	593,353	17,000	83,540	106,412	57,345	171,530
Electric grain cleaning machine	68	38,528	51,512	347	154,897	49,070
Non-electric grain cleaning machine	0	465	1,558	0	0	405
Electric cleaning machines other than for grains	17,212	84,367	152,540	131,378	2,250	77,549
Non electrically cleaning machines other than for grains	2,286	18,932	2,967	7,237	6,656	7,616
Electric rice huller and cone type rice mill	4,122	130,679	11,832	9,421	6,854	32,582
Non-electric rice huller and cone type rice mill	394	3,660	3,705	3,017	7,730	3,701
Electric coffee and corn-milling machine	2,576	19,820	9,726	23,794	15,828	14,349
Non-electric coffee and corn- milling machine	780	974	358	4,502	3,543	2,031
Electric rice-polishing, sieving and husking machine	49,300	13,443	730,976	23,996	75,435	178,630
Electric polishing, sieving and husking machines for crops other than rice	396,700	113,384	66,513	228,838	297,258	220,539
Non-electric rice-polishing, sieving and husking machine	479,359	146,407	27,207	25,863	13,285	138,424
Non-electric polishing, sieving and husking machine for crops other than rice	20,091	29,069	14,440	6,071	1,141	14,162
Parts of electric cleaning machine	4,264	69,555	49,893	0	8,373	26,417
Parts of electric machines, other than cleaning machines	316,140	28,852	333,380	1,538	26,478	141,278
Parts of non-electric cleaning machine	0	0	470	0	0	94
Parts of non-electric machines, other than cleaning machines	596,584	522,401	541,951	317,207	124,692	420,567

Source: Foreign Trade Statistics Bulletin. Export Bulletin. According to Commodity Group and Country. October 2018. Badan Pusat Statistik BPS-Statstics Indonesia; Foreign Trade Statistics Bulletin. Foreign Trade Statistical Bulletin Imports / Imports. December 2018. Badan Pusat Statistik BPS-Statistics Indonesia.

In 2017, almost 80 per cent rice combine harvesters valued at USD 62,853,839 were imported from

China, followed by USD 13,678,117 worth of imports from Thailand and USD 1,107,662 worth of imports from the United States of America. (Buletin Statistik Perdagangan Luar Negeri, 2018).

Table 3.2.20

Agricultural machinery imports, 2012-2016

(United States dollars)

TYPE						*TOTAL 2012-2016*
	2012	*2013*	*2014*	*2015*	*2016*	
Spades and shovels	98,752	69.193	54,611	24,301	29,394	55,250
Hoes (mamooties) and rakes	22,069	6,549	14,084	6,589	187,064	47,271
Mattocks and picks	52,679	65,932	97,647	129,661	145,454	98,275
Axes, bill hooks and hewing tools	32,203	9,325	2,137	9,918	2,467	11,210
Secateurs and one-handed pruners and shears (including poultry shears)	232,021	305,808	230,622	279,861	353,499	280,362
Hedge shears, two-handed pruning shears and similar two-handed shears	134	3,695	16	32	124	800
Hand tools for agriculture, horticulture and forestry	146,920	94,029	630,710	55,355	155,806	315,964
Electric spray gun	313,320	2,764,406	103,531	93,165	353,946	725,674
Non-electric spray gun	232,439	606,332	618,236	120,021	577,270	430,860
Insecticide sprayers	4,338,955	4,209,311	5,195,349	5,698,334	6,606,236	5,209,637
Drip irrigation system	1,897,013	1,819,856	2,483,835	2,659,063	2,420,662	2,256,086
Non-electric sprayers and irrigation system	2,679,931	3,415,045	2,145,824	2,217,340	2,923,121	2,676,252
Electric sprayers and irrigation system	9,351,160	6,610,195	3,121,476	3,854,167	7,784,540	6,144,308
Ploughs	239,024	278,270	477,321	339,347	1,098,169	486,426
Disc harrows	231,606	551,298	461,587	659,793	371,555	455,168
Scarifiers, cultivators, weeders, hoes and harrows	864,281	1,214,438	1,556,350	2,737,349	4,633,367	2,201,157
Seeders, planters and transplanters	494,090	1,439,361	1,952,191	17,749,556	23,826,614	9,092,362
Manure spreaders and fertilizer distributors	1,149,105	556,136	527,834	586,435	505,540	665,010
Soil preparation/cultivation machinery	1,849,179	1,570,166	3,681,633	2,200,581	2,120,758	2,284,463
Machine parts for soil preparation/cultivation	3,872,517	3,313,381	3,221,907	5,075,359	6,287,245	4,354,082
Mowers using powered, horizontally rotating cutting device	6,548,951	6,474,619	6,837,542	2,851,333	3,697,273	5,281,944
Mowers without powered, other than using horizontally rotating cutting device	259,407	468	8,882	0	0	53,751
Mowers using powered, other than using	3,858,620	4,085,064	3,815,228	2,980,468	2,946,929	3,537,262

horizontally rotating cutting device						
Mowers with cutter bars for tractor mounting	1,565,301	772,199	807,473	683,350	915,365	948,738
Combined harvester-threshers	13,077,375	16,069,315	21,996,434	43,480,537	78,727,388	34,670,210
Threshing machinery	709,116	903,323	355,974	454,168	110,168	506,550
Root or tuber harvesting machine	32,193	3,265	10,477	378,293	1,129	85,071
Other parts machine of mowers with powered	791,165	722,172	1,130,590	589,165	447,655	736,149
Other parts machine of mowers without powered	13,501	30,246	116,845	12,480	13,382	37,291
Other parts of harvesting or threshing machine	796,725	2,049,540	2,801,142	4,663,714	5,721,876	3,206,599
Electric gain cleaning machine	7,900,475	17,044,789	17,474,672	26,909,099	9,119,507	15,689,708
Non-electric grain cleaning machine	43,284	25,302	782,966	445,975	884,612	436,428

Source: Foreign Trade Statistics Bulletin. Export Bulletin. According to Commodity Group and Country. October 2018. Central Statistics Agency; Foreign Trade Statistics Bulletin. Foreign Trade Statistical Bulletin Imports / Imports. December 2018. BPS-Statistik Indonesia Central Statistics Agency.

3.2.3. Enabling environment for trade and investment for sustainable mechanization of the agricultural sector

3.2.3.1. Investment environment and policy

a. Public-private partnership in sustainable agricultural mechanization

Agricultural mechanization has a multiplier effect on the local economy, encouraging various related activities such as machine fabrication and repair workshops as well as marketing and agricultural machinery services. Agricultural mechanization will encourage agribusiness and employment creation and the growth of rural agro-industries.

Given the diverse agroecosystems, crop production systems, socioeconomic conditions of farmers and the agricultural infrastructure in Indonesia, strategies and models for mechanizing rice farming also vary. However, their sustainability and success require development of a holistic agricultural machinery approach with a progressive and selective principle and participatory approaches based on location-specific aspects in the selection of technologies as well as infrastructure and supporting institutions. This requires identification of needs, followed by technical testing of machinery through pilot projects.

Of the two alternative models of rice farming mechanization, namely semi-mechanization and full mechanization, the former uses technology developed for specific farming activities while the latter covers all stages of rice farming. The selection of the mechanization model is based on several factors, including the availability and feasibility of technology, local biophysical and socio-economic conditions, rice systems, availability of operators and managers, infrastructure and supporting institutions, workshops, and after-sales services for agricultural machinery. The most suitable model for present conditions is semi-mechanized while lowland paddy farming can be fully mechanized with land consolidation in future. The technology required for both models can be simple or combined with

medium and advanced know-how.

Rice farming mechanization can use a local approach and a technological approach. The former is based on farmers' perceptions and local socioeconomic factors. The technological approach is top-down and involves the introduction of agricultural machinery innovations in the field.

Agricultural mechanization should be based on location-specific principles. Ideally, the type and amount of agricultural machinery needed depends on local farming and socioeconomic conditions and agricultural infrastructure. This should be followed by technical testing and verification through a pilot project to ensure that the agricultural machinery is technically, economically and socially viable. At the development stage, it is necessary to involve the users of agricultural machinery including farmers and farmers' cooperatives as well as service entrepreneurs, sellers, distributors, agricultural machinery workshops and government regulators.

Agricultural mechanization needs are based on cropping patterns, work volume, land area and labour availability. For low-income farmers with limited skills and education, the use of capital-intensive agricultural machinery will not be efficient. Therefore, agricultural mechanization must be based on the rental model and not individual ownership. It would also be more efficient to have technical professionals operating the agricultural machinery. To foster a sense of ownership, agricultural machinery procurement should be provided in the form of purchases through ownership financed through credit schemes with priority access for farmers who can make advance payments. With a sense of belonging and nonpaid goods, it is hoped that UPJA institutions can operate efficiently, independently, and sustainably.

To improve farmers' access to agricultural machinery, the following procurement models can be used:

• Provision of credit for providers and users of agricultural machinery through guaranteed fund assistance;
• ownership through credit of government banks and private financial institutions with the government encouraging state banks and private financial institutions to provide ownership loans for agricultural machinery;
• ownership through farmers' groups and revitalization of the Agricultural Machinery Service Business (UPJA);
• ownership through government agricultural machinery assistance.

In areas with difficult access to credit, partnerships can be developed between dealers and local entrepreneurs such as rice milling unit entrepreneurs, local workshops or wealthy farmers, who are able to sell agricultural machinery The advantages of partnerships are that (i) as partners, workshop entrepreneurs or RMU, dealers are known to farmers, and trusted to take give credit for the purchase of agricultural machinery, (ii) farmers can pay in part and pay the balance after the harvest and (iii) sale to farmers is based on traditional ties.

Continuing human resource training is necessary for sustainable agricultural mechanization including for operators, farmers' groups, cooperative managers, local managers/entrepreneurs and extension workers and should be conducted by distributors/agricultural machinery dealers in collaboration with relevant government agencies. Agricultural extension capacities must be enhanced and be suited to local conditions. Agricultural mechanization must be one of the main extension courses, covering the introduction and economy of mechanization and the operation, maintenance and repair of agricultural machinery.

Demonstration areas near farms are most effective

in technology dissemination, and agricultural mechanization counseling needs to be provided on a pilot basis in various agricultural production centres in Indonesia, especially for food crops and their combinations with livestock. The pilot should be conducted with stakeholder participation, including farmers' groups and the private sector.

Due to constraints of capital, education and skills facing most farmers, mechanization should be based on rental services.

The performance of the Institution of Agricultural Machinery Services Business is still not optimal. Existing institutions do not function properly because of weak management and, improvements need to be made by increasing motivation, knowledge and skills. To prevent distortions from the business market for agricultural machinery services, a regulatory policy is needed to regulate the use of agricultural machinery originating from assistance that can educate farmers to be independent and entrepreneurial, so as to stimulate the growth of independent and sustainable agricultural machinery services.

Management operations in the field of agricultural machinery rental service business must be carried out commercially and independently by local entrepreneurs who have entrepreneurial spirit and are able to see business opportunities, both individually and in groups. Mechanization must be based on farmers' needs in order to ensure the viability of agricultural machinery rental services. Agricultural machinery operations must be based on planting schedules and farm road network limitations, to ensure mobility of agricultural machinery from one location to another. Mobility will provide agricultural machinery service providers a wider operational area and, thus, the minimum number of working days needed to reach break-even point can be exceeded.

b. Role of agricultural machinery manufactures', dealers' and distributors' associations

As Indonesia seeks to achieve food sovereignty, the need for agricultural machinery will increase and the domestic agricultural machinery manufacturing industry will have to meet this demand.

The large domestic manufacturers in Indonesia include PT. Rutan (Agrindo), PT. Yamindo, PT. Kubota Indonesia, CV Karya Hidup Sentosa, PT Ebara Indonesia, CV Adi Setia Utama Jaya, PT Agrindo Maju Lestari, PT. Golden Agin, PT Bina Pertiwi, PT. Tanikaya Multi Sarana, PT. Pura Barutama and PT Firman Indonesia (see Table 3.2.21). Their production covers upstream and downstream needs, including two- and four-wheel tractors, rubber track crawler tractors, land preparation machinery (soil tillage), irrigation pumps, power and manual sprayers, rice transplanters, combine harvesters and post-harvest agricultural machinery. The manufacturers have close links with ALSINTANI, the national private agricultural machinery association which tests domestic and imported agricultural machinery and reports to the Ministry of Industry. Set up by Gabungan Industri Pengerjaan Logam dan Mesin Indonesia (GAMA) on 25 May 25, 1978, ALSINTANI has 40 national agricultural machinery manufacturer members with branch associations in some provinces of Indonesia and hundreds of workshops.

Recently PT. Pindad (Persero), a defense manufacturer, has expanded into the agricultural machinery sector in support of the national goal of achieving food security. The company makes three types of agricultural machines: multipurpose rubber track tractors, amphibious soil tillage equipment and multi-commodity harvesting machines.

Table 3.2.21

Indonesia: agricultural machinery manufacturers, 2015-2016

	COMPANY/INSTITUTION	*PRODUCTS*	*CITY/REGENCY*	*PROVINCE*
1	CV Adi Setia Utama Jaya	Planting, harvesting and post-harvest machinery	Surabaya	Jawa Timur
2	PT. Agrindo Maju Lestari	Sprayer and duster insecticides	Tangerang	Banten
3	PT. Agro Tunas Teknik	Post-harvest machinery	Bekasi	Jawa Barat
4	PT. Bahagia Jaya Sejahtera	Post-harvest machinery	Bogor	Jawa Barat
5	PT. Cans Agrinusa	Post-harvest machinery	Bogor	Jawa Barat
6	CV. Cherry Sarana Agro	Soil tillage equipment, harvest and post-harvest machinery	Payakumbuh	Sumatera Barat
7	PT. Citra Robin Sarana	Sprayer and duster insecticides	Medan	Sumatera Utara
8	PT. Ebara Indonesia	Water pump	Depok	Jawa Barat
9	PT. Erijo Bersaudara Teknik	Tools and manual equipment, sprayer and duster, insecticides	Tengerang	Banten
10	PT. Firman Indonesia	Hand tractor, water pump, soil tillage equipment, planting and harvesting machinery, sprayer and duster insecticides	Tangerang	Banten
11	CV. GHM Farm Tech	Post-harvest machinery	Minahasa	Sulawesi Utara
12	PT. Honda Power Products Indonesia	Diesel and gasoline engine, water pump, Sprayer and duster insecticides, cultivators	Jakarta timur	DKI Jakarta
13	PT. Jogja Inovasi Teknologi	harvesting machinery	Yogyakarta	DIY
14	CV Karya Hidup Sentosa	Tractor, water pump, soil tillage equipment, planting and post-harvest machinery, sprayer and duster insecticides	Yogyakarta	DIY
15	PT. Kemajuan Industrindo	Water pump, post-harvest machinery	Malang	Jawa Timur
16	PT. Kencana Fajar Jaya	Water pump, sprayer and duster insecticides, post-harvest machinery	Surabaya	Jawa Timur
17	PT. Kubota Indonesia	Diesel and gasoline engines	Semarang	Jawa Tengah
18	CV. Mandiri Garlica Pratama	Water pump, post-harvest machinery	Kudus	Jawa Tengah
19	Mitra Balai Industri (MBI)	Soil tillage equipment, post-harvest machinery	Tangerang	Banten
20	PT. Im Hwahaha	Harvesting and soil tillage machinery	Gresik	Jawa Timur
21	PT. Pindad (Persero)	Soil tillage equipment, planting and harvesting machinery	Bandung	Jawa Barat
22	PT. Plasindo Bhama Prasasta	Sprayer and duster insecticides	Tangerang	Banten
23	PT. Pura Barutama	Planting, harvest and post-harvest machinery	Kudus	Jawa Tengah

24	PT. Rutan (Agrindo)	Tractor, water pump, soil tillage equipment, planting, harvest and post-harvest machinery, sprayer and duster insecticides	Surabaya	Jawa Timur
25	PT. Tanikaya Multi Sarana	Soil tillage equipment, Soil Tillage Machinery, water pump, planting Machinery, Sprayer and Duster Insecticides, Harvest Machinery, Post-Harvest Machinery	Jakarta Selatan	DKI Jakarta
26	PT. Yamindo	Tractor, Water Pump, Soil Tillage Equipment, Planting Machinery, Sprayer and Duster Insecticides, Harvest Machinery, Post Harvest Machinery	Pasuruan	Jawa Timur

Source: ALSINTANI, Asosiasi Pengusaha Alat dan Mesin Pertanian Indonesia (Indonesian Agricultural Machinery Association) 1984, Buletin Petunjuk Anggota Asosiasi

Indonesia offers promising opportunities for agricultural machinery manufacturing and a very large number of small- and medium-sized enterprises spread across many regions are engaged in the agricultural machinery and tooling sectors. However, they face capital, raw material, components and technology constraints.

The Government of Indonesia is prioritizing investment in the farm machinery sector, not only to meet local demand but also for export.

Indonesia is actively promoting agricultural manufacturing and building a conducive investment environment for domestic and foreign enterprises through simplification of registration terms and reduction of investment clearance time to less than three working days along with import tariff exemption and corporate income tax incentives.

c. Manufacturing, distribution and sustainable agricultural mechanization initiatives

A constraint to effective and efficient agricultural mechanization in Indonesia is that most rice farmland is not organized and ready for it and needs to be structured along with the provision of appropriate infrastructure. Roads are vital for moving agriculture machinery from and to farms, and workshops are needed for the maintenance of agricultural machinery. Management of agricultural mechanization operations benefits from the availability of commercial agricultural machinery rental services.

The Ministry of Agriculture has promoted the procurement of locally made small-scale, post-harvest machinery from national manufacturers (see Table 3.2.22) for distribution farmers' groups. A significant role has been played by ALSINTANI which is actively involved in protecting both farmers and domestic manufacturers.

Table 3.2.22

Domestic agricultural machinery procurement for distribution by Ministry of Agriculture, 2017

Type/brand	*Company/provider*	*Origin*
2-wheel tractor		
Quick Hand Tractor Quick G3000 Zeva + Kubota RD 85 DI 2S	CV. Karya Hidup Sentosa	Domestic ∞ 90%, Overseas ∞ 10%
Quick Impala Hand Tractor Quick	CV. Karya Hidup Sentosa	Domestic ∞ 90%, Overseas ∞ 10%

Impala + Kubota RD 65 DI 2S		
Quick Hand Tractor Quick Zena Rotary + Kubota RD 110 DI-2T + Plowing Package 1 Zena Rotary	CV. Karya Hidup Sentosa	Domestic ∞ 90%, Overseas ∞ 10%
Quick Hand Tractor Capung Metal Ring 8" – std + GX 200 T2 QD	CV. Karya Hidup Sentosa	Domestic ∞ 90%, Overseas ∞ 10%
Yanmar 2-Wheel tractor Moldboard Plow Type YST PRO XL (8.5 HP)	PT. Yanmar Diesel Indonesia	Domestic ∞ 90%, Overseas ∞ 10%
Yanmar 2-Wheel tractor Rotary Model YZC-L + Iron Wheel (10.5 HP)	PT. Yanmar Diesel Indonesia	Domestic ∞ 90%, Overseas ∞ 10%
4-wheel tractor		
Quick A 360 + Disc Ploug 3 x 22" + Rotary 1.65	CV. Karya Hidup Sentosa	Domestic = 100%
Iseki NT 540F	PT. Rutan	Domestic = 100%
Iseki 4-Wheel tractor NT-548F	PT. Rutan	Domestic = 100%
Maxxi Tractor 40 HP Maxxi WD404	PT. Corin Mulia Gemilang	Domestic = 100%
New Holland TT45–- 4WD (47 HP)	PT. Altrak 1978	Domestic = 100%
Bina Pertiwi Kubota L4400	PT. Bina Pertiwi	Domestic = 100%
Massey Ferguson MF 2615 – 4 WD (47 HP)	PT. Traktor Nusantara	Domestic = 100%
Yanmar 4-Wheel tractor Model EF 393 T (39 HP)	PT. Yanmar Diesel Indonesia	Domestic = 100%
Yanmar 4-Wheel tractor Model EF 494 T (49 HP)	PT. Yanmar Diesel Indonesia	Domestic = 100%
Rice transplanter		
Gunung Biru Transplanter Indo Jarwo	CV. Adi Setia Utama Jaya	Domestic = 100% (Modified)
Maxxi Rice Planting Machine Maxxi PF 48 (Include Nursery Tray 150)	PT. Corin Mulia Gemilang	Domestic = 100%
Maxxi Rice Transplanter Maxxi Twin Jarwo	PT. Corin Mulia Gemilang	Domestic = 100%
Tanikaya Rice Transplanter + 150 Tray	PT. Tanikaya Multi Sarana	Domestic = 100%
Crown Indo Jarwo	PT. Rutan	Domestic = 100% (Modified)
Iseki Rice Transplanter PC4	PT. Rutan	Domestic = 100% (Modified)
Yanmar Transplanter Model AP4	PT. Yanmar Diesel Indonesia	Domestic = 100%
Lambang Jaya Rice Transplanter LJ-RTP 2040 – Jajar Legowo	PT. Lambang Jaya	Domestic = 100% (Modified)
Water pump 3 inch		
Honda Irrigation Pump WB 30XN	PT. Honda Power Products Indonesia	Domestic ∞ 60%, Oversease ∞ 40%
MBI Set Pump 3 inch + Framde Model: MBI-P 80/Yanmar 6.5 HP – 2,200 rpm Suction Hose: 6 M Dispose Hose: 10 M	PT. Mitra Balai Industri	Domestic ∞ 60%, Oversease ∞ 40%
Niagara Pump GTO 3 + Kubota RD65DI-1S	PT. Rutan	Domestic ∞ 60%, Oversease ∞ 40%
Ebara Water Pump 3 inch 80 SQPB – Diesel Engine: Yanmar	PT. Indobara Bahana	Domestic ∞ 60%, Oversease ∞ 40%
Water pump 4 inch		
MBI Pump Set 4 inch + Frame Model: MBI-P 100/Yanmar TF 85 MLYS-di Suction Hose: 6 M Dispose Hose: 10 M	PT. Mitra Balai Industri	Domestic ∞ 60%, Oversease ∞ 40%
Niagara Water Pump + Engine Kubota	PT. Rutan	Domestic ∞ 60%, Oversease ∞ 40%

RD85DI-1S		
Ebara Water Pump 4 inch 100 SQPB – Diesel Engine: Yanmar	PT. Indobara Bahana	Domestic ∞ 60%, Oversease ∞ 40%
Water pump 6 inch		
MBI Pump Set 6 inch + Frame Model: MBI-P 150/Yanmar 11.5 HP – 2,400 rpm Suction Hose: 6 M Dispose Hose: 10 M	PT. Mitra Balai Industri	Domestic ∞ 60%, Oversease ∞ 40%
Niagara GTO 6" + Diamond DI 1100 H	PT. Rutan	Domestic ∞ 60%, Oversease ∞ 40%
Ebara Water Pump 6 inch 150 SQPB – Diesel Engine: Yanmar	PT. Indobara Bahana	Domestic ∞ 60%, Oversease ∞ 40%
Cultivator		
Quick Steel Claw + GX 200 + Main Rotary Blade B + Ridger	CV. Karya Hidup Sentosa	Domestic = 100%
Honda Cultivator FJ 500 (Rotary Axle + Rubber Tire + Final Ridger)	PT. Honda Power Products Indonesia	Domestic = 100%
Yanmar Cultivator Te 550 n	PT. Yanmar Diesel Indonesia	Domestic = 100%
Mini excavator		
Komatsu Mini Hydraulic Excavator Model PC45MR-3	PT. United Tractors, Tbk.	Domestic = 100%
Cat Mini Hydraulic Excavator 304E2 CR/Canopy/Steel Track	PT. Trakindo Utama	Domestic = 100%
Hitachi Mini ExcavatorZX48U	PT. Hexsindo Adiperkasa, Tbk.	Domestic = 100%
Takeuchi TB150C	PT. Gaya Makmur Tractor	Domestic = 100%
Volvo Mini Hydraulic Excavator Type EC55bPro	PT. Indotruck Utama	Domestic = 100%
Hand sprayer		
Maspion Hand Sprayer MH 14	PT. Maspion	Domestic = 100%
Dragon Star Hand Sprayer DS 14 L Deluxe	PT. Star Metal Ware Industry	Domestic = 100%
Tasco Hand Sprayer 425	PT. Agrindo Maju Lestari	Domestic = 100%

Source: Direktorat Alsintan, Kementerian Pertanian 2017. Pembangunan Pertanian Berkelanjutan Menuju Kedaulatan Pangan. Focus group Discussion Penyusunan Roadmap Pengembangan Teknologi Sektor Industri Alat Mesin Pertanian dan Mesin Perkakas, Hotel Pomelotel Jakarta, 15 Desember 2017, Direktorat Industri Permesinan dan Alat Mesin Pertanian. Kementerian Perindustrian Republik Indonesia.

3.2.3.2. Trade environment and policy

a. Risk management

Agriculture as a subsystem in human life aims to produce crops, vegetables, estate crops, and animal biomass (including aquatic biota) by employing natural and aquatic resources effectively and efficiently to promote the welfare and preservation of the environmental carrying capacity. Based on the agricultural regulations, as long as the product is still in the form of biomass, regardless of the form and level of readiness to be consumed or used as raw materials for further production processes, the process activities are still within the scope of agriculture. However, Law No. 8/1984 Ps. 3 paragraph 1 states that:

Industry is an economic activity that processes raw materials, semi-finished goods, and/or finished goods into goods with higher value for their use, including industrial design and engineering activities.

On the basis of the understanding of industry, in Law No. 8/1984 the primary activities for handling yields are included in the industrial category handled by the Ministry of Industry and Trade, Directorate General of Agriculture and Forestry Industry. When it comes to secondary handling of agricultural and forestry products, there are numerous sub-sectors to support the operation of the supply chain.

Grossly dividing agricultural production into two segments on the basis of the limitations of the horsepower's understanding in Law No. 8/1964 and Decree Meperindag No. 30/MPP/SK/2/1996 may not be a productive notion and will inevitably weaken the role of agricultural mechanization in the agro-industry. The main disadvantages of separating the handlers of the agricultural products and biomass production process and its post-harvest handling in the two ministries are:

1) Farmers lose the opportunity to obtain a fair profit from the agriprocessing industry because they only produce the raw material.
2) Reduced opportunities for agricultural machine development and production management that are (a) financially profitable, (b) efficient and (c) increase farmer dignity.
3) Economically weak raw material producers.
4) It establishes an agroindustry system that is not robust because the elements of the system are unevenly distributed.

Thus, sugarcane farmers' earnings are not commensurate with the amount of work done on the farm and they lose the opportunity to use their land capital because the end result of farming is determined by the sugar factory. Cassava, coffee and tea farmers are in a similar situation.

Considering the weaknesses and important values of developing agricultural equipment to support the agricultural industry based on community strength, the following policies are proposed:

• Formulation of an agreement on the insight into new agriculture (on-farm) and the agricultural industry (off-farm) that can place its development interests nationally above the interests of the ministerial office.
• Formulation of a coordination system for agricultural machinery development and agricultural mechanization technology innovation between the Ministry of Agriculture, Ministry of Industry and Ministry of Trade to address problems that arise at the community, on-farm and off-farm levels.
• Agricultural industry should have the opportunity to adapt technology to delimit crop production and allow expansion into related areas such as agri-fisheries and livestock production.

The proposed policy step is key to the development of agricultural mechanization in the 21st century.

b. Regional trade agreements

Indonesia is one of the founders of the World Trade Organization (WTO) and also a founder member of the Association of Southeast Asian Nations (ASEAN). The ASEAN Economic Community (AEC) was formed in 2015 aimed at forming a common Southeast Asian market.

3.2.3.3. Infrastructure and financial development

a. Infrastructure development

The Indonesian government is accelerating infrastructure construction with a new toll road linking the western and eastern regions of Java and several toll roads in Sumatera, Kalimantan, Sulawesi, Papua and Bali, besides improving provincial roads. A harbour now links Sumatera in the west of the archipelago to Papua in the east, where a highway now links Papua's capital Jayapura in the north to Merauke in Papua, which is Indonesia's easternmost city, while another road connects Jayapura to Sorong in Western Papua. On

Sumatera, a toll road links Lampung Province in the south to Aceh in the north while on Kalimantan Island, a railway is planned from East Kalimantan Province to West Kalimantan through Central Kalimantan Province. A national highway system also connects all provinces in Kalimantan while in Sulawesi, the Trans-Sulawesi National Highway connects South, Central and North Sulawesi Provinces.

Since 2014, rural infrastructure development has been accelerated by subsidizing local district and village budgets for farm-to-market roads, small dams and inputs for agronomic activities. A total of 65 multipurpose dams have been built which produce electricity and irrigate 489,515 ha of wetland paddy fields (see Tables 3.2.23 and 3.2.24).

Table 3.2.23

Indonesia: agricultural road construction, 2012 – 2013

(Kilometres)

Province			*Total*
	2012	*2013*	*2012 – 2013*
Sumatera	141	61	202
Java	182	121	303
Bali and Nusa Tenggara	43	33	76
Kalimantan	24	22	46
Sulawesi	39	46	85
Maluku and Papua	18	8	26
Total	**447**	**291**	**738**

Source: Agricultural Infrastructure and Facilities Statistic 2016, Direktorat Jenderal Prasarana dan Sarana Pertanian, Kementrian Pertanian

Table 3.2.24

Dams constructed for electricity generation and irrigation, 2014 – 2019

Province	*2014*		*2015*		*2016*		*2017*		*2018*		*2019*		*Total*	
	N	*Ha*	*N*	*Ha*	*N*	*Ha*	*N*	*Ha*	*N*	*Ha*	*N*	*Ha*	*N*	*Ha*
Aceh	2	1,000	1	9,420	1	11,950	1	6,330	-	-	-	-	5	28,700
Kepulauan Riau	-	-	1	0	-	-	-	-	-	-	-	-	1	0
Sumatera Utara	-	-	-	-	-	-	1	3,302	-	-	-	-	1	3,302
Sumatera Selatan	-	-	-	-	-	-	1	25,000	-	-	-	-	1	25,000
Riau	-	-	-	-	-	-	-	-	1	4,000	-	-	1	4,000
Lampung	-	-	-	-	1	4,000	-	-	-	-	-	-	1	4,000
Banten	-	-	2	22,202	-	-	-	-	-	-	-	-	2	22,202
Jawa Barat	2	93,000	-	-	4	22,450	1	6,000	-	-	-	-	7	121,450
Jawa Tengah	2	6,130	1	2,821	-	-	1	15,069	2	29,924	1	7,627	7	61,571
Jawa Timur	6	18,741	-	-	-	-	1	1,554	1	857	-	-	8	21,152
Kalimantan Timur	2	4,500	-	-	-	-	-	-	-	-	1	18,500	3	23,000
Kalimantan Selatan	-	-	1	5,472	-	-	-	-	-	-	-	-	1	5,472
Sulawesi Selatan	1	7,004	1	7,000	-	-	1	6,430	1	24,400	-	-	4	44,834
Sulawesi	-	-	1	3,714	1	0	-	-	-	-	-	-	2	3,714

Utara														
Sulawesi Tenggara	-	-	-	-	1	7,424	-	-	2	25,363	-	-	3	32,787
Gorontalo	-	-	-	-	-	-	-	-	-	-	2	10,045	2	10,045
Bali	1	1,795	-	-	-	-	1	4,595	1	1,196	-	-	3	7,586
Nusa Tenggara Barat	-	-	3	10,634	-	-	-	-	-	-	1	1,500	4	12,134
Nusa Tenggara Timur	-	-	2	1,760	-	-	1	0	1	5,206	1	5,000	5	11,966
Maluku	-	-	-	-	-	-	-	-	-	-	1	2,900	1	2,900
Total	16	132,170	13	63,023	8	45,824	9	68,280	11	133,946	8	46,272	65	489,515

Source: Subdit Data dan Informasi Ditjen Sumber Daya Air, Status Agustus 2019, Kementerian Pekerjaan Umum dan Perumahan Rakyat

Indonesia has targeted land consolidation in wetland irrigated paddy fields of at least 1,000,000 ha in the next 10 years as part of the 4,751,091 ha land area to be consolidated. Wetland paddy field consolidation began in Japan in the late 19th century and was completed by the 1960s, to be followed by consolidation in China and the Republic of Korea. In the 1970s, India, Malaysia, the Philippines, Sri Lanka and Thailand also began consolidating paddy fields. Indonesia had conducted a pilot land consolidation in 1972 with a grant from the Government of Japan.

b. Financial sector involvement in sustainable agricultural mechanization

Infrastructure policies and budgets have a major impact on agricultural production. Reforms are needed in pricing policies and marketing systems to incentivize technology adoption. Structural adjustment reforms involve cuts in public budgets with detrimental impact on long-term agricultural productivity and policymakers should carefully consider the negative effects of reduced budgets. In Indonesia, strong levels of regional autonomy and weak coordination between government institutions are also major obstacles. For starting a business, the number of procedural clearances is 12, the number of days required is 151, the costs are 131 percent of per capita income and the minimum capital required is 126 percent of per capita income. Law Number 25 enacted in 2007 provides incentives for investment, especially facilitating access to foreign capital. It also offers incentives on income, capital, machinery and equipment tax, tax-free import of raw material, exemption on value added tax and accelerated amortization and property tax. Land use permits are very easy to obtain for foreign investors and have been extended from 70 to 95 years. The law has also cancelled regional regulations that impede business and provides implementation guidelines for developing a one-stop shop by local governments in accordance with the investment climate reform package. (Hadi, 2010)

Law of the Republic Indonesia number 25 of 2007 about capital investment signed by the President on Indonesia on 26th April 2007 regulates investments thought the following main points.

Chapter I

1. Investment is any form of investment activity, either by domestic investors or by foreign investors to conduct business in the territory of the Republic of Indonesia.
2. Domestic investment is an investment activity to conduct business in the territory of the Republic of Indonesia which is carried out by domestic investors using domestic capital.
3. Foreign investment is an investment activity to

conduct business in the territory of the Republic of Indonesia which is carried out by foreign investors, either wholly using foreign capital or jointly with domestic investors.

4. Investors are individuals or business entities making investments in the form of domestic investors and foreign investors.

5. Domestic investors are individuals who are Indonesian citizens, Indonesian business entities, the Republic of Indonesia, or regions that make investments in the territory of the Republic of Indonesia.

6. Foreign investors are individual foreign citizens, foreign business entities, and/or foreign governments investing in the territory of the Republic of Indonesia.

7. Capital is an asset in the form of money or other forms that are not money owned by investors that have economic value.

8. Foreign capital is capital owned by a foreign country, individual foreign citizens, foreign business entities, foreign legal entities, and/or Indonesian legal entities whose capital is partly or wholly owned by foreign parties.

9. Domestic capital is capital owned by the Republic of Indonesia, an individual Indonesian citizen, or a business entity in the form of a legal entity or not.

10. One-stop integrated service is the activity of administering a permit and non-licensing activity which has been delegated or delegated of authority from an institution or agency that has licensing and non-licensing authority whose management process starts from the application stage until the document issuance stage is carried out in one place,

11. Regional autonomy is the right, authority and obligation of an autonomous region to regulate and manage government affairs, and the interests of the local community in accordance with the provisions of laws and regulations.

12. The central government, hereinafter referred to as the Government, is the President of the Republic of Indonesia, who holds the governing power of the Republic of Indonesia as referred to in the 1945 Constitution of the Republic of Indonesia.

13. Regional government is the governor, regent, or mayor, and regional apparatuses as elements of regional government administration.

Chapter II

Principles and objectives:

(1) Investment is carried out based on the principles a. legal certainty; b. openness; c. accountability; d. equal treatment and does not differentiate country of origin; e. togetherness; f. efficiency with justice; g. sustainable; h. environmentally friendly; i. independence; and j. balance of progress and national economic unity.

(2) The objectives of implementing investment are, among other

a. increasing national economic growth; b. creating jobs; c. promoting sustainable economic development; d. increasing the competitiveness of the national business world; e. increasing the capacity and capability of national technology; f. encourage the development of a pe’pl''s economy; g. transforming the potential economy into real economic strength by using funds originating from both within the country and from abroad; and h. improve community welfare.

Chapter III

Basic investment policy:

1.The government shall determine basic investment policies

a. Encourage the creation of a national business climate that is conducive to investment in order to strengthen the competitiveness of the national economy; and b. accelerate the increase in investment.

2. In determining the basic policy as referred to in paragraph 1, the Government

a. give equal treatment to domestic investors and foreign investors while still paying attention to the national interest; b. guarantee legal certainty, business certainty, and business security for investors from the licensing process until the end of

investment activities in accordance with the provisions of laws and regulations; and c. open opportunities for development and provide protection to micro, small, medium enterprises and cooperatives.
(3) The basic policy as referred to in paragraph (1) and paragraph (2) is realized in the form of a General Investment Plan.
Chapter IV
Investor treatment:
(1) The Government shall provide equal treatment to all investors originating from any country carrying out investment activities in Indonesia in accordance with the provisions of laws and regulations.
(2) The treatment as referred to in paragraph (1) does not apply to investors from a country who obtain special rights based on an agreement with Indonesia.

Indicators showing large investment opportunities in Indonesia's agricultural sector:
1. Abundant availability of natural resources (land, water and climate) as well as human resources. Natural resource-based investment is strongly supported by the local availability of raw material.
2. Continuing increase in domestic demand for agricultural products from a large and growing population with rising incomes as well as world demand for Indonesian agricultural products, especially palm oil, rubber, cocoa, coffee, pepper, nutmeg, vanilla and cinnamon.
3. Increase in world food prices.
4. Government commitment to creating a conducive investment climate.

Policies needed to encourage investment:
1. Political, social and economic stability.
2. Good governance, free of corruption, with policy clarity and consistency and an efficient bureaucracy.
3. An effective financial sector and a conducive labour system based on fair wages but not burdensome for companies with clarity on work contracts and a ban on disruptive labour activities. Particularly for smallholder farmers, banks should facilitate necessary investments, including agricultural equipment, irrigation, land clearing and livestock.
4. An easy and simple tax system as well as export-import and domestic trade procedures.
5. Facilitation of ownership or land contracts for private companies but majority of agricultural land should not be controlled by foreign companies.
6. Cancellation of all regional regulations that hinder investment and business.
Increased government investment to complement private and public investment in agriculture, namely in agricultural research and development, road and port infrastructure, irrigation networks, electricity grids and telecommunications.
7. Worker training to enhance skills and work ethic with incentives and disincentives to ensure higher productivity. (Hadi, 2010)

The Indonesian government has prioritized investment in farm machinery from countries which produce and export high quality farm machinery, especially to developing countries. This includes reducing registration requirements to less than three working days, import tariff exemption for domestic and foreign enterprises engaged in agricultural mechanization as well as corporate income tax incentives and exemption from import value added tax.

Foreign investment in agriculture and forestry in Indonesia has increased rapidly, rising from USD 2,260,000 in four projects in 2012 to USD 11,709,000 in 40 projects in 2017. Almost all projects are located on Java Island (see Tables 3.2.25 and 3.2.26).

Table 3.2.25

Indonesia: agriculture and forestry machinery industry investment by province, 2012-2017

(Thousands of USD)

Year	*Province*						*Total*
	Jawa Barat	*Nusa Tenggara Barat*	*Banten*	*Jawa Timur*	*Kalimantan Timur*	*Daerah Istimewa Yogyakarta*	
2012							
Projects	1	1	0	2	0	0	4
Investment	0	2,210	0	50	0	0	2,260
2013							
Projects	2	1	0	2	0	0	5
Investment	0	0	0	3	0	0	3
2014							
Projects	2	0	1	1	0	0	4
Investment	1,625	0	154	0	0	0	1,779
2015							
Projects	3	0	1	3	0	0	7
Investment	293	0	20	1,161	0	0	1,474
2016							
Projects	2	0	3	4	1	1	11
Investment	0	0	0	3,681	0	13	3,694
2017							
Projects	1	0	4	3	0	1	9
Investment	0	0	441	2,059	0	0	2,500
Total							
Projects	11	2	9	15	1	2	40
Investment	1,918	2,210	615	6,953	0	13	11,709

Source: Direktorat Alsintan, Kementerian Pertanian 2017. Pembangunan Pertanian Berkelanjutan Menuju Kedaulatan Pangan. Focus group Discussion Penyusunan Roadmap Pengembangan Teknologi Sektor Industri Alat Mesin Pertanian dan Mesin Perkakas, Hotel Pomelotel Jakarta, 15 Desember 2017, Direktorat Industri Permesinan dan Alat Mesin Pertanian. Kementerian Perindustrian Republik Indonesia.

Japan was the first country to make agriculture and forestry industry investments in Indonesia with seventeen projects valued at USD 6,952,900, followed by the United States of America with three projects worth USD 2,210,000, Singapore with three projects valued at USD 1,625,000, Malaysia with four projects valued at USD 615,000 and the Republic of Korea with six projects worth USD 13,000.

Table 3.2.26

Indonesia: investment by country in agriculture and forestry machinery industry, 2012-2017

(Thousands of USD)

Year of investment	*Country*							*Total*
	Singapore	*Japan*	*United States of America*	*Malaysia*	*Republic of Korea*	*Australia*	*Others*	
2012								
Projects	0	2	1	0	0	0	1	4
Investment	0	50	2,210	0	0	0	0	2,260
2013								
Projects	0	2	1	0	1	0	1	5

Investment	0	2.6	0	0	0	0	0	2.6
2014								
Projects	1	1	0	1	0	0	1	4
Investment	1,625	0	0	153.9	0	0	0	1,778.9
2015								
Projects	1	3	0	1	0	0	2	7
Investment	0	1,160.6	0	20.3	0	0	293.3	1,474.2
2016								
Projects	1	6	0	1	2	1	0	11
Investment	0	3680.9	0	0	12.7	0	0	3,693.6
2017								
Projects	0	3	1	1	3	1	0	9
Investment	0	2,058.8	0	441.2	0	0	0	2,500
Total								
Projects	3	17	3	4	6	2	5	40
Investment	1,625	6,952.9	2,210	615.4	13	0	293.3	11,709

Source: Direktorat Alsintan, Kementerian Pertanian 2017. Pembangunan Pertanian Berkelanjutan Menuju Kedaulatan Pangan. Focus group Discussion Penyusunan Roadmap Pengembangan Teknologi Sektor Industri Alat Mesin Pertanian dan Mesin Perkakas, Hotel Pomelotel Jakarta, 15 Desember 2017, Direktorat Industri Permesinan dan Alat Mesin Pertanian. Kementerian Perindustrian Republik Indonesia.

3.2.4. Summary, conclusions and recommendations

Summary

In 2017, Indonesia had an estimated 15,416,748 food crop farmers and 589,371 farmers' groups, 8,087,373 ha of wetland paddy fields and 28,965,182 ha of dryland for annual food production. Irrigated wetland paddy is cultivated on 4,751,091 ha, non-irrigated wetland paddy fields cover 3,336,202 ha while dryland covers 11,846,954 ha and shifting cultivation is spread over 5,172,502 ha. Rice production grew from 35,943,000 tons in 2013 to 49,169,000 tons in 2016. Although the world's fourth largest rice producer, Indonesia imported about 2,500,000 tons in 2016 and despite increased rice and corn production, ensuring future food security is still a problem because of increasing demand for rice as main staple and for corn as poultry feed. In 1971, Indonesia began a land consolidation project to increase wetland paddy production, known as BIMAS, to bring about a large increase in rice production through intensive agricultural extension services, intensive application of fertilizer and agricultural chemicals and funds. As part of the project Japan consolidated 100 ha of wetland paddy fields located at the Tjihea Tani Makmur Pilot Project, Cianjur District, West Java Province.

In 2017, there were 1,694 large estate crop companies managing palm plantations over 8,417,300 ha which produced 30,112,100 tons of palm fruits, making Indonesia the world leader in area of palm plantations and palm fruit production. Rubber is the second main perennial estate crop with 320 large estate crop companies in 2017 cultivating 555,800 ha to produce 630,200 tons of rubber. Combined with smallholder rubber production, Indonesia is the world's third largest rubber producer.

In 1962, Indonesia set up a state company to grow dryland rice in Jabung, Lampung in Sumatera, Pleihari in, South Kalimantan and Pinrang in South Sulawesi, using four-wheel tractors, tillage, seeder and fertilizer equipment, harvester machinery and trailers for transportation. The farm power and machinery imported from Eastern European countries as a loan from Eastern Europe did not produce a success story.

The Government of Indonesia has actively supported farm mechanization, especially for rice, corn and soybean production, providing power, machinery and even agricultural machine donations to farmers. The agricultural mechanization development programme in Indonesia has the following objectives:
(a) achieving food self-sufficiency,
(b) sustainable use of natural resources,
(c) building synergies between agriculture and industry and
(d) farmer well-being.

Agricultural mechanization will also encourage the growth of the agricultural machinery business, including leasing services as well as repair and maintenance services.

Use of agricultural farm power and machinery has increased rapidly throughout the country, especially since the beginning of the 21st century, especially of two- and four-wheel tractors. There is also increasing use of rubber track crawler tractors for soil tillage, excavators for rehabilitation of irrigation and drainage canals, irrigation pumps, rice transplanters, insecticide power sprayers and electric semi-manual hand sprayers, combine harvesters and power threshers, rice milling machinery and dryers.

Indonesia is also trying to replace fossil fuel use with bioenergy from cassava, sugarcane and palm oil.

The national private agricultural machinery association ALSINTANI ensures agricultural machinery quality and prevents imports of low-standard machinery that does not comply with national standards.

The government is also accelerating transport connectivity across the archipelago with new toll roads across Java, Sumatera, Kalimantan, Sulawesi, Papua and Bali while improving the quality of provincial roads. Focus is needed on consolidation of wetland irrigated paddy fields and the government has targeted 4,751,091 ha out of at least 1,000,000 ha over the next 10 years.

Conclusion

Agricultural mechanization plays a strategic role in increasing the production and competitiveness of food crop agriculture and farmer community well-being. Notwithstanding adequate availability of technologies, agricultural mechanization in Indonesia has been slow and needs to be accelerated. This requires pilot projects with active participation of farmers and farmers' groups, entrepreneurs, extension agents and government agencies.

Indonesia also needs overarching regulation of agricultural mechanization with an active role for local governments at all levels and effective support to the agricultural industry, especially from financial institutions.

Four- and two-wheel tractors account for 90 per cent of agricultural machinery exports, followed by irrigation pumps and semi-automatic sprayers. Harvesting machinery exports are also increasing rapidly.

Recommendations

Agricultural mechanization should not be limited to on-farm food crop production and cover off-farm agriculture as well.
Mechanization will also encourage youth who have a crucial role in agriculture but are reluctant to take up manual agricultural work.

It is important to ensure easy access to production resources, especially irrigation for wetland paddy in Indonesia.

Challenges remain, including the low level of farmer education, low land ownership with most agricultural workers being farm labour, farmers' limited access to capital for farming activities and weak farmers organizations. Farmers' groups for production, efficient water-use agricultural machinery need to be organized along with village cooperatives.

3.3. Pakistan

3.3.1. Overview of the agricultural sector

3.3.1.1. The agricultural economy

Pakistan is the world's sixth-most populous country with 212.7 million people. Having a 1,046 km coast along the Arabian Sea and the Gulf of Oman, Pakistan borders India in the east, Afghanistan in the west, Iran (Islamic Republic of) in the south-west and China in the north-east. The country has a total land area of 79.61 million ha of which 35.01 million ha are cultivable (see Table 3.3.1), the cultivated area comprising 39 per cent of total area and forests covering 7 per cent of total land (see Figure 3.3.1). The climate varies from semi-arid to subtropical and soil conditions range from sandy loam to clay loam.

Agriculture is the backbone of Pakistan's economy and integral to national food security with about 65 per cent of the population dependent on farming directly or indirectly. Its significant contribution to national income, employment, industry and exports, make agriculture the foundation of Pakistan's economy (Amjad, and others, 2013; Badar, Ghafoor, and Adeel, 2017).

The sector accounts for about 18.5 per cent of gross domestic product and employs about 38.5 per cent of the total labour force of 61.04 million (Ministry of Finance, 2019a). Agricultural growth of 3.8 per cent in the fiscal year ending 2018 (Ministry of Finance, 2018), exceeded the targeted 3.5 per cent (see Table 3.3.2) and was driven by higher yields, attractive output prices, supportive government policies, improved availability of certified seeds, pesticides, credit and intensive fertilizer use. The crops sector saw impressive growth of 3.83 per cent up from the preceding year's 0.91 per cent with growth in the subsectors of important crops, other crops and cotton ginning, registering 3.57 per cent, 3.33 and 8.72 per cent, respectively, compared to 2.18 per cent, - 2.66 and 5.58 per cent, respectively, in the preceding year (see Table 3.3.2). Sugarcane and rice output also surpassed production targets, recording 7.45 and 8.65 per cent growth, respectively, while cotton crops too exceeded the preceding year's production by 11.85 per cent. However, wheat and maize growth declined by 4.43 and 7.04 per cent, respectively (Ministry of Finance, 2018). Other crops grew by 3.33 per cent on the back of increased production of fodder, vegetables and fruits while livestock saw growth of 3.76 per cent compared to 2.99 per cent in 2016-17. Fisheries grew by 1.63 per cent compared to 1.23 per cent in the preceding year, and forestry by 7.17 per cent on account of higher timber production in Khyber Pakhtunkhwa (see Table 3.3.2). Cotton and other important crops are major contributors to agricultural growth (see Figure 3.3.2).

Agriculture is a major contributor to export earnings with agriculture and agro-product exports bringing nearly two-thirds of total foreign exchange earnings (Ministry of Finance, 2019a). Agricultural products are also major suppliers of major industrial raw materials for export. The sector is undergoing increasing commercialization with technological innovation, rising consumer demand and export potential of agricultural products. Thus, agriculture

remains the foundation of Pakistan's economy due to its contribution to national income, employment, industry, and export (Amjad, Kalwar, Shahid & Ahmad, 2013; Badar, Ghafoor, & Adeel, 2017).

Table 3.3.1

Pakistan: land utilization

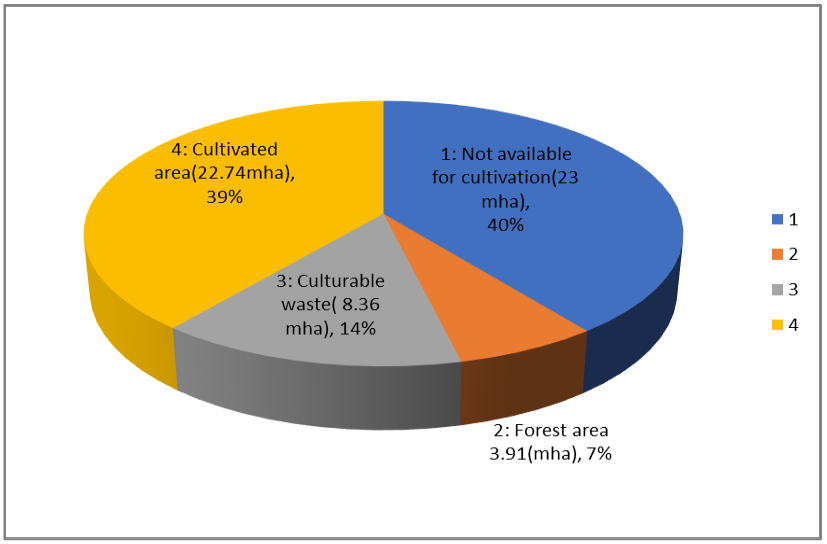
(Millions of hectares)

	Category	*Area*
1.	Geographical area	79.61
2.	Total reported area (3+4)	58.01
3.	Not available for cultivation	23.00
4.	Agriculture land (5+6)	35.01
5.	Forest area	3.91
6.	Arable land (7+8)	31.10
7.	Cultivable waste	8.36
8.	Cultivated area (9+10)	22.74
9.	Current fallows	7.10
10.	Net area sown	15.64
11.	Area sown more than once	7.96
12.	Total cropped area (10+11)	23.60

Source: Pakistan Economic Survey 2017-2018.

Figure 3.3.1

Pakistan: land utilization



Source: Ministry of Finance, 2018

Domestic fertilizer production decreased slightly by 5.4 per cent in 2017-2018 (July-March) from the corresponding period of the preceding year due to the diversion of piped natural gas from small-scale urea producers to domestic users. Fertilizer imports increased by 21.1 per cent during that period and fertilizer use declined by 3.6 per cent. Higher budgetary support for agriculture saw agriculture credit increasing to 1,001 billion Pakistan Rupees (PKR), 43 per cent over the preceding year while the outstanding portfolio of agriculture loans increased from PKR 79.5 billion to PKR 452.6 billion, by 21.3 per cent (Ministry of Finance, 2019). Tractor production grew 44.68 per cent. Agricultural performance fluctuates according to market prices of agricultural products, input availability and climatic conditions (Ministry of Finance, 2019).

Table 3.3.2

Pakistan: agricultural growth (base: 2005-2006)

(Percentage)

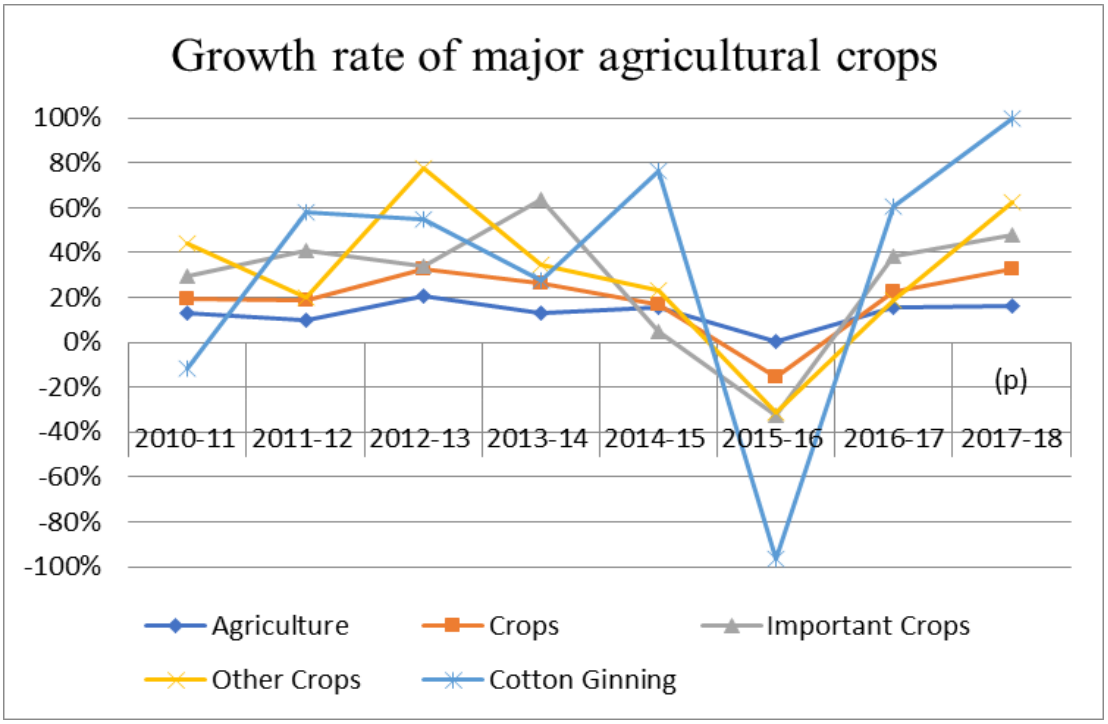
Sector	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018 (*)
Agriculture	1.96	3.62	2.68	2.50	2.13	0.15	2.07	3.81
Crops	0.99	3.22	1.53	2.64	0.16	-5.27	0.91	3.83
Important Crops	1.50	7.87	0.17	7.22	-1.62	-5.86	2.18	3.57
Other crops	2.27	-7.52	5.58	-5.71	2.51	0.4	-2.66	3.33
Cotton ginning	-8.48	13.83	-2.90	-1.33	7.24	-22.12	5.58	8.72
Livestock	3.39	3.99	3.45	2.48	3.99	3.36	2.99	3.76
Forestry	4.76	1.79	6.58	1.88	-12.45	14.31	-2.57	7.17
Fishing	-15.20	3.77	0.65	0.98	5.75	3.25	1.23	1.63

Source: Pakistan Bureau of Statistics, 2017 & Ministry of Finance, 2018

*Provisional

Figure 3.3.2

Growth rate of major crops, 2010-2018



Source: Pakistan Bureau of Statistics, 2017 and Ministry of Finance, 2018

3.3.1.2. The agricultural production system

Wheat, rice, cotton, sugarcane and maize account for 38 per cent, 12 per cent, 12 per cent, 6 and 5 per cent, respectively, of total cropped area. Once a net importer of these crops, Pakistan now is a surplus producer and exports wheat, rice, cotton and sugarcane (see Table 3.3.3). Wheat is the dietary staple accounting for up to 72 per cent of daily per capita energy intake with a per capita consumption of around 110 kg/year.

Pakistan exported 600,000 tons of wheat in 2016-2017 and rice export totaled 4 million tons (Ministry

of Finance, 2019). Surplus production has helped stabilize wheat and rice consumer prices (see Table 3.3.4 and Figure 3.3.4).

Table 3.3.3

Pakistan: area and production of important crops

(Millions)

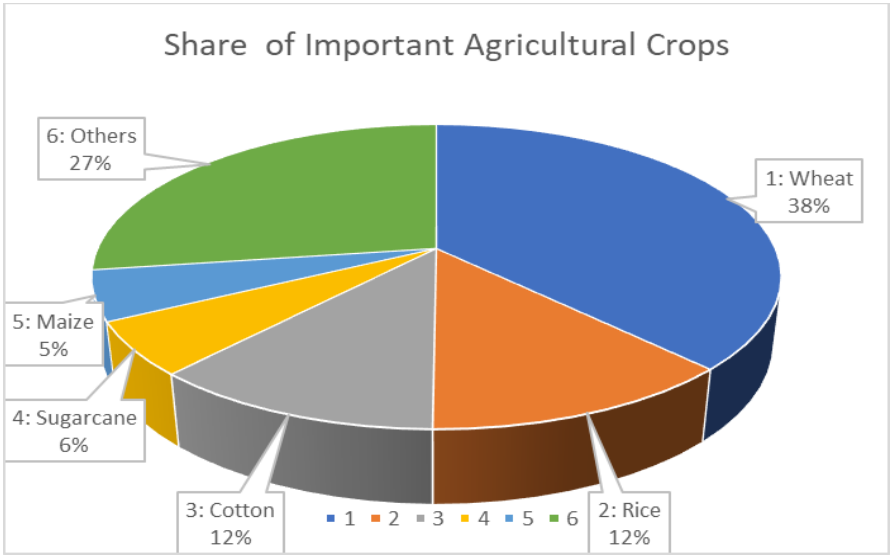
Year	Wheat		Rice		Cotton		Sugarcane		Maize	
	Area (hectares)	Production (tons)	Area	Production (tons)	Area	Production (bales)	Area	Production (tons)	Area	Production (tons)
2011-2012	8.6498	23.473	2.5712	6.61	2.8345	13.595	1.0575	58.3964	1.0873	3.338
2012-2013	8.6602	24.211	2.3088	5.536	2.8788	13.031	1.1288	63.7499	1.0595	4.222
2013-2014	9.1994	25.979	2.7892	6.738	2.8057	12.769	1.1725	67.4601	1.1685	4.944
2014-2015	9.2039	25.086	2.8906	7.003	2.9613	13.96	1.1405	68.826	1.1425	4.937
2015-2016	9.2237	25.633	2.7395	6.801	2.9019	9.917	1.1316	65.482	1.1912	5.271
2016-2017	8.9725	27	2.724	6.849	2.4889	10.671	1.2176	75.482	1.3484	6.134
2017-2018*	8.734	25.492	2.899	7.442	2.699	11.935	1.313	81.102	1.229	5.72

Source: Ministry of Finance, 2018 and Pakistan Bureau of Statistics, 2017

*Provisional

Figure 3.3.3

Area under important agricultural crops



Source: Ministry of Finance, 2018 and Pakistan Bureau of Statistics, 2017

Table 3.3.4

Wholesale price trend of important food items

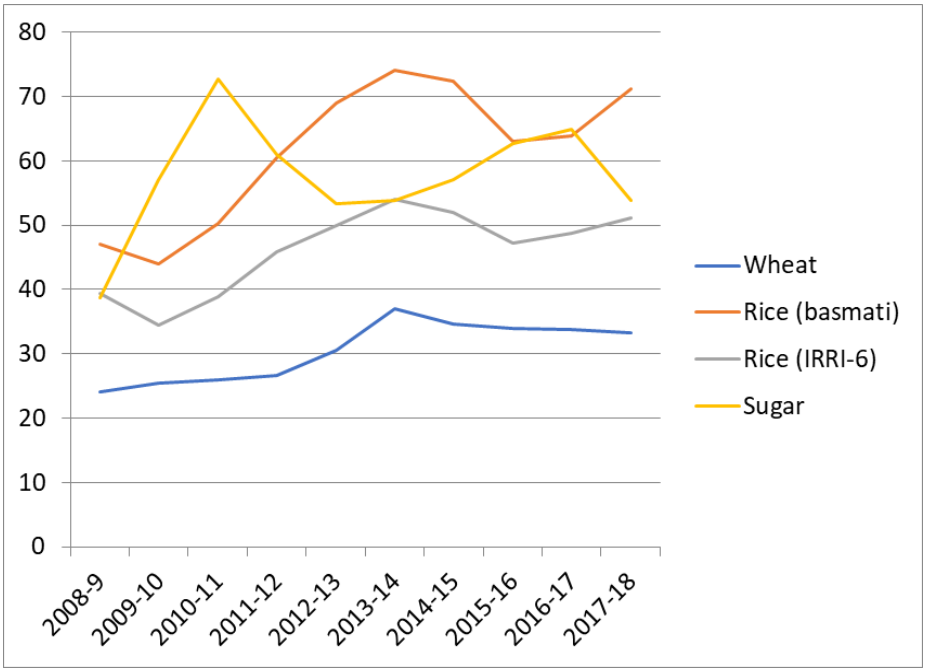
(Rupees per kilogram)

Year	Wheat	Rice(basmati)	Rice (IRRI-6)	Sugar
2008-2009	24.1	47.1	39.4	38.7
2009-2010	25.5	44.0	34.4	57.1
2010-2011	26.0	50.3	38.9	72.7
2011-2012	26.7	60.4	45.9	61.0
2012-2013	30.6	69	50.0	53.3
2013-2014	37.0	74.1	54.0	53.8
2014-2015	34.6	72.4	52.0	57.1
2015-2016	33.9	63.0	47.2	62.6
2016-2017	33.7	63.9	48.7	64.9
2017-2018	33.2	71.2	51.1	53.9

Source: Ministry of Finance, 2018

Figure 3.3.4

Price trend of important food items



Source: Ministry of Finance, 2018

Pakistan has taken a holistic view of issues faced by the agriculture sector and sound recommendations have been made to improve productivity. The following projects have been initiated under the Prime Minister's Agriculture Emergency Program, (Ministry of Finance, 2019a):

a) Productivity Enhancement of Wheat, Rice, and Sugarcane: Five-year budgetary support of PKR 19,301 million, PKR 11,433 million and PKR 3,912 million, respectively, to increase wheat, rice and sugarcane productivity, respectively. Key interventions for each crop comprise (i) promoting mechanization through a 50 per cent subsidy for purchase of crop-specific machinery, (ii) development of high-yield hybrid varieties and improving the supply of certified/tested seeds, (iii) setting up new and upgrading research institutes by

engaging international experts, (iv) re-organizing extension services at all levels including, agronomy, plant protection and marketing and (v) upgrading crop processing methods and facilities.

b) National Oilseeds Enhancement Program: Five-year budget of PKRs 10,176 million for (i) registration of oilseed growers for grant of subsidy, (ii) a subsidy of PKR 5,000 per acre (around 0.4 hectare), up to a maximum of 20 acres (around 8 hectare), (iii) a 50 per cent subsidy for oilseed machinery, (iv) ensuring hybrid seed availability through national and multinational seed companies, (v) establishment of Procurement Centers in collaboration with the All Pakistan Solvent Extractors Association (APSEA) under government monitoring and (vi) demonstration oilseed plots.

c) Conserving Water through the Lining of Watercourses: The project targets the lining of up to 50 per cent of the total length of 73,078 water courses (reconstruction and new) inclusive of 13,875 water storage tanks. This project also covers financial support for purchasing laser land levellers, on a 50 per cent cost-sharing basis with the government's share capped at PKR 250,000 per beneficiary. The total project cost is PKR 179,705 million over five years. The key interventions are: (i) social mobilization through capacity-building of Water Users Associations; (ii) minimization of conveyance and field application losses; (iii) reduction in waterlogging and salinity; (iv) equity in water distribution; (v) reduction in water disputes/thefts/litigation; (vi) motivation/ participation of farmers; (vii) poverty reduction through employment generation; (viii) increasing crop yield/food sufficiency.

d) Enhancing Command Area of Small & Mini Dams in Rainfed Areas: With a five-year budget of PKR 27,700 million, the key interventions are (i) development of command area of small and mini dams, (ii) improving land and water productivity, (iii) poverty reduction through employment generation, (iv) increasing cropping area and food sufficiency and (v) improving economic condition of farmers in rainfed areas.

e) Water Conservation in Rainfed Areas of Khyber Pakhtunkhwa: The project with a budget of PKRs 13,020 million over five years includes (i) construction of water ponds, (ii) construction of check dams, (iii) inlet-outlet spillways, (iv) water retaining facility/reservoirs, (v) terracing, (vi) pipelining/open channel flow water courses, (vii) high-efficiency drip, and sprinkler irrigation system, (viii) solarization of water reservoirs/pond and (ix) high-efficiency irrigation systems.

f) Shrimp Farming: With a five-year budget of PKR 4,842.78 million, the key objectives are (i) promotion of shrimp aquaculture in the country, (ii) development of shrimp value chain support services and legal framework, (iii) rural livelihood and job creation and (iv) increasing export earnings from aquaculture.

g) Cage Fish Culture: The key objectives of the project, costing PKR 6,856.87 million over five years, are (i) optimal utilization of natural water resources, (ii) upscaling cage culture technology across Pakistan, (iii) rural livelihood and job creation, (iv) increasing per capita fish consumption and (v) increasing export earnings from cage aquaculture.

h) Trout Farming in Northern Areas of Pakistan: The project, costing PKRs 2,291.97 million over five years has as key objectives (i) promotion of trout farming in cages and ponds through effective utilization of land and water resources, (ii) value chain development for trout fish, (iii) promoting entrepreneurship through commercial fish production by local communities, (iv) rural poverty reduction and (v) fish stock replenishment of natural water bodies to promote tourism.

i) Saving & Fattening of Calf: With a PKRs 5,344 million, four-year budget, the project aims to (i) increase livestock productivity, (ii) improve livestock quality and ensure disease-free livestock for export of halal meat, (iii) enhance meat exports, (iv) enhance export of livestock products and by-products, (v) increase farmers' incomes from sale of fattened calves and (vi) rear breeds for the international meat market.

j) Backyard Poultry Program: Costing PKRs 329.13 million over four years, the programme seeks to (i) create livelihood opportunities for rural landless, mostly women, (ii) rear small flocks in traditional sheds, (iii) use household/organic waste as feed, (iv) utilize free-ranging and minimal inputs, (v) create a ready source of eggs and meat for the poor and (vi) alleviate poverty through supplemental income from poultry products.

These initiatives supplement government efforts to improve agricultural productivity, including wheat, rice, sugarcane and oilseeds to harness the untapped potential of fisheries conserve water and increase meat exports. The projects are funded from the Public Sector Development Program (PSDP) at the federal level with a major share being funded by the provinces from their respective Annual Development Programs (Ministry of Finance, 2019a).

3.3.2. Agricultural mechanization

3.3.2.1. National policy on agricultural mechanization

Despite several agricultural mechanization initiatives, Pakistan did not have a formal mechanization policy and strategy (Ahmad, 2015) till 2017 when the Ministry of National Food Security & Research (MNFS&R) formulated the National Food Security Policy and mechanization policy to promote agricultural mechanization through the following measures:

(i) Reduction in duties and taxes on import of farm machinery.
(ii) Reduction in the general sales tax (GST) for farm machinery.
(iii) Promotion of precision agriculture for profitability.
(iv) Incentives for purchasing processing and value addition machinery to reduce post-harvest losses for fruits and vegetables.
(v) Incentives for import of hay/silage making, milking, dairy and meat processing machinery.
(vi) Aquaculture mechanization for intensive production, processing and cold chain maintenance.
(vii) Establishment of a "National Center for Testing of Agricultural Machinery (NCTAM)" with regional/provincial satellite institutions under the Ministry of Industry and supported by the Engineering Development Board.
(viii) Development of a National Network of Agricultural Mechanization to coordinate agricultural mechanization research and development (R&D).
(ix) Promoting the use of alternate and renewable energy sources at farm level.
(x) Establishment of machinery pools as farm-service centres in provinces by the private sector (Ministry of National Food Security & Research, 2017).

The 2017-18 budget reduced the sales tax on tractors and agricultural machinery to 5 per cent. Moreover, customs duty (CD) exemption was given for the import of combine harvesters up to five years old while a 10 per cent regulatory duty (RD) was levied on combine harvesters that are between 5 to 10 years old. Similarly, a 20 per cent RD was levied on combine harvesters that are more than 10 years old. Full sales tax exemption has also been given for the import of combine harvesters of up to 5 years old and sales tax exempted on agriculture diesel engines with power ranging from 3 to 36

horsepower (hp) (Ministry of Finance, 2018).

3.3.2.2. National programmes on agricultural mechanization

Agricultural mechanization technologies were introduced early in the country with the establishment of the Department of Agriculture in Punjab province to rent out bulldozers and tubewell boring machines to farmers. Faculties of agricultural engineering were also established in provincial universities including R&D institutions for the development and indigenization of farm mechanization technologies. Liberal government policies like duty rebates for raw material imports and sales and income tax exemptions/reductions, saw farm machinery manufacturing increase from only 15 manufacturers, none of them making tractors, in 1959, to around 500 manufacturers in 1984. The number of agricultural machinery manufacturers has now dramatically increased, and the local manufacturing industry is producing machines for a variety of agricultural operations such as land development, seedbed preparation, crop stand establishment, interculture, crop protection, harvesting and threshing, and farm produce haulage. However, complex machinery like transplanters for vegetables and paddy, combine harvesters, sugarcane harvesters, cotton pickers, corn pickers, fodder cutters-cum-choppers, silage balers, hay balers, tedder rakes, mango pruners, carrot washers and fruit and vegetable graders is still not produced locally. Pakistan now has three tractor manufacturing plants with an annual production capacity of 65,000 units and about 50,000 tractors are being produced every year (University of Agriculture Faisalabad, 2015).

Agricultural engineering education

The Department of Agricultural Engineering was established in Khyber Pakhtunkhwa province (KPK) in 1961 and was followed by the setting up of the College of Engineering in the University of Peshawar. Formal agricultural engineering education began in 1962 and the first batch of agricultural engineers passed out in 1965. The Agricultural Mechanization Department was set up in 1958 in the Engineering College Workshops of Peshawar University to provide applied agricultural engineering knowledge to students in the College of Agriculture. Service courses in farm mechanics were taught at different levels to all students on shop practice, surveys, farm power, and machinery. In 1981, the Department developed a curriculum for the B.Sc. (Hons) and M.Sc. (Hons) courses in agricultural mechanization (UET Peshawar, 2018).

The Faculty of Agricultural Engineering and Technology was established in Punjab province in 1961 with the Punjab Agriculture College, Lyallpur given the status of University of Agriculture, Lyallpur. A pioneering faculty of its kind in Pakistan, its main objective was to meet the growing needs of mechanized farming in Punjab. In 1961, a diploma class in agricultural engineering was started to support the Thal Development Authority (TDA) and the Agricultural Engineering Workshop, being replaced by a four-year B.Sc. Agricultural Engineering degree in 1963.

The faculty provides training and conducts field research on irrigation and drainage, farm power and machinery, structures and environment, textile technology and food engineering. The faculty has played a vital role in mechanizing agriculture in Punjab.

In 1977, the B.Sc. Agricultural Engineering course was started in Sindh Agriculture University, Tandojam. The course was expanded and also started at Bahauddin Zakariya (BZU) University, Multan in 2004 and in PirMehr Ali Shah Arid Agriculture University, Rawalpindi in 2013 (University of Agriculture, Faisalabad, 2015).

Progress of farm mechanization

The history of farm mechanization in Pakistan begins with a 1928 report of the colonial-era Royal Commission on Agriculture recognizing the need for replacing bullocks with tractors and emphasizing the importance of agricultural mechanization research. This led to the establishment that year of the Engineering Workshop of the Agriculture Department at Faisalabad which undertook research and development work on agricultural implements. The 1945 Famine Inquiry Commission also emphasized the need for replacing bullocks with tractors for cultivation and in 1951, the Pakistan Agricultural Inquiry Committee recommended use of machinery for rapidly creating new arable lands and cultivating riverine tracts. In 1960, the Food and Agricultural Commission also considered mechanization of agriculture but cautioned against the displacement of human labour by machinery. The 1964 Revelle report recommended major attention to designing agricultural equipment and systems suitable for smallholdings and the development of small-power tractors (Agriculture-Field, Punjab, 2019a). Pakistan's five-year development plans funded the expansion of land development with heavy machinery and the setting up of a network of agricultural workshops in Punjab province. In 1958, the Farm Mechanization Committee investigated farm mechanization issues in Pakistan, analyzed the agricultural system and recommended programmes for 5 years, 10 and 15 years. The National Network of Agricultural Mechanization was established in 1982 under the Ministry of Food, Agriculture and Livestock but has since ceased functioning. The role of farm mechanization in boosting agricultural production was recognized in the Sixth Five Year Plan (1983-1988) and the 1986 National Commission on Agriculture emphasized the need for farm mechanization. In 1987, the Regional Network for Agricultural Mechanization issued guidelines for mechanization policies and strategies and during the 1990s, the government prioritized farm mechanization (Ahmad, 2015; Amjad, 2017b; and Agriculture-Field, Punjab, 2019a).

In the province of Punjab, the Agriculture Machinery Organization (AMO) was established in the Agriculture Department. The Government of then West Pakistan continued its activities already in progress under the initiative of "Power Farming", and the Agriculture Research Station Faisalabad began to have the mandate of developing lands and augmenting water supplies with the help of machinery. Bulldozers and power drilling rigs were added to supplement activities of the Thal Development Authority which merged into the Agricultural Engineering Department in 1970. The Directorate General Agriculture (Field) Punjab, Lahore, was established in 1973 in charge of supervising the Engineering Wing of the Agriculture Department. There are five directorates, namely the Directorate of Agricultural Engineering (DAEs) with branches at Faisalabad, Multan and Lahore, the Directorate of Soil Conservation (DSC) with branches at Rawalpindi, the Directorate of Agricultural Mechanization Research Institute at Multan and the Directorate of Agricultural Engineering with branches in Balochistan, Khyber Pakhtunkhwa and Sindh provinces, which rented out bulldozers and other agricultural machines to farmers (Agriculture-Field Punjab, 2019a).

In the 1950s, farmers started replacing draught animals with diesel engines for pumping irrigation water (Ghulam and Hussain, 1986). Tractors and practically all farm machines were imported in the first few years after independence in 1947, with Massy Ferguson, Ford, International, Belarus and Zetor tractors imported in CKD (completely knocked down) form. Later, Ford and Belarus tractors were assembled in Pakistan, but these companies went out of business in the 1990s. Efforts were made to introduce small four-wheel tractors in the 19-26 kW power range including MF 210, Kubota L295, Ford 1910, Russian T25 and Taishan 18-35 hp and power tillers. These tractors were imported from China,

Europe, Japan and the Russian Federation but were not accepted by farmers who wanted to rent out the tractors and small tractors had little scope for rental services.

The move towards mechanization started in the mid-1960s with the introduction of high-yielding Mexican wheat varieties that required greater fertilizer use, irrigation and judicious use of resources. The new seed technologies required more intensive cultivation that was difficult with traditional methods. The use of mechanical wheat threshers began in the 1970s to offset the large harvest losses caused by a shortage of labour and heavy rains. Reapers and combine harvesters were introduced in the mid-1980s and tractors, electric and diesel pumping sets began to replace traditional power (Ahmad, 1988). The use of farm machinery during the last four decades has kept pace with the changes in agriculture in the country. Mechanization has increased productivity and generated extra farm income (RNAM, 1993). Medium-sized tractors are being widely used but small tractors, power tillers and rice transplanters have not been adopted (Ahmad, 1988). Wheat drills, cotton planters and weeders were introduced in the 1980s and with the introduction of hybrid maize, the use of sunflower row crop planters began in the late 1990s.

Farmer access to mechanization

Farm machines are expensive for small and medium landholders and there is a trend of farmers renting out tractors with tillage implements, sprayers and wheat threshers, to neighbours as well as renting of combine harvesters from custom hiring companies. The Khyber Pakhtunkhwa province has set up farm machinery service centres for the use of small farmers.

Mechanization initiatives to support small farmers

• Farm Mechanization for Food Security (2008-2010): agricultural machines/implements provided to selected small-scale farms at 50 per cent subsidized rates in 35 districts of Punjab; a total of 9,542 units, including rotavators, disc harrows, chisel plows, MouldBoard plows, colter drills, roto-drills, groundnut diggers and reapers were supplied at a cost of PKR 314.7 million.

• Promotion of Mechanized Multi-crop Farming in Mixed Cropping Zone of the Punjab (2009-2010): implemented in 14 districts of mixed cropping zones of the province with the objective of increasing yields by mechanizing various stages of farm operations; a total of 3,995 potato planters, potato diggers, sugarcane planters, sugarcane ridgers, vegetable ridgers, maize shellers, citrus sprayers and disc harrows supplied at a 50 per cent subsidy at a cost of PKR 145 million.

• Wheat Straw Management in Wheat Growing Areas of Punjab (2009-2010): a total of 180 units of wheat straw choppers provided to farmers on a cost-sharing basis in 25 districts of Punjab, with a 50 per cent subsidy at a cost of PKR 31.5 million.

• Establishment of Hi-Tech Mechanization Service Centers (HMSCs) (2016-2021): establishing of state-of-the-art farm mechanization service centres in all Punjab districts to rent out farm machinery and equipment to farmers; the PKR 3830.205 million project has set up the service centres (Agriculture-Field Punjab, 2019b).

Most commercial banks in the country offer credit for the purchase of farm machinery to small and medium farmers while the federal government awards tractors in prizes to farmers who achieve higher wheat yields.

Agricultural mechanization and gender

Tillage is almost fully mechanized in Pakistan but maize, cotton and vegetable sowing, and rice transplanting are still performed by women who are being replaced in wheat and rice harvesting operations by reaper-windrowers and combine harvesters. On small family farms, women still harvest pulses while about 80 per cent of cotton and

vegetable picking is done by women.

During the 1960s, women used a hand tool called khurpa to harvest groundnuts and potatos, but this is now mostly done using groundnut and potato diggers. Threshing and cleaning operations, once performed by women, are now almost fully mechanized but on small family farms, cutting and chopping fodder is mostly done by women, with farm accidents caused by unsafe fodder chopping machines.

There is a need for small farm machines suitable for use by women such as dibblers to sow vegetables, maize and cotton. Most rice transplantation is done by women and children and there is a need for mini-transplanters suited for handling by women.

With decreasing farm size, the number of small farmers is increasing in Pakistan and this, together with their limited incomes, is a challenge for mechanization. There are inadequate custom hiring services available to small farmers as rental service providers prefer big landholders (Amjad, 2017a).

3.3.2.3. Current level of agricultural mechanization

Adoption of agricultural mechanization has remained selective and is still limited in Pakistan; only those operations which face labour and/or power constraints have been mechanized. Most farm operations are partially-to-fully mechanized, except the sowing of rice, sugarcane and maize on furrow which are still manual. Cotton and sugarcane harvesting is not yet mechanized (see Table 3.3.5).

Table 3.3.5

Mechanization of crop production

Crop	Land preparation	Sowing	Irrigation	Spraying	Inter-culture	Harvesting	Threshing
Wheat	Highly mechanized	Low mechanized	Semi-mechanized	Low mechanized	Nil	Semi-mechanized	Highly mechanized
Cotton	Highly mechanized	Semi-mechanized	Semi-mechanized	Highly mechanized	Highly mechanized	Nil	-
Rice	Highly Mechanized	Nil	Semi-mechanized	Low mechanized	-	Semi-mechanized	Semi-mechanized
Sugarcane	Highly mechanized	Semi-mechanized	Semi-mechanized	Semi-mechanized	Semi-mechanized	Nil	-
Maize	Highly mechanized	Semi-mechanized	Semi-mechanized	Low mechanized	Semi-mechanized	Low mechanized	Highly mechanized
Potato	Highly mechanized	Semi-mechanized	Semi-mechanized	Highly mechanized	Highly mechanized	Semi-mechanized	-
Pulses (Gram)	Semi-mechanized	Semi-mechanized	Low mechanized	Low mechanized	Low mechanized	Low mechanized	Highly mechanized

Source: Ahmad T. (2015)

The level of mechanization of land preparation and spraying operations ranges from 85 to 90 per cent while 40 per cent of weeding/intercultural and harvesting operations are mechanized (see Table 3.3.6). Rice transplanting is done manually while 25 per cent of sugarcane, maize, cotton and wheat planting operations are semi-mechanized. Despite the availability of planters and seed drills, farmers

still use manual labour.

Table 3.3.6

Mechanization of farm operations, 2010

(Percentage)

	Farm operation	Mechanization level
1	Seedbed preparation	85
2	Sowing/planting	25
3	Weeding/interculture	40
4	Spraying	95
5	Harvesting	40

Source: Pakistan Bureau of Statistics, 2010, cited by University of Agriculture, Faisalabad, 2015

The number of tractors, farm machines and implements has increased substantially over the last three decades (see Table 3.3.7).

Table 3.3.7

Pakistan: agricultural machines and implements used

(Units)

Machinery	Census year				
	1975	1984	1994	2004	2010
Tractor	35,714	157,310	252,861	401,663	737,202
Cultivator	31,619	146,863	236,272	369,866	-
Mouldboard Plough	2, 734	7,319	28,413	40,050	-
Bar/Disc harrow	2, 373	8,140	13,233	23,764	-
Disc plow	2,938	6,355	20,372	29,218	-
Drill/planter	1,174	11,251	64,126	70,810	295,184
Ridger	1,174	4,711	10,987	71,338	-
Trailer	18,074	98,787	176,412	242,655	-
Thresher	5,635	78,377	112,707	137,270	353,768
Reaper	-	-	8,073	13,600	66,958
Combine harvester	-	-	359	3,355	29,344
Sprayer			20,778	21,756	1,438,991

Source: Pakistan Bureau of Statistic,1975, 1984, 1994, 2004, 2010b

Of the 7.88 million farms in the country or 95 per cent of total reported cultivated land, some 6.04 million, or 76.76 per cent of total, covering 19.51 million ha, used tractors (see Table 3.3.8). Another 1.55 million farms covering 4.02 million ha, reported using both tractors and draught animals while the use of bullocks and other animals for cultivation was reported by only 0.3 million farms covering 0.52 million ha.

Table 3.3.8

Use of tractors and draught animals for cultivation

(Millions, millions of hectares)

Administrative unit	Farms	Farms		
		Tractor	Draught animal	Tractor and draught animal

	Number	Area	Number	%	Area	Number	%	Area	Number	%	Area
Pakistan	7.88	19.51	6.04	76.76	14.97	0.30	2.65	0.516	1.546	20.60	4.02
KPK*	1.44	2.13	0.86	61.90	1.32	0.18	10.46	0.222	0.395	27.64	0.59
Punjab	5.10	11.69	4.18	81.97	9.58	0.06	0.77	0.090	0.857	17.26	2.02
Sindh	1.07	3.83	0.82	75.78	2.90	0.04	3.85	0.148	0.205	20.37	0.78
Balochistan	0.28	1.86	0.18	63.06	1.18	0.01	3.01	0.056	0.090	33.93	0.63

Source: Pakistan Bureau of Statistic, 2010

* Khyber Pakhtunkhwa

Farm machinery use

a) Tillage

(1) Machinery for soil moisture conservation

In the rainfed areas of Pakistan (Potohar), moisture conservation is an essential farm operation. After the wheat harvest and before the monsoon rains, farmers usually plough with a 50 hp tractor, 3-bottom M.B. plow and 9-tines cultivator to conserve moisture. Some farmers also use a disc harrow.

(2) Precision land levelling machinery

Tractor-mounted front and rear blades are available from private rental services while bulldozers can be rented from government agencies for land leveling. The use of laser land levelers is also on the rise. Tractors of 50 horsepower, with a 7 ft-wide front blade and a 5 ft-wide rear blade, are used.

(3) Primary tillage implement

Tillage operation for most crops is almost fully mechanized and uses a cultivator, followed by a disc harrow and a rotavator. In irrigated areas, the majority of farmers use tine cultivators with a working depth of 3-4 inches. Progressive farmers use a 3-bottom M.B. plow, a 3-discs plow and a 3-tines chisel plow. Bullock-drawn implements have been almost phased out except in some hilly areas where tractor access is limited.

(4) Secondary tillage implement

The tine cultivator is widely used but the use of disc harrows and rotavators is catching up rapidly. Mounted type offset 16-discs harrows and 18-discs offset trailed type disc harrows are used along with rotavators with 40 to 48 blades.

(5) Seed bed preparation implement

A cultivator with wooden plank is mostly used while progressive farmers also use disc harrows, rotavators and ridge formers.

b) Nursery and planting machinery

Vegetables and rice nurseries are manually transplanted. Direct drilling of rice is becoming popular and direct-seeded rice drills are being manufactured in rice-growing areas. Cotton and maize planters are available but about 80 per cent of the maize and 50 per cent of the cotton crop is planted on ridges using manual dibbling operation, bed and furrow planters and pneumatic row crop planters. About 70 per cent of wheat and 98 percent of grasses are manually broadcast.

Although seed drills are available, farmers and individual service providers prefer broadcast methods for sowing wheat, grasses and pulses in irrigated areas. In rainfed areas, the “Rabi” seed drill is used but farmers broadcast the fertilizer. Sugarcane planters are available, but farmers prefer manual set sowing methods with a ridger. In manually harvested paddy fields, a zero-tillage drill is used for wheat sowing. Fertilizer band placement drills and bed and furrow seed drills are being used in irrigated areas.

c) Intercultural operations and weeding machinery

The intercultural operation for sugarcane, cotton, maize and vegetables is done with row crop weeders and sweep cultivators. Pre- and post-emergence weedicides are becoming popular. Weeding for sugarcane and maize crops is 80 per cent mechanized. For crops sown in rows, rotary weeders and tillers are used on a limited scale with manual labour being mostly used for this operation.

d) Irrigation

Flood and furrow irrigation methods are used in canal irrigated areas. Where canal irrigation is not available and underground water is fit for irrigation, turbine and submersible pumps for deep wells are used, while centrifugal pumps are used where groundwater is available at shallow depth. Sprinkle and drip irrigation are being used and the use of solar irrigation pumps is on the rise, supported by a government subsidy.

e) Fertilizer application

This is mostly through the broadcast method while for row crops, fertilizer is manually poured.

f) Harvesting

Wheat harvesting is 80 per cent mechanized and uses reaper-wind-rowers, cutter binders and combine harvesters. Otherwise, the wheat crop is harvested manually and threshed by stationary threshers. In Punjab, 80 per cent of the rice crop is harvested by combines while in Sindh and Balochistan, it is manually harvested and threshed by locally produced, high-capacity threshers. Pulses, maize, cotton and sugarcane are harvested manually. Vegetables are totally picked by hand. Where wheat is harvested by combines, wheat straw choppers are used for harvesting stubbles and lifting wheat straw, and balers are later used for making straw bales for long-distance hauling. About 95 per cent of groundnut harvesting is done using locally produced groundnut diggers and threshers. The potato crop is harvested with locally produced potato diggers.

g) Post-harvest and grading

After manual or reaper harvesting, the wheat crop is mechanically threshed. The bulk of rice in Balochistan and Sindh is threshed using locally produced rice threshers. Almost all pulses are threshed mechanically. About 95 per cent of maize in Punjab and 80 per cent in Khyber Pakhtunkhwa is shelled using maize shellers. More than 700 seed companies use seed graders.

h) Processing

Primary processing is done by wheat straw chopper-cum-blowers, maize shellers, dates dryers, grain dryers, butter churn machines, seed graders and mobile seed processing units. For value added products, packaging machines, psyllium processing machinery, rice processing machinery, flour- and pulses-processing machinery, mango- and citrus-processing machinery, milk tankers, milk cooling tanks, milk processing machines, poultry and meat processing machinery, and silage processing machinery, are being used.

i) Hand tools and implement

With the increased availability of tractors, the use of bullock-drawn implements and hand tools manufacturing has declined considerably. In desert areas, ploughing and sowing is done by camels while in the plains, there is negligible use of animal power. Traditional implements are used only in hilly areas (Amjad, 2017a; and University of Agriculture Faisalabad, 2015).

j) Solar technology

The use of solar technology is catching up with

farmers across the country. Solar-powered tubewells and electricity-generating panels have become popular in recent years with several progressive farmers (Aazim, 2014).

Presently, about 675,000 tractors (within the 10-year depreciation period) are in operation in Pakistan. Of these, 92 per cent are equipped with cultivators, 30 per cent with MB plows, 15 per cent with disc plows, 5 per cent with chisel plow, 15 per cent with rotavators, 25 per cent with disc harrows, 5 per cent with ridgers and 20 per cent with seed drills. Average farm power usage in Pakistan is 1.25 kW/ha excluding tubewells and 1.63 kW/ha including tubewells (see Table 3.3.9). The share of human power, animal power, power from medium tractors, large tractors and tubewells is 4.2 per cent, 2.2 per cent, 37.88 per cent, 28.11 and 30.57 per cent, respectively (see Figure 3.3.5). Tractor power accounts for almost 66 per cent of power usage, the rest being provided by manual labour, work animals and tubewells. If tubewells are excluded, tractor power accounts for 91 per cent of power supply and, assuming 95 per cent of tractors are available for cultivation, then one 50 hp tractor is available for 32.6 ha cultivated area (Pakistan Statistical Yearbook, 2017).

Table 3.3.9

Pakistan: farm power

Source	*Numbers millions*	*Kilowatt per unit*	*Power available (millions of kilowatt)*	*Share (percentage)*
Agricultural labour *	24.2	0.075	1.82	4.2
Work animals *	2.42	0.4	0.96	2.2
Medium-size tractors – 65 per cent of total population (675 000) **	0.438	37	16.2	37.88
Large tractors – 35 per cent of total population (675 000) **	0.236	51	12.03	28.11
Tubewells (diesel, electric, others) ***	1.31	7.457	11.77	30.57
Total power	42.78			
Total power, excluding tubewells	31.01			
Power available for cultivation (95 per cent assumed), excluding tubewells	29.45			
Total cultivated area (millions of hectares) **	23.6			
Power available (kilowatt per hectare), excluding tubewells	1.25			
Power available (kilowatt per hectare), including tubewells	1.63			

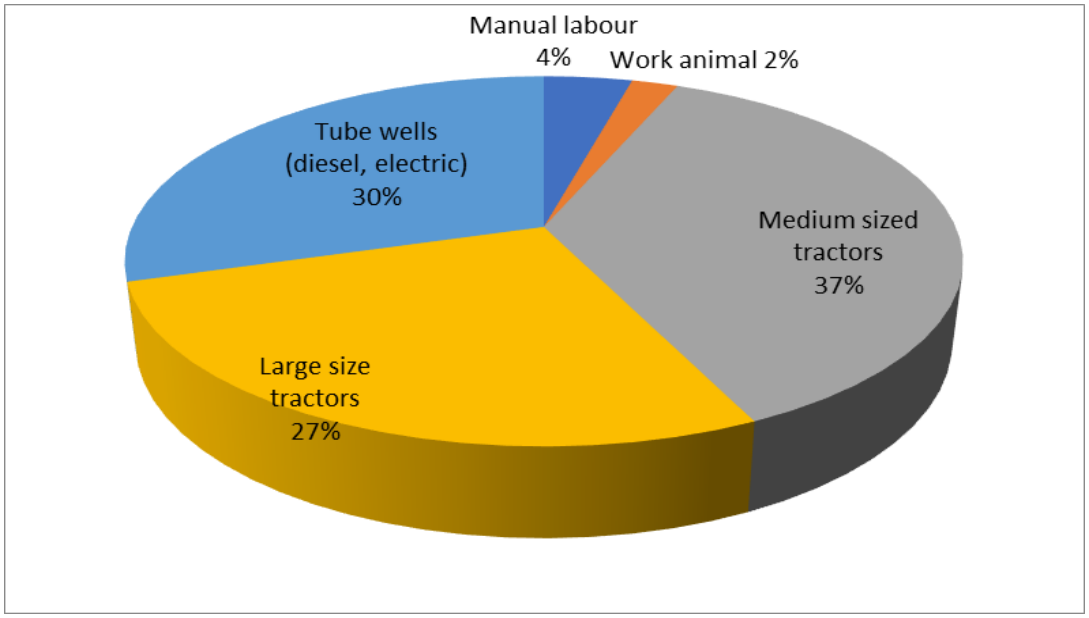
Source: * Ministry of National Food Security &Research, 2017

** Pakistan Bureau of Statistics, 2017

*** Ministry of Finance, 2018

Figure 3.3.5

Percentage share of farm power



Source: Ministry of National Food Security &Research, 2017, Pakistan Bureau of Statistics, 2017 and Ministry of Finance, 2018

Agricultural implements and machine industry

Agricultural machinery manufacture began in Pakistan in the early 1950s with the establishment of Isakhel Estate Farm, KotSamaba, District Rahim Yar Khan, Punjab, which imported the country's first tractor in 1954 and set up a manufacturing unit with the collaboration of the United States-based John Deere company. Isakhel Estate Farm also trained local farmers and provided repair and maintenance services for tractors and implements. From only 15 in 1959, the number of farm machinery manufacturers in the country had increased to 500 by 1984. The number of manufacturers grew during 1978-1984 due to liberal government policies such as import duty rebates for raw materials and income tax exemptions. However, production by medium-sized manufacturers ended or declined due to the withdrawal of these government incentives (University of Agriculture Faisalabad, 2015).

Pakistan's domestic industry makes a wide range of farm machinery except complex machines like transplanters for vegetables and paddy, combine harvesters, sugarcane harvesters, cotton pickers, corn harvesters, fodder cutters-cum-choppers, balers for silage, hay balers, tedder rakes, mango pruners, carrot washers, and fruit and vegetable graders. More than 600 local manufacturers are producing machinery for tillage, land development, seedbed preparation, seeding/planting, intercultural operations, harvesting, threshing and crop protection besides trailers for haulage. Production of farm implements and harvesting machines has been mostly indigenized (see Table 3.3.10) (Ahmad, 2015; and University of Agriculture Faisalabad, 2015).

Table 3.3.10

Pakistan: indigenization of locally manufactured farm machinery

Item	Origin	Local content (percentage)
Tractor		
Belarus MTZ-510 (41kW)	Former Soviet Union	30
Fiat-480 (37 kW), Fiat-640 (48 kW), NH-70-54 (63 kW), NH- 55-56 (41kW)	Italy	90
IMT-565 (44 kW), IMT-549 (37 kW), IMT-577((57)	Yugoslavia	70
MF-240 (37 kW)	United Kingdom	93
MF-260 (45 kW), MF-360 (45kW)	United Kingdom	85
MF-375 (56kW), MF-385 (63kW)	United Kingdom	82
Land development implements		
Front and rear blades, land leveler, laser land leveler, scrapers	Pakistan	100
Planting implements		
Seed drill, potato, maize and cotton, and groundnut planters, ridger, a post hole digger	Pakistan	100
Weeding and hoeing implements		
Bar harrow, rotary weeder, row crop weeders, and sweep cultivators	Pakistan	100
Primary tillage implements		
Moldboard plow, chisel plow, subsoiler,	Pakistan	100
Disc plow	Spain/Pakistan	60
Secondary tillage implements		
Cultivator	Pakistan	100
Disc harrow, border disc	Australia, Brazil, Spain	80
Rotavator	Pakistan	100
Harvesting machinery		
Reaper-windrower, potato digger, groundnut digger, groundnut thresher	Pakistan	100
Combine harvester	Europe (replacement parts)	15
Threshing machinery		
Wheat thresher, multi-crop thresher, sunflower thresher, maize sheller, rice thresher	Pakistan	100
Handling & haulage machines		
Trolley, wheat straw chopper Others	Pakistan	100
Cane crusher, chaff cutter, grain cleaners, dryers, pumps, ditchers, sprayers, and broadcasters	Pakistan	100
Diesel engine (high speed)	China	60
Milk production machinery	Türkiye	90
Farm-level food processing machinery	Different	100
Machinery livestock and poultry	Different	100
Lawn mowing machinery	Different	100
Horticultural equipment	Different	100

Source: Ahmad T. (2015)

Tractor manufacturing

Tractor manufacturing began in Pakistan with the establishment of Rana tractors (now Millat Tractors Limited) in 1964 and an assembly plant was set up in 1967 to assemble tractors imported in semi-knocked down (SKD) condition. The Government of Pakistan approved local production of tractors with

a programme in 1981 and five manufacturers were licensed. The manufacturers of Belarus, Ford and IMT tractors went out of business and now only M/s Millat Tractors Ltd. Lahore and M/s Al-Ghazi Tractors Ltd. Dera Ghazi Khan are producing 8 models in the power range of 50 to 85 hp. Both companies have well-established manufacturing/assembling plants and a network of distribution and after-sale service centres throughout Pakistan. M/s Millat Tractors Ltd. produces 45,000 units annually while M/s Al-Ghazi tractors Ltd. has an installed capacity of over 30,000 tractors on a single shift basis. Besides these two major manufacturers, there are a few others producing and marketing locally assembled and imported tractors on a limited scale such as IMT and Belarus tractors being assembled by OMNI group in Karachi, although their market share is less than 4 per cent. (University of Agriculture Faisalabad, 2015).

There are three main tractor manufacturers and about 50,000 units are produced annually in Pakistan although the national installed manufacturing capacity is 65,000 units per year.

The effects of mechanization have been overall positive, not only increasing on-farm income and labour productivity but also generating off-farm employment in manufacturing, supply, agricultural machinery servicing, supply of other inputs and post-harvest handling of the increased agricultural production.

3.3.2.4. Agricultural mechanization research and development

Farm mechanization research and development in Pakistan started with the establishment of the Agricultural Engineering Research Division at Faisalabad in 1964 which was upgraded into a full institute in 1976 and named Agricultural Mechanization Research Institute (AMRI). In 1976, a small farm mechanization research programme was started in Islamabad named the IRRI-PAK Research Program. In 1979, the Agricultural Machinery Division (AMD) was established, which was upgraded in 1982 to a fully-fledged institute named Farm Machinery Institute (FMI) under the Pakistan Agriculture Research Council (PARC). The FMI was subsequently renamed as Agricultural and Biological Engineering Institute (ABEI) and is now known as the Agricultural Engineering Institute (AEI). Both institutes are actively involved in R&D for design and development, testing and evaluation, and promotion of low-cost and appropriate farm mechanization technologies. These institutions also test and evaluate imported and locally produced farm machinery for adaptation and provide technical assistance to the local farm machinery industry and farmers.

Several organizations are working on agricultural mechanization. These include: (i) Ministry of National Food Security & Research, and its related development institutions mainly AEI, National Agricultural Research Centre (NARC) Islamabad, under PARC at the federal level; AMRI, Multan, under the Punjab government; Agricultural Mechanization Research Cell (AMRC), Tandojam under the Sindh government; Centre for Agricultural Machinery Industries, MianChannun under the Punjab government; and Agricultural Light Engineering Program (ALEP), Mardan under the Khyber Pakhtunkhwa government; (ii) agricultural machinery manufacturers; (iii) financial institutions; (iv) federal and provincial autonomous bodies; (v) provincial directorates of agricultural engineering; (vi) and agro-services providers (Ahmad, 2015; and University of Agriculture Faisalabad, 2015). Both AEI and AMRI are involved in testing and evaluating local and imported farm machinery, developing new machines and adapting imported machines to local conditions, improving locally manufactured machines and providing technical assistance to the local farm machinery industry (see Table 3.3.11),

(Ahmad, 2015; and University of Agriculture Faisalabad, 2015).

Table 3.3.11

Mechanization technologies developed and commercialized

	Agricultural Engineering Institute (AEI), NARC, Islamabad	Agricultural Mechanization Research Institute (AMRI), Multan
Activities	Design and development of low-cost farm machines. Testing and evaluation of agricultural machines and implement Industrial extension and commercialization of developed farm machines and providing technical assistance to local manufacturers Agricultural mechanization research studies Standardization of agricultural machines Training in operation and maintenance of farm machinery Advisory services to PARC and MNFS&R on policy matters related to agricultural mechanization	R&D for low-cost and appropriate agricultural machinery and farm mechanization technologies. Industrial extension service to local agricultural machinery manufacturers for production of standardized and quality machinery and implements through prototype development, testing and evaluation. Technical guidance to farmers for proper selection, operation and maintenance of agricultural machinery and equipment.
Mechanization technologies developed and commercialized	Tractor front mounted reaper-windrower, groundnut digger, groundnut thresher, sunflower thresher, soybean thresher, paddy thresher, pneumatic row crop planter, zero-till drill, fertilizer band placement drill, canola thresher, wheat straw chopper-cum-blower, milking machine, mobile seed processing unit, and olive oil extractor.	Seed drills, planters, ridger, bed shaper, weeders, wheat thresher, rotary slasher, potato planter, groundnut digger, maize sheller, rotary tiller, boom sprayer, fertilizer spreader, axial flow pump, seed cleaner grader, hand dibbler, furrow bed/shaper planter, soil hardpan tester, bullock drawn implements, and mobile “bhoosa” chopper and baler.
Mechanization technologies being developed	Pak seeder, PTO disc plow, vegetable planter, turmeric dryer, solar-cum- gas-fired dryer, mini seed cleaner-cum grader, flatbed dryer for canola, sunflower and maize, date dryer, mango picking and pre-cooling technology machine, nursery raising plant, hot-water treatment plant for eradicating mangoes fruit fly infestation, and wood shredder, maize fodder cutter and shredder, mobile high capacity sugarcane crusher and psyllium processing machinery, groundnut digger-cum-shaker.	Trencher, fodder cutter bar, sugarcane base cutter, pneumatic drill, rotary ditcher, briquette, ejector pump, biogas plant, groundnut sheller, seedbed finisher, stubble shaver, carrot harvester, and orchard sprayer.

Source: Ahmad T. (2015)

3.3.2.5. Import and export of agricultural machinery

Pakistan imports high-power tractors, harvesters, silage machinery, diesel engines for pumping sets, discs for disc harrows and disc plows, and parts of laser levelers. Pakistan also exports tractors, planters, reapers, threshing machines and some

implements to Afghanistan, countries in the Middle East, South Africa, Sri Lanka, Sudan, Tanzania and Zimbabwe (The Nation, March 24, 2012). Agricultural machinery imports grew by 4.77 per cent during the financial year 2017-2018. During the July-June 2017-2018 period, agricultural machinery worth USD 124.412 million was imported against import of USD 118.743 million in the same period of the preceding year (Ministry of Finance, 2019).

The Government of Pakistan has exempted customs duty and sales tax on the import of combine harvesters up to five years old while levying a 10 per cent regulatory duty (RD) on combine harvesters between five to ten years old. Similarly, 20 per cent RD has been levied on combine harvesters more than ten years old while sales tax is exempted on agricultural diesel engines of between 3 to 36 hp (Ministry of Finance, 2018).

3.3.3. Enabling environment for trade and investment for sustainable mechanization of the agricultural sector

3.3.3.1. Investment environment and policy

a. Public-private sector partnerships in sustainable agriculture mechanization

The private sector has played a key role in the commercialization of agricultural mechanization technologies in Pakistan. The R&D institutions AEI and AMRI provide drawings, prototypes and technical assistance to the private sector for local production (Amjad, 2017a).

The Government of Pakistan is encouraging joint ventures between the private sector and foreign investors in the agricultural field (Dawn, 2019). There is good business opportunity in manufacturing specialized/critical components like gears, sprockets, wearing parts of soil-engaging parts of agricultural machinery which will also promote quality in manufacturing and create job opportunities.

Joint ventures for manufacture of sophisticated and complex machinery like rotavators, disc plows, vegetable and paddy transplanters, combine harvesters, sugarcane harvesters and cotton pickers need to be promoted with government incentives such as soft-term loans, import duty exemptions and tax holidays.

Strategically located as a gateway to Central Asia, with an over 60 per cent youth population, a large pool of scientists, engineers, bankers, lawyers and other professionals, an improving economic outlook, a robust stock market and several special economic zones, Pakistan is an attractive foreign investment destination. Consumer goods, power generation, renewable energy, telecommunication equipment and services, agricultural machinery and equipment, franchising, waste management and healthcare have been identified as best industry prospects for the next several years (US International Trade Administration, 2020).

b. Role of agricultural machinery manufacturers', dealers' and distributors' associations

The private sector dominates agricultural machinery manufacture in Pakistan. Before 1991, two of the five tractor manufacturing plants in the country were managed by the government. But now, all are privately owned though only three plants remain in business, with an installed capacity of more than 65,000 units per year. Prices of local tractors are low compared to imported units and the domestic industry is meeting local demand with surplus production being exported and also used in the China-Pakistan Economic Corridor (CPEC) project for road construction (Ahmad, 2015; Amjad, 2017a; and University of Agriculture Faisalabad, 2015).

There are seven main agricultural machinery

manufacturing centres, namely Daska, Faisalabad, MianChunu, Hafizabad, Gujranwala, Multan and Rahim Yar khan (Badar, Ghafoor and Adeel, 2017). Other agricultural machinery manufacturing cities include Buraywala, Okara, Sargodha, Bhakkar, Chakwal, Talagang, Rawalpindi, PindiGheb, Lahore and Sheikhupura in Punjab. Agricultural implements and machines are also manufactured in Mardan, Sarderi, D.I.Khan, and Peshawar in KPK. In Sindh, agricultural machines and implements are manufactured in Nawabshah, Larkana, Hyderabad, Sukkar and Karachi. These medium and small manufacturers do not make specialized machines like transplanters and combine harvesters. Implements and machines manufactured in Daska, Faisalabad, and Multan are being exported to Afghanistan and some countries in Africa through private channels.

Farm machinery manufacturers work with a network of dealers to supply agricultural machinery to farmers and provide after-sales service. They also have local associations to resolve issues faced by the industry. The Pakistan Agricultural Machinery and Implements Manufacturers Association (PAMIMA) collaborates with federal and provincial research institutes, agriculture departments, agriculture universities and farmers to undertake, aid, promote and coordinate agricultural implements research and promotion of agricultural mechanization technologies.

c. Initiatives in manufacturing, distribution and adoption of sustainable agricultural mechanization technologies

The government is promoting the localization of agricultural machine manufacturing through imports, testing and joint ventures with local manufactures. Agricultural mechanization R&D institutions such as AEI, NARC Islamabad, AMRI Multan, AMRC Tandojam, Centre for Agricultural Machinery Industries MianChannun and Agricultural Light Engineering Program (ALEP) Mardan, have set up local production and are disseminating agricultural machinery by involving agricultural machinery manufacturers, financial institutions, federal and provincial autonomous bodies, provincial directorates of agricultural engineering and agro-services providers.

Both AEI and AMRI are involved in testing and evaluating local and imported farm machines, development of new machines, adaptation of imported machines to local conditions, improvements in locally manufactured machines and providing technical assistance to the local farm machinery industry (Ahmad, 2015).

Programmes, projects and initiatives:

- ChakPunjFaiz machinery training and dissemination project, in collaboration with the German Government initiated in the 1960s in Multan (Wikipedia, 2019).

- The Punjab government established the Rural Supply Cooperative Corporation (RSCC), which created Farm Services Centers (FSC) in the 1980s (Noor & Abbas, 2014).

- Crop Maximization Program in coordination with the Italian Government in the 1980s (PARC, 1989).

- Barani Agriculture Research and Development Program in coordination with the Canadian Government in the 1990s (PARC, 1989).

- Joint venture for tractor manufacturing in the 1980s.

- Tax exemption for setting up factories in some new economic zones (Amjad, 2017a).

- Creation of Pakistan Agricultural Machinery and Implements Manufacturers Association (PAMIMA) in January 1985 with head office in FMI Islamabad

(RECAMA, 2019).

● Provision of technical assistance to manufacturers by R&D departments through MOUs and provision of prototypes and drawings (PARC, 2018).

● Deregulation of prices of tractors and spare parts in the 1990s.

● Reduction in customs duties and other taxes for import of agricultural machinery.

● Subsidy for farmer purchase of tractors and implements (Noor & Abbas, 2014).

● Establishment of agricultural mechanization research institutes AEI, AMRI and ALEP.

● Training programmes by provincial governments on operation and maintenance of agricultural machinery (Noor & Abbas, 2014; Ahmad, 2015; and Amjad, and others, 2011).

3.3.3.2. Trade environment and policy

a. Risk management

With a population of approximately 207 million and GDP close to USD 305 billion, Pakistan is the seventh-largest market in the Middle East Gulf, African and South Asian regions, in terms of Purchasing Power Parity (PPP). The country's young population, a growing middle class with English as the main business language and a highly evolved services sector make it an attractive market for multinational firms, particularly in the fast-moving consumer goods sector and infrastructure development (US International Trade Administration, 2019). The World Bank's 2020 "Ease of Doing Business Report" ranked Pakistan 108 out of 190 economies for ease of doing business, compared to Afghanistan at 173, Bangladesh at 168, India at 63 and Sri Lanka at 99 (World Bank, 2020).

However, the attractiveness of doing business in Pakistan is hindered by a challenging security environment, electricity shortages and a burdensome investment climate. The financial sector is the primary FDI recipient, followed by the chemicals industry and construction. China is the biggest investor although its relative share fell in the second half of 2018 as Japan, Republic of Korea and the United Kingdom stepped up investments (Santander, 2020).

Despite security threats and emerging market concerns over intellectual property rights, contractual enforcement, economic and governance issues, Pakistan has few restrictions on capital movement by foreign companies, no shareholding restrictions, beyond a few sensitive sectors, simple work permit rules, no technology transfer requirements and a large and sophisticated entrepreneurial class (US International Trade Administration, 2019). There are no foreign exchange controls in Pakistan with free repatriation of profits and capital allowed (Santander, 2020).

Strong and weak points for investment:

Strengths

• A huge domestic market of 207 million people, decreasing poverty, a strong middle class and vibrant demographics.
• Abundant and low-cost workforce.
• High GDP growth in recent years (5.2 per cent in 2017); ranks 108 out of 190 economies for ease of doing business (World Bank, 2020), up from 147th place in 2018.
• Policy to attract FDI with numerous privatizations, equal treatment guaranteed for foreign and local investors, comprehensive tax incentives and efforts in economic reforms.
• Financial and logistical support from the International Monitory Fund (IMF).

Weaknesses

• Security issues in the past, but the situation improved after the 2018 election and an improved relationship with neighbours.

• Corruption, particularly in government procurement, international contracts and the tax system.

• Low fiscal resources with poor improvement prospects due to continuing importance of the informal economy.

• High vulnerability to natural disasters and their negative impact on agriculture.

• Climate change risks for water and food security. (Santander, 2020)

Foreign direct investment (FDI) policy

Several economic liberalization measures have been initiated to attract foreign investors, including a number of tax incentives for industrial units in the energy, ports, highways, electronics and software sectors (Ministry of Finance, 2019b)[1]. Export processing zones (EPZs) have been set up, offering investors exemptions from all federal, provincial and municipal taxes for exports, exemptions from all taxes and duties on equipment, machinery and materials, and access to the Export Processing Zone Authority "one window" services.

There are also incentives for Export-Oriented Units, which are stand-alone industrial units allowed to operate anywhere in the country but required to export 100 per cent of production. However, there are ceilings in strategic sectors like agriculture and certain social areas while foreign investment in some sectors is forbidden for national security reasons (Santander, 2020).

Pakistan's ease of doing business index has improved by 11 points with three reforms in the areas of starting a business, registering property, and resolving insolvency, recognized in the World Bank's "Ease of Doing Business 2019" report. The Board of Investment has committed to creating a conducive business environment (Ministry of Finance, 2019b).

b. Regional trade agreements

Pakistan has joined several bilateral and multilateral trade agreements, including membership of the WTO, the South Asian Free Trade Area Agreement, trade and investment framework agreement with the United States, Pak-Afghanistan Transit Trade Agreement, Pak-Malaysia Trade agreement, Pak-Malaysia Early Harvest Program, Pak-China Free Trade Agreement in Goods and Investment, Pak-China Free Trade Agreement in Services, Pak-China Early Harvest Program, Pak-Sri Lanka Free Trade Agreement, Pak-Iran Preferential Trade Agreement, Pak-Mauritius Preferential Trade Agreement and Pak-Indonesia Preferential Trade Agreement (Ministry of Commerce, 2019).

The country has bilateral investment agreements with Australia, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgo-Luxembourg Economic Union, Bosnia and Herzegovina, Bulgaria, Cambodia, China, Czech Republic, Denmark, Egypt, France, Germany, Indonesia, Iran (Islamic Republic of), Italy, Japan, Kazakhstan, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Mauritius, Morocco, Netherlands, Oman, Philippines, Portugal, Qatar, Republic of Korea, Romania, Singapore, Spain, Sri Lanka, Sweden, Switzerland, Syria, Tajikistan, Tunisia, Türkiye, Turkmenistan, United Arab Emirates, United Kingdom, Uzbekistan and Yemen. These investment treaties generally include provisions to take disputes that cannot be settled through mutual consultation, to arbitration under the United Nations Commission on International Trade Law, the World Bank's International Center for

Settlement of Investment Disputes or the Court of Arbitration of the International Chamber of Commerce. Pakistan is a member of the Multilateral Investment Guarantee Agency (MIGA), an arm of the World Bank.

Pakistan has a bilateral tax treaty with the United States of America since 1959. Pakistan also has double taxation avoidance agreements with Austria, Azerbaijan, Bangladesh, Belarus, Belgium, Canada, China, Denmark, Finland, France, Germany, Greece, Hungary, India, Indonesia, Iran (Islamic Republic of), Ireland, Italy, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Libya, Malaysia, Malta, Mauritius, Netherlands, Nigeria, Norway, Oman, Philippines, Poland, Qatar, Republic of Korea, Romania, Saudi Arabia, Singapore, South Africa, Sri Lanka, Sweden, Switzerland, Syria, Thailand, Tunisia, Türkiye, Turkmenistan, United Arab Emirates, United Kingdom and Uzbekistan, (Ministry of Commerce, 2019).

3.3.3.3. Infrastructure and financial development

a. Infrastructure development

Pakistan has a vast infrastructure for agricultural development which includes farm-to-market roads, irrigation networks, agricultural markets as well as a vast pool of skilled human resources. Highways, energy production plants, seaports and economic zones are being set up under the CPEC projects in the country (Amjad, 2017a).

b. Financial sector involvement in sustainable agricultural mechanization

The use of modern agricultural technologies requires substantial capital investment. Agricultural and private banks in Pakistan provide soft loans to farmers for the purchase of agricultural machines while the government subsidizes the purchase of tractors and farm implements.

In 1994, the federal government offered a 50 per cent subsidy to farmers for the purchase of 10,000 imported tractors. During 2008-2018, the Sindh government provided up to PKR 0.8 million on each tractor sold to farmers as a 50 per cent subsidy. Other provincial governments including Punjab have also provided a 50 per cent subsidy on farm machinery purchase to selected farmers. The Punjab government has subsidized purchase of improved farm implements by tractor-owner farmers from time to time through the "Promotion of Agriculture Mechanization in Punjab" project implemented during 2015-2017. Disc harrows, rotavators, seed drills and subsoilers were provided to selected farmers in all Punjab districts on a 50 per cent subsidy basis at a total cost of PKR 1,184 million (Agriculture Department, Government of Punjab, 2019).

Several agencies are actively providing institutional credit to farmers, including the government ZaraiTaraqiati Bank, commercial and cooperative banks and some NGOs. In the past, about 90-95 per cent of tractors were purchased through financial assistance from ZaraiTaraqiati Bank. Start-up credit is also provided for agricultural mechanization enterprises and loans given for combine harvesters, manufacturing tractor components and agricultural implements and establishing machinery pools (RNAM, 1993).

3.3.4. Summary, conclusions and recommendations

Summary

Agriculture accounts for 18.5 per cent of Pakistan's GDP, provides livelihood to about 65 per cent of rural people and employs about 38.5 per cent of the total national work force of 61.04 million. Agriculture is a major contributor to overall export earnings.

The major crops in Pakistan are wheat, rice, cotton,

sugarcane and maize. Wheat, rice, cotton, sugarcane, and maize are grown on 38 per cent, 12 per cent, 12 per cent, 6 and 5 per cent, respectively, of cropped area. Once a net importer of these crops, Pakistan now produces a surplus of wheat, rice, cotton and sugarcane which is exported. Wheat flour contributes about 72 per cent of Pakistan's daily caloric intake with per capita consumption of around 110 kg/year, one of the world's highest, while annual per capita consumption of rice, edible oils, milk, sugar, pulses and fish is 13, 12, 119, 25, 7 and 2.01 kg, respectively.

The agriculture sector faces challenges both at research and policy levels. Sustainable agricultural growth is based on a paradigm of profitable farming, high productivity, diversification of high-value crops and demand-based production. Small and large farmers get low yields of important crops due to scarcity of resources and inputs. Most small farmers cannot afford necessary inputs while large farmers lack resources and management skills for timely use of inputs and to conduct agricultural operations at the required time for the whole area. Pakistan also faces water scarcity due to increasing climate variability and extreme weather events.

Presently, about 675,000 tractors are in operation in Pakistan. Of these, 92 per cent are equipped with cultivator, 30 per cent with M.B. plow, 15 per cent with disc plow, 5 per cent with chisel plow, 15 per cent with rotavator, 25 per cent with disc harrow, 5 per cent with ridger and 20 per cent with seed drill. Theaverage farm power available in Pakistan is 1.25 kW/ha, excluding tubewells and 1.63 kW/ha, including tubewells. The power share of manual labour, draught animals, medium-size tractors, large-size tractors and tubewells is 4.2 per cent, 2.2 per cent, 37.88 per cent, 28.11 and 30.57 per cent, respectively. The share of total tractor power is almost 66 per cent and the rest is met by manual labour, draught animals and tubewells. Excluding tubewells, the share of tractor power is 91 per cent with a 50 hp tractor available for 32.6 ha cultivated area on average. However, tractor power is underutilized because that individual tractor owners do not own a complete set of affiliated equipment for different operation purposes and limited availability of custom tractor hiring services.

Most farm operations, including tillage and seedbed preparation are partially-to-fully mechanized except the sowing of rice, sugarcane and maize on furrow, which is done manually. Most farm machines and implements are manufactured in Pakistan except some harvest and post-harvest machines. More than 600 local farm machinery manufacturers are producing machinery for land development, seedbed preparation, seeding/planting, intercultural operation, harvesting, threshing and crop protection, besides trailers for haulage.

Some operations are still not mechanized for a variety of reasons, such as the harvesting of cotton and sugarcane. Sugarcane harvesters and cotton pickers are complex machines and very expensive and farmers also want to avoid losses caused by the use of sugarcane harvesters and cotton pickers. Farmers cannot access modern machinery such as rice transplanters, vegetable planters, fruit pickers and orchard pruning equipment. There is partial use of greenhouses and other advanced vegetable production techniques. Farm-level value addition equipment is almost non-existent.

The government has tried to increase domestic agricultural machinery manufacturing through imports, testing and joint ventures between foreign and local manufactures. The private sector has been highly successful in the commercialization of agricultural mechanization technologies in Pakistan. Research and development institutions support the private sector in the commercialization of new agricultural mechanization technologies by providing drawings, prototypes and technical assistance. Agricultural and private banks provide

soft loans to farmers for the purchase of agricultural machines and there are government subsidies for the purchase of tractors and farm implements.

The use of solar-powered tube wells and electricity-generating panels has grown rapidly in recent years among some progressive farmers.

The key constraints to farm mechanization include: a) inefficient utilization of tractor horsepower; b) slow adoption of high-efficiency irrigation; c) limited manufacturing focus on small-scale value added machinery and implements; d) use of low-efficiency, second-hand combine harvesters; e) lack of machinery for small-scale dairy farming; f) lack of standardized farm implements; and g) lack of the whole variety of machinery needed at community level.

Pakistan imports high-power tractors, harvesters, silage machinery and diesel engines for pumping sets, discs for disc harrows and disc plows, and laser leveler parts. Pakistan exports tractors, planters, reapers, threshing machines and some implements to Afghanistan, Sri Lanka and some countries in Africa.

Government initiatives for attracting foreign investment have improved Pakistan's investment attractiveness. The financial sector is the primary FDI recipient, followed by the chemical industry and construction. China is by far the biggest investor besides Japan, Republic of Korea and the United Kingdom. Investor protection is high compared to other Asian countries and there are few restrictions on the movement of capital for foreign companies with no shareholding restrictions.

Pakistan has bilateral and multilateral trade agreements with many nations and international organizations. It is a member of the WTO, South Asian Free Trade Agreement and the China–Pakistan Free Trade Agreement.

Pakistan has a vast agricultural infrastructure including farm-to-market roads, irrigation networks, agricultural markets as well as a vast pool of skilled human resources. Highways, energy production plants, seaports and economic zones are being set up under CPEC projects.

Conclusion

A predominantly agricultural economy, Pakistan has a good industrial base, a large domestic market, an ample supply of skilled human resources and a comparatively well-developed physical and communications infrastructure.

A major driver of economic growth, agriculture also provides inputs for industries such as textiles, including cotton and wool. National economic growth depends on healthy agricultural growth for which the sector must be highly efficient and competitive besides ensuring food and nutritional security as well as a surplus for exports. However, agricultural production costs are not competitive due to low productivity linked to inefficient farming practices.

Several government programmes and incentives, both at federal and provincial level, seek to modernize and expand agricultural mechanization capacity. These include easy and long-term credit facilities, farmer education programmes and subsidized inputs. In addition, there is government budgetary support for low taxation programmes for agricultural machinery.

Most farm operations are semi-mechanized and mechanized except for the planting of rice and vegetables and the harvesting of sugarcane and cotton. The current farm power use level meets the minimum FAO recommendation but is still considerably low and cannot meet the additional

demands of mechanized farming. Tractor and other machinery manufacturing levels are adequate, but quality and standardization need to be improved. Pakistan's mechanization is focused on crop production and the primary processing of agricultural produce is inadequate. Free market and globalization challenges also necessitate agricultural modernization, including development/introduction, testing and commercialization of efficient, cost-effective and sustainable agricultural mechanization technologies. While there has been some progress in this regard, there is a need for greater and coordinated public and private initiatives.

Pakistan's new National Food Security Policy has plans for setting up Agricultural Development Zones as part of the CPEC to increase yield to benefit farmers. Sophisticated agricultural and food processing capabilities will not only increase output and efficiency but also increase agricultural exports.

The Prime Minister's Agriculture Emergency Program has the following components: (i) productivity enhancement of wheat, rice and sugarcane; (ii) oilseeds enhancement programme; (iii) water conservation through lining watercourses; (iv) enhancing the command area of small and mini dams in rainfed areas; (v) water conservation in rainfed areas of Khyber Pakhtunkhwa; (vi) shrimp farming; (vii) cage fish culture; (viii) trout farming in the northern areas of Pakistan; (ix) save-and-fattening-of-calf programme and (x) backyard poultry programme.

The Government of Pakistan is committed to providing a business-friendly environment to attract foreign investment and the CPEC is a milestone in this regard.

Regional agricultural trade is low except for the export of some farm machinery and tractors to Afghanistan. There is not enough FDI in agricultural mechanization despite government encouragement for corporate farming and machinery pools.

Recommendations

Implementation of the Prime Minister's Agriculture Emergency Program will improve wheat, rice, sugarcane and oilseeds productivity, harness untapped fisheries potential, conserve water and increase meat exports. It will also promote agricultural mechanization through the grant of a 50 per cent subsidy for production machinery. The National Food Security Policy and the mechanization policy and measures related to mechanization will also benefit agriculture and farmers.

Small farmers should have easy access to credit for purchasing farm machinery and inputs as well as innovative practices to increase yields and soil fertility such as precision/hydroponic agriculture. Farm machinery pools should be established in provinces by the private sector to enable farmers to rent expensive farm machinery. Import duties and taxes on farm machinery should be reduced in the short to medium term and GST on the sale of farm machinery should also be reduced to speed up farm mechanization. Mechanized precision farming should be promoted through service centres and locally produced agricultural machines and irrigation pumps need to be made energy-efficient and environment-friendly. Standardization of quality agricultural machinery should be enforced.

Agricultural mechanization R&D should be extended to agricultural produce processing for value addition and use of alternate farm energy sources. Efficient farm mechanization and processing technologies should be developed to reduce production costs, enhance the timeliness of operations, add value to crops and reduce post-harvest losses at the farm level. Value addition should be enhanced by using the cluster approach

for primary processing of agricultural produce.

Incentives should be offered to improve quality of farm machine manufacturing and indigenize economically viable farm mechanization technologies as well as for the import of machinery for hay/silage making, milking, dairy and processing meat products. Appropriate machinery should be developed for the livestock sector such as for fodder harvesting and chopping, silage making and storage, milking, milk processing and packaging dairy products at farm level. Attention should be given to rural housing and human resource development. Aquaculture mechanization should be promoted for intensive production, processing and cold chain maintenance.

A National Center for Testing of Agricultural Machinery with regional/provincial satellite institutions should be established along with the National Network of Agricultural Mechanization to coordinate agricultural mechanization R&D.

Public sector agricultural mechanization R&D institutions should be strengthened, and the private sector encouraged to i) initiate in-house agricultural machinery R&D activities, ii) improve product quality and standards to meet international requirements and iii) improve manufacturing facilities to international standards at competitive costs.

Regional trade of agricultural machinery should be promoted through trade agreements. The CPEC offers an opportunity to promote the trade of agricultural machinery with Afghanistan, Central Asian countries, China and Iran (Islamic Republic of).

3.4 Philippines

3.4.1. Overview of the agricultural sector

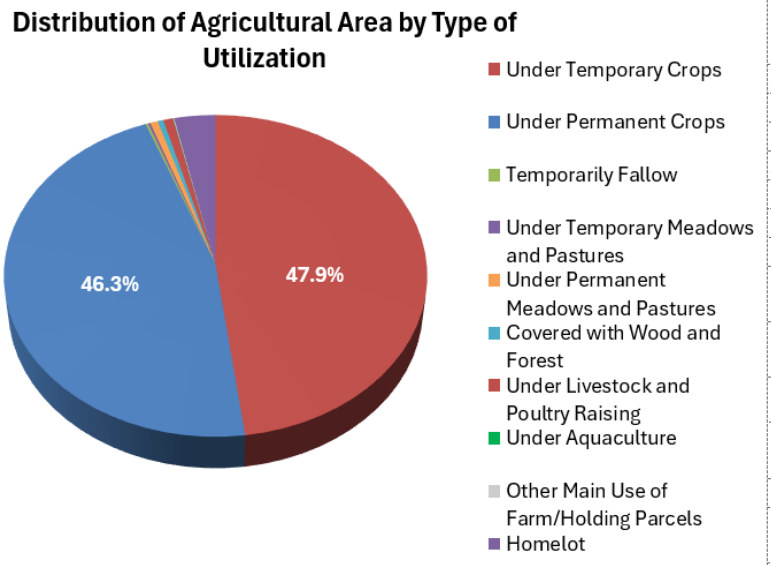
3.4.1.1. The agricultural economy

An archipelagic nation in Southeast Asia, the Philippines comprises about 7,641 islands (Barile, 2017) with a total area of 300,000,000 km2, of which 298,170,000 km2 are land and 1,830,000 km2 are water.

The Philippines has an agriculture-based economy; with an estimated 106.5 million people and an average population growth rate of 1.5 per cent (Worldometer, 2018) the sector provides employment to about 11.29 million people (8.39 million men and 2.90 million women), accounting for 29 per cent of total employment. The country's farms produce abundant food, feed, fiber and fuel as well as industrial raw materials. Agricultural production takes place on an estimated 10,188 km2 of land and 1,830 km2 of water (Figure 3.4.1). Rice and corn are the staple food. Sugarcane, coconut and banana are other major agricultural products, the last being one of the country's top exports.

Figure 3.4.1

Philippines: utilization of agricultural area



Location:	Southeastern Asia, archipelago between the Philippine Sea and the West Philippine Sea, east of Vietnam
Area:	total: 300,000 square kilometers
	land: 298,170 square kilometers
	water: 1,830 square kilometers
All Farms/Holdings:	7.190 million hectares
Under Temporary Crops	3.444 million hectares
Under Permanent Crops	3.329 million hectares
Temporarily Fallow	0.014 million hectares
Under Temporary Meadows and Pastures	0.014 million hectares
Under Permanent Meadows and Pastures	0.044 million hectares
Covered with Wood and Forest	0.033 million hectares
Under Livestock and Poultry Raising	0.057 million hectares
Under Aquaculture	0.002 million hectares
Other Main Use of Farm/Holding Parcels	0.005 million hectares
Homelot	0.240 million hectares

Source: (PSA, 2018)

Agriculture accounted for 8.1 per cent of GDP in 2018, its share declining from 2011 to 2018 despite an increase in economic growth from 3.7 to 6.2 per cent during the same period, largely driven by industry and services (see Table 3.4.1).

Table 3.4.1

Philippines: economic structure

(Percentage)

	2011	2012	2013	2014	2015	2016	2017	2018
GDP growth	3.70	6.70	7.10	6.10	6.10	6.90	6.70	6.20
Sectoral share								
Agriculture	11.50	11.09	10.47	10.03	9.47	8.75	8.53	8.10
Industry	32.05	32.22	32.87	33.37	33.49	33.86	33.99	34.14
Services	56.45	56.70	56.66	56.60	57.04	57.39	57.48	57.76
Sectoral growth								
Agriculture	2.60	2.80	1.10	1.70	0.10	-1.20	4.00	0.90
Industry	1.90	7.30	9.20	7.80	6.40	8.00	7.10	6.70
Services	4.90	7.10	7.00	6.00	6.90	7.50	6.80	6.80

Source: (PSA, 2018)

Note: All in constant 2000 prices

3.4.1.2. The agricultural production system

There were about 5,563,138 farms in the Philippines covering an area of about 7,271,446 ha in 2012 (PSA, 2019). Water availability is critical to ensuring food security with agriculture accounting for 80 per cent of all water consumption, largely due to inefficient water use on farms. Irrigated rice takes up about half of the total harvested rice area and accounts for 70 per cent of total rice production in the country

(FAO, 2016). Irrigated rice area totaled 1,731,128 ha in 2015 with an average growth rate of 2.46 per cent from 2011 to 2015 (PSA, 2016).

The Philippines ranked 8th among the world's main rice producers with 12.24 million tons of milled rice produced in 2017-2018 from a cultivated area of 4.5 million ha (Statista, 2019). It was also the 7th largest rice importer, accounting for 3 of the 49.9 per cent purchased by the top 15 rice importing countries (World's Top Exports, 2019).

Rice and corn yields increased between 2011 and 2017 despite the disparity in planted area of these crops (see Table 3.4.2). Rice is the most consumed food along with vegetables, meat and seafood which comprise the staple national diet (see Table 3.4.3). However, rice consumption declined from 119.08 kg in 2009 to 114.26 kg in 2012 while corn consumption grew from 7.02 kg in 2009 to 10.26 kg in 2012.

Table 3.4.2

Philippines: production and area of main crops and livestock

(Thousands of tons, thousands of hectares)

Production							
	2011	2012	2013	2014	2015	2016	2017
Rice	16,684	18,033	18,439	18,968	18,150	17,627	19,276
Corn	6,971	7,407	7,377	7,771	7,519	7,219	7,915
Coconut	15,245	15,864	15,354	14,696	14,735	13,825	14,049
Sugarcane	28,377	26,396	24,585	25,030	22,926	22,371	29,287
Banana	9,165	9,227	8,646	8,885	9,084	8,904	9,166
Pineapple	2,247	2,398	2,459	2,507	2,583	2,612	2,672
Coffee	89	89	79	75	72	69	62
Mango	788	768	816	885	903	814	737
Tobacco	45	48	54	61	56	56	51
Abaca	69	69	65	68	70	72	69
Area							
	2011	2012	2013	2014	2015	2016	2017
Rice	4,537	4,690	4,746	4,740	4,656	4,556	4,812
Corn	2,545	2,594	2,564	2,611	2,562	2,484	2,553
Coconut	3,562	3,575	3,551	3,502	3,518	3,565	3,612
Sugarcane	440	433	437	432	421	410	437
Banana	450	454	446	443	443	443	447
Pineapple	58	58	61	62	63	65	66
Coffee	120	120	116	117	114	115	113
Mango	187	189	188	188	188	188	186
Tobacco	32	34	34	36	33	33	31
Abaca	139	139	138	135	134	134	132
Average yearly production of certain livestock							
	2011	2012	2013	2014	2015	2016	2017
Carabao	148	143	141	143	142	145	144

Cattle	256	254	258	261	267	270	266
Hog	1,940	1,974	2,012	2,032	2,120	2,232	2,265
Goat	78	76	75	76	77	77	77

Source: PSA, 2019

Average farm gate prices show an increasing trend because of the rising price of commodities for food, feed, fiber and fuel (see Table 3.4.4).

Table 3.4.3

Annual per capita consumption of agricultural commodities

(Kilograms)

	2009	2012
Rice	119.080	114.265
Corn	7.072	10.261
Camote	4.056	4.307
Cassava	3.120	2.829
Banana	16.692	20.904
Mango	3.172	3.490
Pineapple	1.196	1.079
Vegetables	22.568	24.528
Meat	18.564	18.838
Egg	3.172	4.032
Seafood	14.248	18.266
Milk	0.156	0.189

Source: PSA, 2019

Table 3.4.4

Philippines: farm gate prices

(Philippine peso (PHP) per kilogram)

Product	2011	2012	2013	2014	2015	2016	2017	2018
Dried Palay (Fancy)	13.55	14.35	17.33	20.01	18.04	19.07	20.54	24.74
Dried Palay (Other Variety)	15.17	16.22	16.93	20.07	17.33	17.43	18.21	20.4
Yellow corn	11.95	12.43	11.62	12.73	12.01	11.78	11.6	14.01
White corn	14.4	13.35	13.81	13.9	13.07	12.3	12.81	14.51
Cassava	6.4	7.09	7.63	6.52	5.45	6.29		
Abaca	39.40	39.60	37.84	43.31	47.23	58.80	64.01	69.61
Coconut matured	8.05	5.63	5.30	7.14	6.46	7.84	8.62	6.24
Dried coffee beans	65.70	67.04	72.47	75.51	81.82	82.27	96.29	96.14
Sugarcane	34.04	31.66	31.00	32.94	35.61	38.45	35.67	38.57
Tobacco	87.83	140.84	100.13	98.88	102.73	107.32	138.04	138.49
Banana	9.23	9.64	10.87	12.00	12.27	13.74	12.68	12.71
Mango	18.09	18.85	18.22	19.35	19.66	20.63	24.14	25.10
Pineapple	7.06	7.17	6.92	7.27	9.15	9.14	10.72	11.52

Source: PSA, 2019

Although the farm gate price of palay (unhusked rice) has increased over the years, farmers need a higher farm gate price because of the rising costs of farm inputs. From 2011 to 2017, a rice farmer could only get a net return of PHP 22,495 per hectare for the dry cropping season and PHP 20,140 per hectare for the wet cropping season (PSA, 2019).

The majority of Filipino farmers are smallholders with an average of 1.3 ha of farmland (PSA, 2019). The rice farmer, on average, has around 3 ha, ranging from 2.01 to 5 ha, while the average corn farm holding ranges from 0.51 to 10 ha (SEARCA, 2019). Most rice farmers are members of irrigator's associations (IAs), cooperatives or farmers' associations (FAs) because government subsidies are only available to legally accredited groups. There are established value chains for rice and corn, but most rice farmers sell immediately after the harvest to traders from whom they borrow to buy seeds, fertilizers, pesticides and fuel for irrigation. While government subsidies for farm inputs are distributed through Local Government Units (LGUs) to farmers' groups, individual farmers who are not members of IAs, FAs and cooperatives usually buy their own farm inputs. According to a 2019 study, about 61.1 per cent rice farmers sell directly to traders while 65.71 per cent of the corn harvest is picked up by traders from the farm (SEARCA, 2019). Farmers prefer to sell to traders even at prices lower than the buying price set by the National Food Authority, the government agency responsible for ensuring food security through stability of supply and palay prices.

Most government subsidies for agricultural mechanization technologies (AMTs) are channeled to farmers' organizations such as agricultural cooperatives, FAs and IAs and individual smallholder farmers not belonging to any group do not directly benefit from these subsidies which range from 10 to 15 per cent of machinery cost (SEARCA 2019).

3.4.2. Agricultural mechanization

3.4.2.1. National policy on agricultural mechanization

The integration of sustainable agricultural mechanization in various farm production systems to attain self-sufficiency in food, feed, fiber and fuel is a major component of agricultural development in the Philippines. Agricultural mechanization enhances production of agricultural raw materials needed by a variety of industries. The success of sustainable agricultural mechanization depends on the availability of appropriate technologies, human resources and laws and policies.

The following laws and national policies aim to promote agricultural mechanization in the country and increase sustainable agricultural productivity.

a) RA 11203 – An Act Liberalizing the Importation, Exportation and Trading of Rice, Lifting for the Purpose the Quantitative Import Restriction on Rice (Agricultural Tariffication Law of 2019)

Enacted in February 2019, this amended Republic Act 8178 of 1996 (An Act Replacing Quantitative Import Restrictions on Agricultural Products, except Rice, with Tariffs, Creating the Agricultural Competitiveness Enhancement Fund, and for other purposes).

RA 11203 aims to ensure food security and make agriculture viable, efficient and globally competitive through adoption of non-tariff import restrictions to protect local agricultural producers. It formulates policies for the agricultural sector and its mechanization to make farmers competitive and efficient. The objectives of the law as provided by the National Economic Development Authority on its stakeholders' consultation in February 2019 are: 1. Fulfill the international commitment made when the Philippines joined the WTO in 1995. Replace the

Quantitative Restriction (QR) on rice with another form of protection that is more transparent and generates revenues to support tariff.
2. Ensure the availability of rice in the domestic market for the accessibility of a greater population by allowing more private traders (big or small) to participate in importing rice.
3. Lower domestic rice prices to an affordable level to a greater population.
4. Make the domestic market function effectively and efficiently with much reduced/no government intervention.
5. Provide farmers equivalent protection with the imposition of 35 per cent or higher tariff rates on rice imports and preferential assistance to rice farmers, adversely affected by tariffication.
6. Provide opportunities for farmers to earn more in the world market. The law also lifted the restriction on rice exports to encourage farmers to produce much better-quality heirloom/ traditional rice geared to exports.
7. Provide support/safety nets to farmers, especially those who will be adversely affected by the removal of the QR by:

a. Establishing a Rice Competitiveness Enhancement Fund (RCEF) to fund key interventions such as mechanization, seeds, financing and other strategic interventions that will improve productivity and competitiveness, enhance the value chain and increase farm incomes. The RCEF will be over and above the regular budget of the Department of Agriculture (DA). An efficient monitoring system will be established to ensure that the fund benefits farmers.
b. Providing excess tariff revenue collection to farmers to provide preferential support for those who will be greatly affected (e.g. direct financial assistance).

Objective number 7 of QR provides direct support to the farmers with the removal of the quantitative restrictions on rice which may have a direct impact on their competitiveness due to the expected influx of rice in the country.

Section 13 of the law provides for the establishment of the RCEF with an annual appropriation of PHP 10 billion for the next six years. Section 13a indicates that 50 per cent (PHP 5 billion) of the rice fund shall be released and implemented by the Philippine Center for Postharvest Development and Mechanization (PhilMech) as a grant-in-kind to eligible farmers' associations, registered rice cooperatives and LGUs. The grant to eligible farmers' groups shall be in the form of farm equipment such as tillers, tractors, seeders, threshers, rice planters, harvesters, irrigation pumps, small solar irrigation, reapers, dryers and millers for improving farm mechanization (PhilMech, 2019).

PhilMech, as one of the implementers of the rice tariffication law, launched a programme to mechanize rice agriculture under the RCEF mechanization component to increase rice farmers' productivity and improve their competitiveness through improved access to and use of appropriate farm machinery and equipment. Specifically, the programme aims to: (1) promote the use of efficient and cost-reducing rice mechanization interventions among rice farmers; (2) make appropriate rice production and post-harvest machinery and equipment accessible through the establishment of Farm Machinery Service Centers; and (3) strengthen technology development, fabrication and manufacturing, and marketing services of the local agri-machinery industry. The programme is envisioned to reduce production costs and increase farmer productivity. Financial support to mechanization for machinery grants, capacity-building and technology development is pegged at PHP 30 billion for 2019 to 2024 or PHP 6 billion per year over six years (PhilMech, 2019).

Moreover, Section 13 stipulates a budget allocation of 30 per cent for seed development, 10 per cent for

Expanded Rice Credit Assistance, 10 per cent for Rice Extension Services per year out of the annual PHP 10 billion appropriation. This significant government investment in mechanization and other related agricultural support is expected to increase the mechanization level and productivity of farmers.

b) RA 10601–- An Act Promoting Agricultural and Fisheries Mechanization Development in the Country (Agricultural and Fisheries Mechanization Law of 2013, hereinafter referred as "AFMech Law")

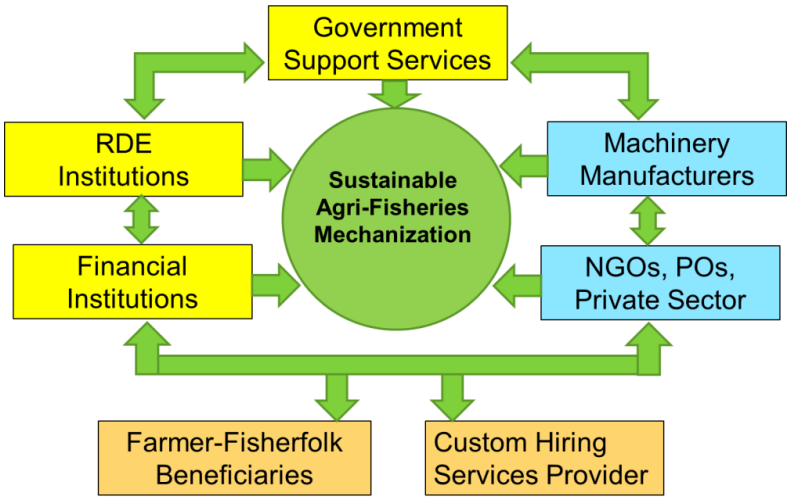
The AFMech Law focuses on six strategic areas towards attaining comprehensive agricultural mechanization: (1) the promotion of appropriate agricultural and fisheries mechanization technologies to increase agricultural productivity for food security and safety, and farmers' income; (2) the improvement of the local assembling and manufacturing industry; (3) the development and enforcement of standards, testing and evaluation, and registration of agricultural and fisheries machinery to ensure their quality and safety; and accreditation of suppliers, assemblers and manufacturers for their compliance to quality standards; (4) the improvement of support services including marketing and credit facilities, research, training and extension programmes, infrastructures and post-harvest facilities; (5) the implementation of agricultural and fisheries mechanization programmes; and (6) the provision of integrated support services to farmers and stakeholders for the successful operation and management of agricultural and fisheries mechanization projects. The law directs the support and participation of the various stakeholders which include farmers/fisherfolk and their associations or cooperatives, government line agencies, local government units, academic institutions, private agencies (local assemblers, manufacturers, suppliers, importers, cooperatives), and all other concerned agencies/stakeholders (R.A. 10601). Its implementing rules and regulations require the formulation of the National Agricultural Mechanization Program every 5 to 6 years to achieve its goals and objectives. The plan addresses the gaps, issues and concerns on agricultural mechanization.

With the enactment of AFMech Law of 2013, the government has invested in various activities for the advancement of agricultural mechanization in the country. The law recognizes the significant role and contribution of agricultural mechanization in agricultural development. It provides a comprehensive legal framework for the distribution, supply, assembling, manufacturing, research, development and extension, promotion, regulation, use, operation, maintenance and project implementation of agricultural and fisheries machinery and equipment in the country (DA, 2017). One of the strategic policy goals of RA 10601 is to provide farmers and fisherfolk access to appropriate and affordable agri-fishery machinery and equipment through the promotion of local manufacturing and assembling to lower costs as specified in Sections 15 and 16 of the law. Hence, the private sector has a very important role in propelling and promoting sustainable agricultural mechanization technologies (AMTs), equipment, and practices in the country.

There are various key players in the promotion of AMTs in the Philippines including in agri-fisheries (Figure 3.4.2).

Figure 3.4.2

Philippines: enabling environment for sustainable agri-fisheries mechanization



Source: Amongo, et al. 2018.

c) RA 8435 - An Act Prescribing Urgent Related Measures to Modernize the Agriculture and Fisheries Sectors of the Country in Order to Enhance their Profitability and Prepare said Sectors for the Challenges of Globalization through an Adequate, Focused and Rational Delivery of Necessary Support Services (Agricultural and Fisheries Modernization Act of 1997)

The Agricultural and Fisheries Modernization Act of 1997 (AFMA Law or RA 8435) stipulates immediate strategies and ways to modernize the agriculture and fisheries sectors of the country with the overall goal of increasing profitability. It includes measures to equip the sector logistically and other supporting services to address the challenges of globalization. For instance, one strategy is to encourage a shift to more profitable crops. These supporting services are: (a) production and marketing supporting services; (b) credit; (c) irrigation; (d) information and marketing supporting services; (e) other infrastructure including public and private such as fish ports, seaports and airports, farm-to-market roads, common infrastructure, water supply systems, research and technology infrastructure, research and technology facilities, public markets, abattoirs and agricultural machinery. The application of an appropriate marketing strategy to target specific sectors is crucial in the development of the agricultural sector.

The AFMA Law also aimed to accelerate industrialization through agricultural development by establishing agro-industries which employ human resources efficiently and use natural resources more sustainably. Specific principles to attain sustainability for the agricultural and fisheries sectors include: (a) poverty alleviation and social equity; (b) food security; (c) rational use of resources; (d) global competitiveness; (e) sustainable development; (f) people empowerment; and (g) protection from unfair competition.

d) Establishment of the Philippine Council for Agriculture and Fisheries (PCAF)

An agency under DA, the PCAF was established based on Executive Order 366, Series of 2004, which consolidated and merged the functions of two former councils, the National Agricultural and Fishery Council (NAFC) and the Livestock Development Council (LDC). The integration of NAFC and LDC into PCAF, strengthened the coordination functions, monitoring of agricultural

and fisheries modernization processes and development of public-private partnerships as well as its role as an advisory unit of DA. The mandates of PCAF based on Executive Order No. 116, series of 1987 and DA Administrative Order No. 6, series of 1998 were:

1. It shall (1) act as advisory unit to DA to ensure the success of its programmes and activities; and (2) shall establish a nationwide network of agricultural and fishery councils to serve as the forum for consultative and continuing discussions within the agriculture and fisheries sector.
2. It shall (1) formulate and establish comprehensive policy guidelines for the department of the livestock industry; (2) formulate long and short-range programmes to achieve major self-sufficiency, efficiency and stability in food commodities of animal origin; (3) coordinate, integrate and supervise all policies and programmes of all government agencies with the implementation thereof; and (4) assist, coordinate and integrate private sector activities with that of the government sector with the purpose of involving the private sector in the food development programmes of animal origin and allied industries, among others.
3. It shall (1) assist the DA in the broad-based monitoring and coordination of the agriculture and fisheries modernization process; and (2) serve as an integrative and consultative structure for inter-agency and inter-sectoral collaboration in agriculture and fisheries modernization.

e) Establishment of the Agricultural and Fisheries Mechanization Committee (AFMeC)

The Agricultural and Fisheries Mechanization Committee (AFMeC) is an advisory committee of the Department of Agriculture-Philippine Council for Agriculture and Fisheries (DA-PCAF) that ensures the successful implementation of the programmes and activities on agricultural and fisheries mechanization. Under the coordinated PCAF, the AFMeC additionally conducts consultative and feedback mechanisms from the different levels of decision makers for agricultural and fisheries mechanization. Its other function is to assist in the formulation of the goals and scope of the country's agricultural and fisheries mechanization and infrastructure policies, plans and programmes. The agricultural and fisheries mechanization subcommittees under the regional, provincial, city, municipal and barangay (sub-municipal unit) agricultural and fishery councils shall integrate, coordinate, unify and monitor the field implementation of the agri-fisheries mechanization and infrastructure of various projects conducted by national government agencies, LGUs, banking and financial institutions, and the private sector.

3.4.2.2. National programmes on agricultural mechanization

In 2017-2018, DA-PCAF commissioned an evaluation by the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) titled "Intensive Use of Mechanized Technology in the Agriculture Sector: an Evaluation of the Effects and Implications in Selected Commodity Value Chains". The objective was to generate critical policy recommendations in support of the DA's priority agenda on farm mechanization, as well as strategic and effective post-harvest, storage and processing facilities that can lead to increased productivity and competitiveness of the specific commodity value chains, in the light of the efforts for ASEAN integration.

Recent DA mechanization programmes

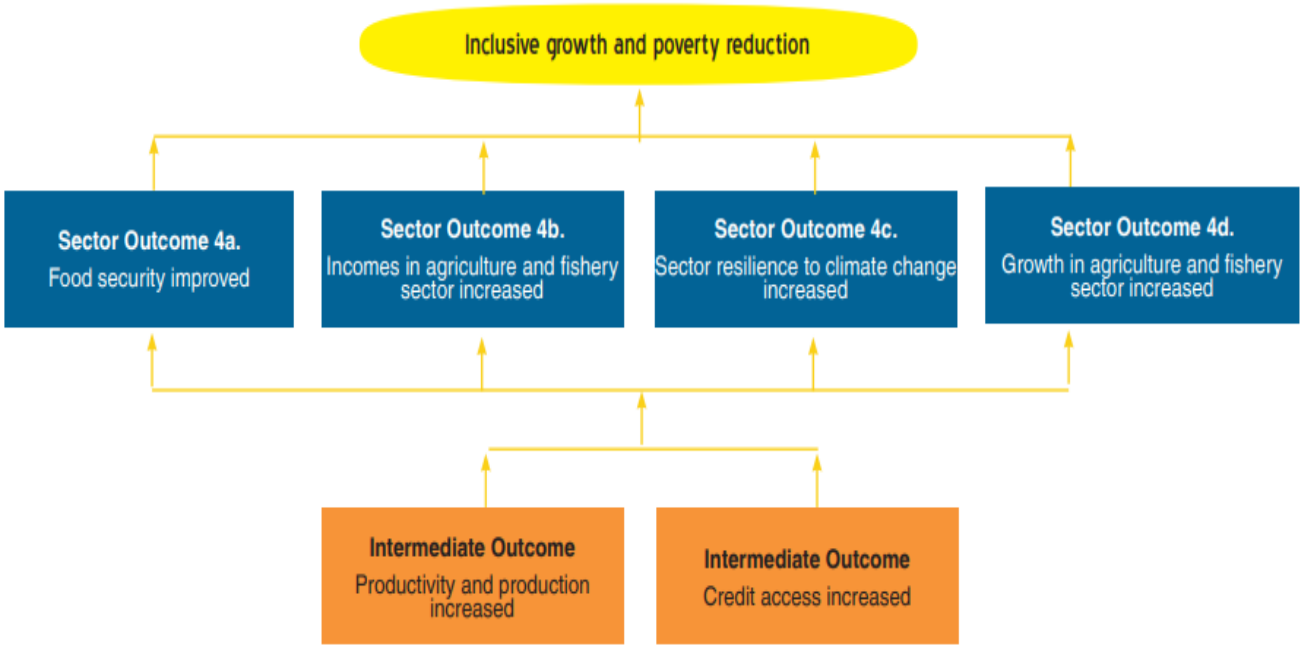
The study conducted by SEARCA (2019) identified past DA mechanization programmes to enhance productivity along the value chain of four crops, namely rice, corn, coffee and cassava. The

programmes were aligned with the Philippine Development Plan (2011) having as the main goal the attaining of inclusive growth and poverty reduction in the agriculture and fisheries sectors (Figure 3.4.3). The plan envisioned increased productivity and production and increased credit access leading to: (1) improved food security, (2) increased agricultural and fisheries incomes, (3) increased climate resilience and (4) increased agricultural and fisheries growth leading to attainment of the main goal of the Philippine Development Plan.

The factors that contribute to increasing productivity and production include use of high-yielding varieties, fertilizers, other farm inputs, irrigation services and modern mechanization technologies. While mechanization may not have a direct impact on yield, it is expected that efficient and timely farms operations, loss reduction and reduction in cost may have an effect on farm productivity (SEARCA, 2019). Moreover, increased access to credit may enable farmers and fisherfolk to sustain farm and economic activities by using necessary inputs and mechanization technologies.

Figure 3.4.3

Philippines: development plan for competitive and sustainable agriculture and fisheries, 2011-2016



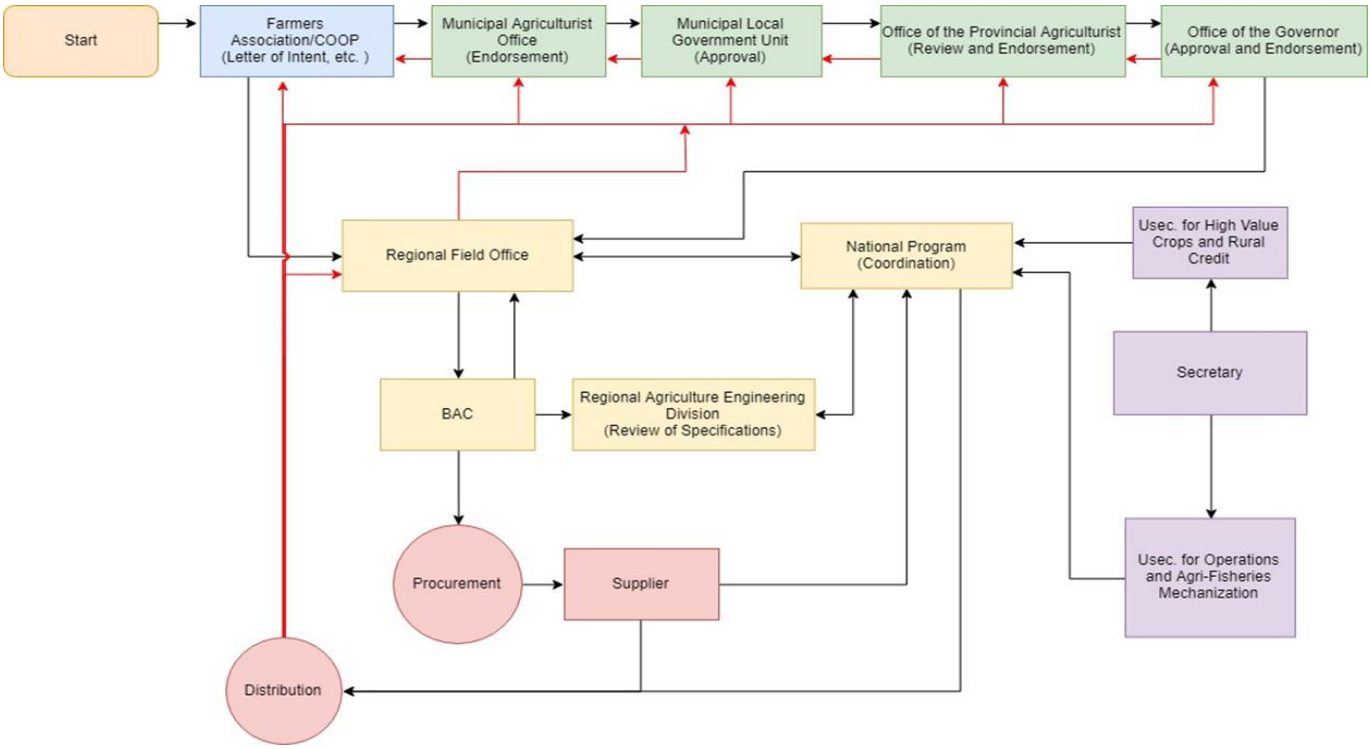
Source: Philippine Development Plan, 2011

Agricultural and fisheries mechanization technologies (AFMTs) are usually procured and distributed by the government, although individual farmers may also avail themselves of AFMTs, especially affordable small machinery (Figure 3.4.4). The request is generally made by eligible cooperatives or farmers' groups using a bottom-up approach while distribution is a top-down process. The DA regional offices usually consolidate, prioritize and coordinate with the DA central office where a centralized procurement system is applied. If there are no takers, the procured AFMTs are usually distributed as grants to as many qualified organizations as possible. Machinery suppliers usually coordinate delivery with regional or provincial offices. The supplier also provides training and after-sales service. Some suppliers conduct one-time trainings on operation and simple

repairs while others only organize a machine demonstration.

Figure 3.4.4

Philippines: procurement and distribution of agricultural and fisheries mechanization technologies



Source: SEARCA (2019)

Issues and gaps

The SEARCA (2019) evaluation of the effects and implications of agricultural mechanization in the four commodity value chains was conducted in 13 regions which are key producing areas, and the survey for each crop covered five regions except for coffee which covered only four regions (see Table 3.4.5). Focus group discussions and key informant interviews were also conducted to identify issues, gaps and concerns related to the implementation of the DA mechanization programme at different levels of the value chain. The stakeholders were DA programme implementers at regional, provincial and municipal level, farmers' groups or cooperatives as beneficiaries, traders and/or consolidators.

Table 3.4.5

Philippines: regional crop mechanization survey, 2019

Rice	Corn	Cassava	Coffee
Region II	Region I	Region II	CAR
Region III	Region II	Region III	Region IV A
Region IV B	Region VIII	Region VII	Region X*
Region VI	Region X	Region X	Region XI
Region X	Region XII	Region XII	CARAGA

Source: SEARCA

Note: No data on machinery distribution for coffee in the Region

The following gaps, issues and concerns were identified by the stakeholders for the four commodities (see Table 3.4.6):

Project implementers

1. Lack of comprehensive mechanization assessment prior to machinery distribution.
2. Inconsistent mechanisms for requesting machinery and subsequent distribution.
3. Machinery procurement process.
4. Machine quality and screening process.
5. Insufficient training in operation, repair and simple maintenance (ORM) and lack of operator's manual for most distributed machines.
6. Not enough spare parts locally available.

Farmers and cooperatives

1. Lack of after-sales service.
2. Machines incompatible with the needs of beneficiaries or not meeting specifications requested by cooperatives or farmers' groups.
3. Subsidies and equity requirement.

Traders and consolidators

1. Lack of drying facilities.
2. Low harvest due to typhoons and floods.

(SEARCA, 2019)

Table 3.4.6

Commodity value chain gaps and constraints affecting mechanization, 2019

Gaps and constraints	Commodity/crop			
	Rice	Corn	Coffee	Cassava
Small land parcels	√	√		
Low productivity; (high demand but low local supply highlighted for coffee)		√	√	√
Need for other subchain (value chain concentrated on specific subchains, e.g. corn subchain concentrated on animal feed)/ Underdevelopment of other potential value chains to serve as stable market		√		√
Farm labour availability except in peak planting, harvesting periods	√			
Agricultural machinery manufacturing dependence on imports which do not always match local conditions	√			
No needs and demand assessment matching technologies to local conditions and farmers' preferences	√	√		√
Disparity in power utilization for different farming operations (concentration of mechanized technology in land preparation, harvesting/threshing/shelling)	√	√		
Inequitable profit/benefit distribution in commodity value chain	√			
Farmers' limited access to after-sales service and spare parts	√			
Lack of water supply (irrigation) in some production areas	√			
Need for other subchain (subchain concentrated on subchains, e.g. corn subchain concentrated on animal feeds) Underdevelopment of other potential value chains to serve as stable market		√		√

Limited monitoring of machine utilization		√		
Low quality machines/Inconsistent machine quality		√		√
Limited cropping season		√		
Fluctuating prices due to competition		√		
Different grains quality at processing stage		√		
Hoarding and availability of imported grains		√		
Need for re-evaluation of grant policy through counter-parting or outright grant				√
Need for gearing RDE towards strengthening value chains				√
Non-integration of production areas into strategic production clusters to strengthen supply nodes of sub-value chains				√
Use of mechanization index as target for sound mechanization practice rather than an outcome of sound mechanization practice				√
Need to enhance opportunities to increase farmer income				√

Source: SEARCA (2019)

The SEARCA (2019) report made the following general policy recommendations requiring government intervention and support, to address the issues and gaps concerning the mechanization of the four commodity value chains:

1. Transforming fragmented production areas such as irregular shaped and small land parcels into highly productive, efficient and resilient production zones for optimal utilization of mechanization technologies, through land clustering and contiguous and synchronous farming where applicable.
2. Comprehensive mechanization needs assessment for different crop commodities especially in major production areas where mechanization will fully benefit the performance and stability of value chains.
3. Developing local machinery manufacturing, initially for single cylinder engines.
4. Innovative investment programmes to encourage new industries within different subchains of the concerned commodity.
5. Establishing a comprehensive and up-to-date management information system responsive to the needs of commodity value chains to address asymmetry in the sub-value chains.
6. Prioritizing productivity increases, especially in key production areas.
7. Rationalizing machinery provision programmes for farmers through innovative loan and complementary schemes.
8. RDE programmes for strengthening value chains where technology is the driving force.
9. Mandatory quality testing of machines during delivery.

3.4.2.3. Current level of agricultural mechanization

The accelerated diffusion, adoption and utilization of AFMTs is a flagship government programme as stipulated in the AFMech Law of 2013. The level of mechanization is measured by the Agricultural Mechanization Index (AMI) and given the importance of agricultural technology, an operational policy to standardize the AMI is needed to update and assess the level of mechanization for policy reference. It is imperative, in order to ensure food security for the ever-growing population, that the level of mechanization is accelerated.

As agricultural mechanization institutions in the Philippines were using different AMI methodologies

(Amongo et al., 2017a), the Department of Agriculture developed the Modified Agricultural Mechanization Index (MAMI) in 2017, to provide decision makers a basis for well-informed decisions for the acquisition, distribution and utilization/adaption of agricultural mechanization technologies. Although numerical values were used and the unit hp/ha was the same, different parameters and approaches were used for calculating these values. The 2013 index was the last AMI officially used in the Philippines (see Table 3.4.7). The harmonized MAMI methodology was used in subsequent assessments.

Agricultural mechanization has been a precursor to industrialization in many Asian countries but the path from mechanization towards industrialization has not been easy. Political will, social preparation and suitable laws are some factors contributing to its success.

Table 3.4.7

Philippines: agricultural mechanization index (AMI), 1968-2013

(Horsepower per hectare)

Year	AMI	Considerations	Source
1968	0.198	Rice-based farming system	RNAM (1994) as cited by PCAARRD, 2007. Mechanization Status. Agricultural Machinery Information Network.
1980s	0.360	Rice-based farming system	as cited by S.C. Capareda.1994. Issues and Trends in Farm Power and Machinery. Philippine Agricultural Mechanization Bulletin. Vol. II No.3. AMDP, CEAT, UP Los Baños.
1990	0.520	Rice-based farming system	RNAM, 1990. Technical Report. Economic and Social Commission for the Asia and the Pacific. Regional Network for Agricultural Machinery (ESCAP-RNAM).
1998	1.680	Rice- and corn-based farming system utilizing human, animal and mechanical power	Rodulfo, V.A. Jr., R.M.C. Amongo and M.V.L. Larona. 1998. Status of Philippine Agricultural Mechanization and Its Implications to Global Competitiveness. Philippine Agricultural Mechanization Bulletin. Vol. V No.1. AMDP, CEAT, UP Los Baños.
2010	1.500	Rice-based farming system utilizing single cylinder engines	Panagsagan, J.R. 2011. 2006-2010 Engine Sales Statistics Relevant to Determining the Level of Mechanization. Paper presented at the Harmonization Workshop on the Level of the Philippine Agricultural Mechanization. (presented by AMMDA)
2013	2.310 1.230	Rice-based farming system For all crops	R.SM. Dela Cruz, S.B. Bobier. 2013. Farm Power Available for Utilization in Philippine Agriculture. Unpublished Report. PhilMech

			(paper submitted for publication)

Source: Amongo et al., 2017b

Level of mechanization for rice and corn in selected provinces

The agricultural mechanization index for lowland rice, the staple food, was determined using the MAMI in selected provinces as representatives of the regions, namely Cagayan and Isabela for Region 2, Nueva Ecija and Pampanga for Region 3, Laguna and Quezon for Region 4A, Oriental Mindoro and Occidental Mindoro for Region 4B, Capiz and Iloilo for Region 6 and Bukidnon and Misamis Oriental for Region 10. The Philippines has 16 administrative regions and one autonomous region. The level of mechanization ranges from 1.661 to 5.103 hp/ha for lowland rice in man-machine system using the combination of ploughing, harrowing and reaping-threshing operations and from 1.232 to 4.290 hp/ha for rototilling and combine harvesting (see Table 3.4.8). Land preparation and harvesting account for the maximum mechanization in rice production.

Table 3.4.8

Modified agricultural mechanization index (MAMI) for rice in man-machine system in selected provinces
(Horsepower per hectare)

Farm operation	Man-machine system, MAMIRICE							
	Cagayan and Isabela 1 (Region 2)	Nueva Ecija and Pampanga1 (Region 3)	Laguna2 (Region 4A)	Quezon 2 (Region 4A)	Or. Mindoro 2 (Region 4B)	Or. Mindoro and Occ. Mindoro 1 (Region 4B)	Capiz and Iloilo1 (Region 6)	Bukidnon and Misamis Oriental 1 (Region 10)
Land preparation plowing/ harrowing	1.967	2.645	0.835	2.538	1.361	2.241	1.922	1.816
Land preparation Rototilling	1.060	1.264	0.362	0.385	0.668	1.221	0.976	0.899
Crop establishment	0.202	0.426	0.103	0.113	0.049	0.080	0.043	0.134
Crop care	0.141	0.646	0.045	0.992	0.078	0.276	0.255	0.207
Harvesting Reaping – threshing	0.749	0.832	0.532	0.592	1.519	0.579	1.018	0.815
Harvesting rice combine	1.293	1.401	0.576	0.500	0.963	0.997	0.965	0.815
Hauling	0.351	0.425	0.139	0.112	0.010	0.302	0.019	0.245

Drying	0.105	0.129	0.007	0.218	0.012	0.078	0.168	0.135
TOTAL Plowing Harrowing Reaping Threshing	3.616	5.103	1.661	4.565	3.029	3.557	3.424	3.351
TOTAL Rototilling Rice combine	3.254	4.290	1.232	2.505	1.780	2.955	2.427	2.434

Source: 1 SEARCA, 2019; 2 Amongo et al., 2018b

The level of agricultural mechanization for corn, the other staple food, was determined using MAMI corn in selected provinces, namely Ilocos Sur and Pangasina for Region 1, Cagayan and Isabela for Region 2, Capiz and Iloilo for Region 6, Bukidnon and Misamis Oriental for Region 10 and South Cotobato for Region 12.

The mechanization level in man-machine system using picking and shelling ranges from 3.264 to 4.070 hp/ha while for corn combine harvesting ranges from 3.349 to 4.414 hp/ha, with the highest mechanization level in land preparation (see Table 3.4.9).

Table 3.4.9

Modified agricultural mechanization index (MAMI) for corn in man-machine system in selected provinces
(Horsepower per hectare)

Farm operation	Man-machine system MAMICORN				
	Ilocos Sur and Pangasinan1 (Region 1)	Cagayan and Isabela1 (Region 2)	Capiz and Iloilo1 (Region 6)	Bukidnon and Misamis Oriental1 (Region 10)	South Cotobato1 (Region 12)
Land preparation	1.676	1.927	1.050	1.782	1.554
Crop establishment	0.034	0.291	0.301	0.474	0.480
Crop care	0.888	0.743	0.304	0.185	0.592
Harvesting Picking-shelling	0.406	0.544	0.527	0.496	0.372
Harvesting corn combine	0.883	0.888	0.527	0.890	0.372
Hauling	0.226	0.540	0.920	0.558	0.194
Drying	0.034	0.024	0.310	0.046	0.157
TOTAL Picking-shelling	3.264	4.070	3.411	3.543	3.349
TOTAL Corn combine	3.742	4.414	3.411	3.937	3.349

Source: SEARCA, 2019

Although the current mechanization level at an average of 3.54 hp/ha for rice and 3.52 hp/ha for

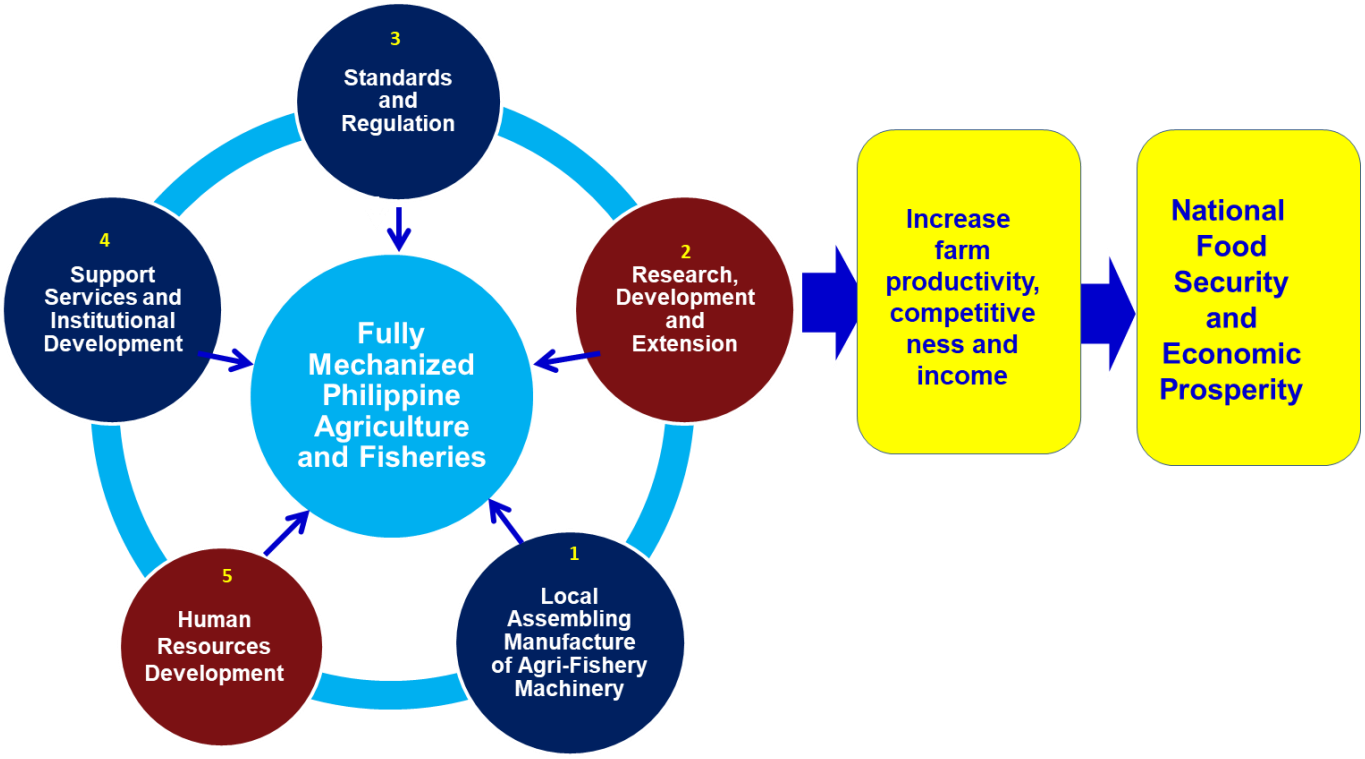
corn production, is below the ideal level of at least 5 hp/ha (Amongo, et al.; PJABE 2018), it has improved from the 2013 AMI. The contribution of land preparation and harvesting operations to the agricultural mechanization index for rice and corn reflects the purposive distribution of land preparation equipment by the government, including two- and four-wheel tractors and harvesting equipment such as rice and corn combine harvesters as subsidy to rice and corn farmers. Four-wheel tractors and combine harvesters are imported while two-wheel tractors are either imported or locally made. This also reflects the government's trade and investment policies for agricultural machinery.

3.4.2.4. Agricultural mechanization research and development

The AFMech Law of 2013 has five major components aiming to fully mechanize agriculture and fisheries to increase productivity, competitiveness and income and achieve national food security and economic prosperity (Figure 3.4.5). It also focuses on strengthening agricultural mechanization through the Research Development and Extension (RDE) component as presented in the National Agri-Fisheries Mechanization Program (2016-2020) of the Department of Agriculture.

Figure 3.4.5

Philippines: National Agri-Fisheries Mechanization Program, 2016-2020



Source: Department of Agriculture as cited by Amongo & Rico, 2017c

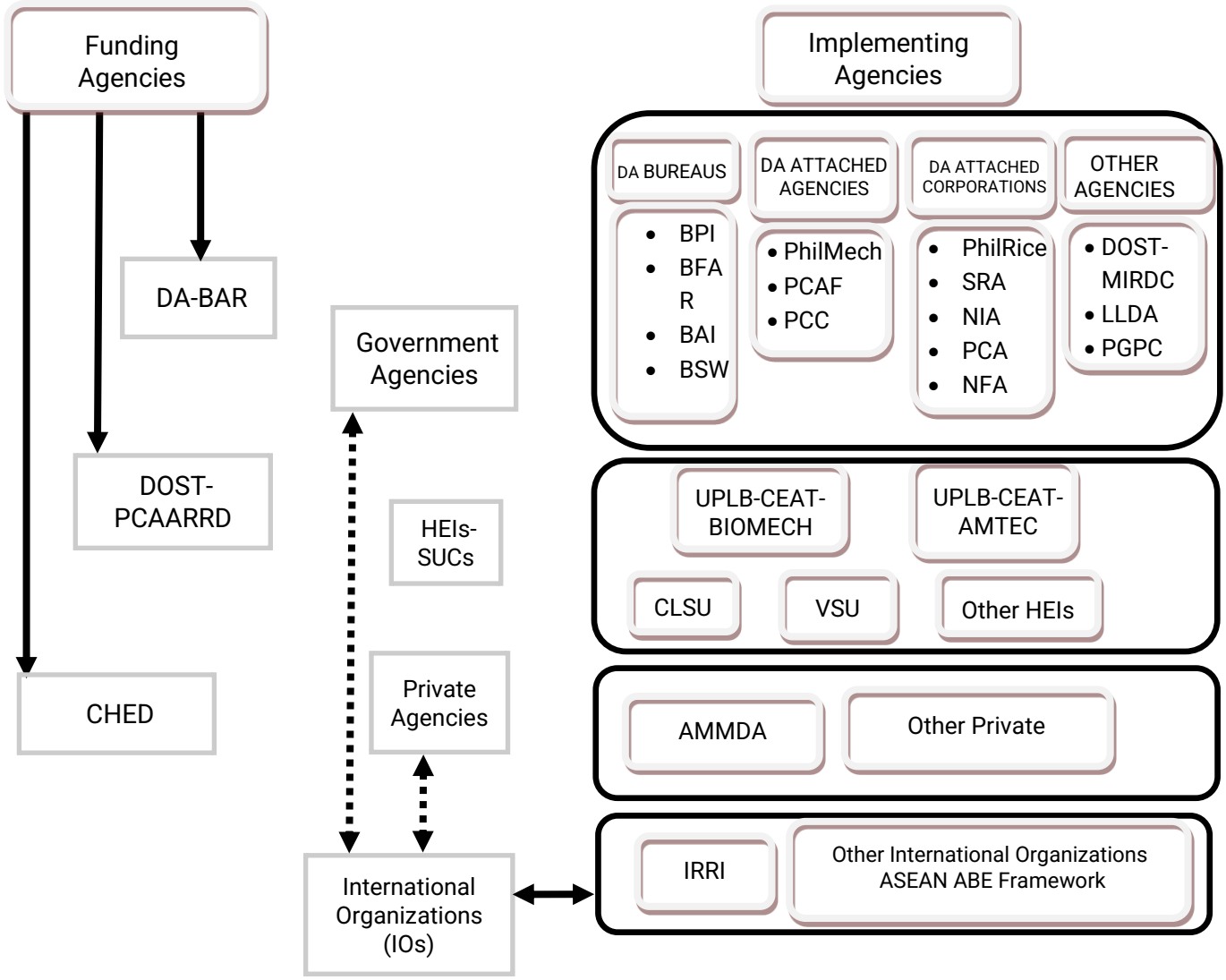
The RDE, a major component of RA 10601, is a network of various agencies directly or indirectly involved in innovative research development and extension for developing, designing, producing and promoting AFMTs for crops and fisheries (Figure 3.4.6). It comprises implementing and funding agencies where the former can be government and private research development institutions (RDIs) and higher education institutions (HEIs) representing about 60 state colleges and

universities (SUCs) offering agricultural and biosystems engineering courses as well as international agencies based in the Philippines. The RDIs and HEIs are the technology generators including agricultural machinery with potential for marketing and trading in local and foreign markets.

Private sector participation in short-term R&D for improving and adapting commercially available machinery for local conditions has been vital. Most RDE contribution by the Agricultural Machinery Manufacturers and Distributors Association Foundation, Inc. (AMMDA). Its members are involved "in the manufacture, assembly, distribution and servicing of farm machinery, namely 4-wheel tractors (standards and compact) and their implements; power tillers and their attachments; irrigation equipment; postharvest equipment; processing equipment; gasoline and diesel engines; crop maintenance and protection equipment; and other agricultural machinery. AMMDA members are either importer/distributors or manufacturers. Manufacturers-members produce local-made hand tractors, threshers, shellers, flatbed dryers, pumps, drilling rigs, shredders, decorticators, among others. Moreover, two-wheel tractor attachments and threshers/shellers are manufactured with an average volume of 20,000 to 30,000 and 15,000 to 20,000 units, respectively. Other machines are fabricated through orders. Further, there are manufacturers who own modern fabrication equipment with at least 5 members with computers and CNCs" (Amongo, et al., 2015).

Figure 3.4.6

RDE network for crop and agri-fishery mechanization

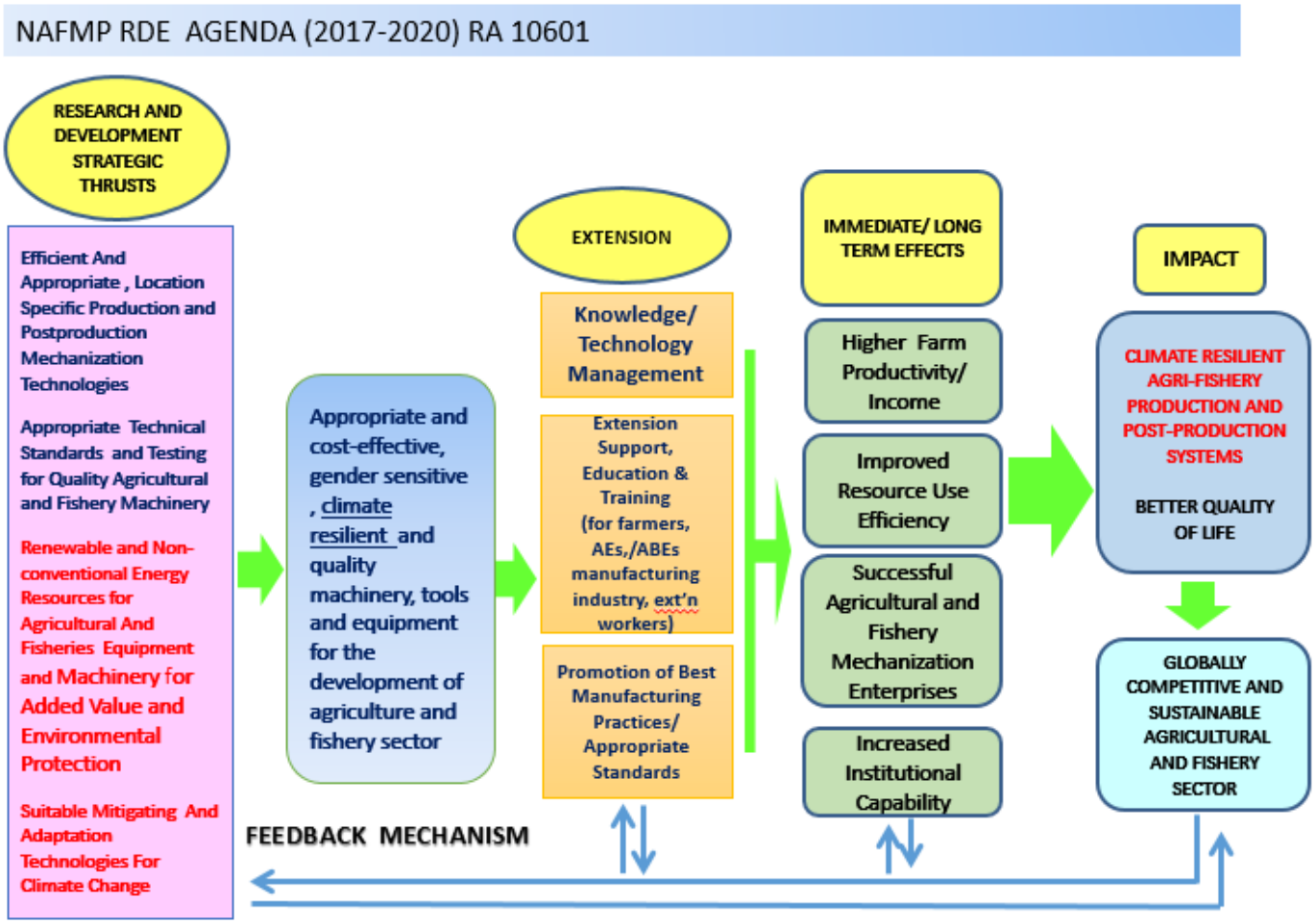


Source: Amongo et al. 2013

With the enactment of the AFMech Law of 2013, RDIs and HEIs were integrated into the RDE network to address issues, gaps and other concerns pertaining to AFMTs for agriculture and fisheries. The National Agriculture and Fisheries Mechanization Program (NAFMP)-RDE Agenda for 2017-2020 is based on the AFMech Law (Figure 3.4.7).

Figure 3.4.7

Philippines: RDE 2017-2020 Agenda for the AFMech Law of 2013



Source: Pasalo, 2016

The RDE network plays an important role in the trade of agricultural machinery. It is responsible for designing appropriate and innovative agricultural mechanization technologies that can be locally manufactured as a substitute for imports and even have export potential.

3.4.2.5. Import and export of agricultural machinery

The local agricultural machinery sector mostly manufactures small to medium-scale machines for local use. Power tillers, threshers, shellers, flatbed dryers, pumps, rice mills and corn mills are fabricated locally while four-wheel tractors, combines, reapers, recirculating dryers and multi-pass rice mills are imported. The mostly small to medium-scale manufacturers have limited capability to make large and sophisticated machinery. Most advanced manufacturers are members of AMMDA which comprises about 20 per cent of agricultural machinery manufacturers in the country.

Table 3.4.10

Philippines: farm machinery in use, 2012

	Units
Tractors	
1) Four-wheel tractor	9,306
2) Power tiller	1,000,000
Paddy thresher	
1) Rice thresher	74,551
2) Pedal thresher	20,149
3) Multipurpose thresher/sheller	6,259
Mechanical harvester	
1) Combine harvester	50
2) Reaper	100
Post-harvest machinery	
1) Corn sheller	5,340
2) Flatbed dryers	2,620
3) Recirculating/Columnar mechanized dryer	1,330
4) Corn mill	2,340
5) Rice mill (single pass)	24,420
6) Rice mill (multi-pass)	904

Source: Amongo & Rico, 2016

Agricultural machinery is also distributed by the government (see Table 3.4.11).

Table 3.4.11

Philippines: machines distributed by government and PhilMech, 2011-2016

Machines/infrastructure	REGIONAL AGRICULTURAL ENGINEERING DIVISION offices*	Philippine Center for Postharvest Development and Mechanization (PhilMech)	SMALL SCALE IRRIGATION PROJECT, 2019	TOTAL
4WD tractor	661	13 735		14396
Hand tractor	2097	251 712		253 809
Planters	341	1 809		2 150
Sprayers	6	93 294		93 300
Harvesters	416	1 489		1 905
Combines	203	2 714		2 917
Threshers/shellers	1073	89 825		90 898
Dryers (with MPDP)	798	40 002		40 800
Size reduction machinery	925	18 976		19 901
Processing Facilities	28	333		361
Coffee-processing equipment (de-pulper and roaster)	115			115

Hullers	5	745		750
Seed/grain cleaner	83	4 398		4 481
Cold storage		39		39
Irrigation				
Pump and engine	155	98296		98 451
STW		252		252
DD**			236	236
SD**			14	14
SWIP**			9	9
SSIP***			5300	5 300
*rice/corn/Cassava/Coffee	**Data from Bureau of Soils and Water Management		***Data from Survey (Region 4A & 4B)	

Source: SEARCA, 2019

Abbreviations: 4WD, four-wheel drive; DD, (Diversion Dam); MPDP, multi-purpose drying pavement; SD, (Spring Development); SSIP, Small Scale Irrigation Project; STW, shallow tubewell; SWIP, Small Water Impounding Project.

Most large agricultural machines are imported as are small cylinder engines (SCEs) ranging from 5 to 20 hp, the major power source of most agricultural machinery, because of the absence of local manufacturing capacity (see Table 3.4.12).

Table 3.4.12

Philippines: import of agricultural machines, 2018

Machine	Units
4WD tractor	958
Hand tractor	686
Milling machine	887
Planter	185
Dryer	1,014
Sprayer	111,264
Combine harvester	279
Harvester	1,142
Processing machine	150
Pump	45,723
Engine	71,294

Source: Bureau of Customs, 2018.

Note: Only considered machines identified for agricultural use

3.4.3. Enabling environment for trade and investment for sustainable mechanization of the agricultural sector

3.4.3.1. Investment and environment policy

a. Public and private sector participation in sustainable agriculture mechanization

The private sector plays an important role in sustainable agricultural mechanization in the Philippines, partnering various government initiatives and joins in policy formulation as members of the DA Agricultural and Fisheries Committee. It also supplies locally manufactured and imported AFMTs and collaborates in agricultural mechanization R&D. The private sector is also an extension agent for the dissemination and utilization of AFMTs in the country and as such, a partner of farmers and fisherfolk in sustainable agricultural mechanization.

b. Role of agricultural machinery manufacturers' and distributors' associations

Established in 1964 by various agricultural machinery distributors to encourage agricultural mechanization and adoption of latest trends in farm operations, the Agricultural Machinery Distributors Associations was later renamed Agricultural Machinery Manufacturers and Distributors Association, Inc (AMMDA) and represents 95 per cent of the countries' largest farm machinery manufacturers and distributors (Philippine Companies.com, 2019).

Members of AMMDA produce large machinery such as four-wheel tractors and implements, rotary tillers and attachments, post-harvest and processing machinery and small machinery like gasoline and diesel engines, irrigation systems and crop care and crop protection equipment (PhilippineCompanies.com, 2019).

As official spokesperson of the agricultural machinery industry, AMMDA provides the government and other private institutions with necessary data for policymaking, sales forecasting and market analysis. The association coordinates with government agencies, particularly the Department of Agriculture, Bureau of Soils and Water Management (BSWM), PhilRice, PhilMech, Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCCARRD), Center for Agri-Fisheries and Biosystems Mechanization of the University of the Philippines Los Baños (BIOMECH – UPLB) as well as the International Rice Research Institute (IRRI) for the promotion of agricultural mechanization. It also promotes and supports local manufacturers of farm machinery such as hand tractors and implements, four-wheel tractor implements and floating tillers, with the assistance of the government (PhilippineCompanies.com, 2019).

Among the association's notable achievements is the removal of tariff duties for diesel and gasoline engines of 25 hp and below, resulting in increased utilization of powered farm machinery. Its efforts also led to the creation of the Agricultural Machinery Distributors/Manufactures Accreditation Committee (AMDAC) funded by Bangko Sentral ng Pilipinas, which plays a vital role in evaluating agricultural machinery companies' sales and service capacities. The group has also given three Cabinet Secretaries to the government, namely Arturo R. Tanco, Jr. of the Ministry of Agriculture, Ceferino L. Follosco of the Department of Science and Technology and Salvador M. Enriquez, Jr. of the Department of Budget and Management (PhilippineCompanies.com, 2019).

The Agricultural Machinery Testing and Evaluation Center (AMTEC) recorded about 354 small to medium-scale local manufacturers in 2001 and this data has not been updated (see Table 3.4.13).

Table 3.4.13

Philippines: agricultural machinery manufacturers and dealers

Region		Number	Percentage
LUZON:	I	18	5.1
	II	22	6.2
	III	35	9.9
	NCR	113	31.9
	IV	29	8.2
	V	27	7.6
VISAYAS:	VI	30	8.5
VII		2	0.6
VIII		7	1.9
MINDANAO:	IX	13	3.7
X		18	5.1
XI		19	5.4
XII		21	5.9
TOTAL		354	100

Source: AMTEC 2001

c. Initiatives in manufacturing, distribution and adoption of sustainable agricultural mechanization

Article IV Section 15 of RA10601 (2013) states: "Local Assembling and Manufacturing. – Production of locally-made engines and other machinery for agricultural and fisheries purposes shall be promoted and encouraged by the DA in partnership with the private sector, and through joint venture agreements. For this purpose, the DA in partnership with the recognized national organization of agricultural machinery assemblers, manufacturers and distributors, agricultural engineers and the Department of Science and Technology (DOST) shall undertake the feasibility study and R&D for the local assembly and manufacture of agricultural engines/prime mover, and other agricultural machinery and equipment."

Under this mandate, the DA, through the Philippine Council for Agricultural and Fisheries (PCAF), initiated a policy study to aid local production of small cylinder engines in the country, which was led by BIOMECH-UPLB. Small cylinder engines are the primary power source for many agricultural operations and particularly used in hand tractors, irrigation systems and for threshing. Local production is expected to reduce costs and promote mechanization, stimulate manufacturing sector growth and local employment while reducing dependence on imported engines and opening the possibility of local engine exports (Cayona, 2017).

Local assembly of small cylinder engines is not new and began in the early 1980s. Delta Motors Corporation (DMC) started manufacturing its own CX-engines in 1982 designed after the Briggs and Stratton 10 hp engine. The company also built the 12R engine model for the Toyota Corporation of Japan. However, financial difficulties and Toyota's backing out of the partnership saw DMC halt manufacturing two years after inauguration (Rodulfo et al., 2017).

Local manufacturing resumed in 1996 when DOST partnered with Solanda Enterprises to get Kohler engine parts manufactured locally with Solanda assembling and distributing the engines. Solanda

was licensed by Kohler to manufacture the engines and was in talks with local manufacturers through DOST- PCAARRD but the project was scrapped when DOST-Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD) took over the programme citing concerns over economies of scale (Rodulfo et al., 2017).

In 2000, Super Trade Enterprises (STE) started assembling Taro Engines from Taiwan using CKD parts. In 2005, local manufacturer Allied Motors Manufacturing Phils. Inc. (AMMPI) agreed with US company Briggs and Stratton Corp. (B&S) to move its production of single cylinder engines to the country. AMMPI produced four major engine parts, namely cylinder block, engine base, crankshaft and cam gears. The manufacturing plant had an annual capacity of 14,000 units with 50 per cent of the engines being exported to South America. Unfortunately, operations ceased around 2012 when B&S retracted AMMPI's license to distribute and eventually the license to manufacture (Rodulfo et al., 2017).

In 2014, the government tried to reinvigorate local engine manufacturing with the Metal Industry Research and Development Center (MIRDC) developing a 12 hp engine, looking forward to a 20 per cent reduction in cost compared to imported brands. The engine has undergone field testing and the agency is negotiating with local manufacturers and suppliers to ensure the sustainability of the project (Rodulfo et al., 2017).

The experience of the local manufacturing industry and government counterparts provided data for the national roadmap for local engine manufacturing. As proof that the local industry is capable of developing a small cylinder engine (SCE), the study headed by Rodulfo, Jr (2017) made the following policy recommendations:

1. The DA-PCAF shall establish the SCE Assembling and Manufacturing (SEAM) Program and Roadmap.
2. DA-PCAF shall initiate the formation of an intersectoral committee to oversee implementation of the SEAM Program and formulate criteria for the selection and accreditation of local and foreign partners, giving preference to partners with a proven global track record, including ownership of internationally recognized brands.
3. DA-PCAF shall recommend to BOI that "local engine production" be specified and explicitly stated as part of qualified manufacturing activities under preferred activities for investment. The recommendation shall also include retention of local engine production in the list of preferred activities for investment in the 2017 IPP in succeeding years of its activity.
4. Initially, assembly of CKD parts is recommended. Manufacture of peripheral and other internal parts shall follow a localization plan wherein it shall follow a progressive local content target.
5. DA-PhilMech, in collaboration with MIRDC shall continue research and development to increase the local content of the single cylinder engine.
6. DA-ATI, in coordination with TESDA (Technical Education and Skills Development Authority), MIRDC and private manufacturing associations shall develop human resource capabilities to complement the demand for skilled human resources.
7. DA-PCAF shall coordinate with government financing institutions to provide credit to local manufacturers for upgrading and modernizing facilities.
8. DA-PCAF shall encourage and support local manufacturers and distributors, such as AMMDA, to promote sales and after-sales service to end-users of locally produced engines.
9. The implementation of the preceding policy recommendations shall constitute the roadmap of the SCE assembling and manufacturing industry.

3.4.3.2. Trade environment and policy

a. Risk management

Located on the 'Pacific Ring of Fire', the Philippines is highly vulnerable to natural disasters and ranked by a United Nations study as the world's third most climate change- vulnerable country, while environmental organization German Watch has ranked it the world's most vulnerable to natural calamities, based on 2013 data (Pagaddu, 2016).

Two agencies were established to mitigate the effects of natural disasters on the agricultural sector. The Philippine Crop Insurance Corporation (PCIC) manages the agricultural insurance programme to protect farmers from losses from natural calamities, pests and crop disease as well as from damage or loss of non-crop farm assets, including agricultural machinery and infrastructure like transport facilities and post-harvest processing centres (PCIC, 2019). The National Disaster Risk Reduction and Management Council (NDRRMC) set up by RA 10121 of 2009 is a multi-interagency committee of government and non-government agencies and also mitigates natural calamity impact, including on the agricultural sector (Bueza, 2017).

With average GDP growth of 6.87 per cent, agricultural, industrial and services growth of respectively 1.5 per cent, 6.8 and 6.63 per cent during 2011-2018 (PSA, 2019), the Philippine index of economic freedom is 68.80 per cent. The country was ranked A4 in terms of country risk rating, which according to Coface in 2018, is a "somewhat shaky political and economic outlook and a relatively volatile business environment that can affect corporate payment behavior. However, corporate default probability is still acceptable on average". Identified weaknesses included inadequate infrastructure (including agricultural), low fiscal revenues, governance shortcomings, high corruption perception, high income inequality, the southern insurgency, strict bank secrecy and casinos facilitating money laundering. The Philippines is expected to maintain its momentum as significantly affected by domestic demand and household spending (70 per cent of GDP) is expected to contribute significantly to growth. It was also found that investments (25 per cent of GDP) should grow moderately in 2019 with most investment growth attributable to public infrastructure projects (Coface for trade, 2019).

Steady investment in mechanization and support services is expected in the agricultural and fisheries sector over a 6-year period with an annual appropriation of 10 billion during 2019-2024 provided under the Rice Tariffication Law of 2019.

b. Regional trade agreements

The Philippine-Japan Economic Partnership Agreement (PJEPA) is the country's only bilateral trade agreement to date (DTI, 2019). The PJEPA covers trade in goods (TIG), trade in services (TIS), investments, movement of natural persons (MNP), intellectual property (IP), customs procedures, improvement of the business environment (IBE) and government procurement (GP) (DTI, 2019).

Japan is the country's largest trading partner since 2010 with an estimated total bilateral trade value of USD 21 billion as of 2016. Since implementation of PJEPA, the trade balance has increased in favour of the Philippines, corresponding to a 19 per cent rise in total trade and a 53 per cent growth in exports. Japanese investment in the country has doubled with total approved investment of USD 569.75 million. Japan is now the fourth largest source of investments in the Philippines based on 2016 data (DTI, 2019).

The PJEPA has also benefited the agricultural and industrial trade sector with a rise in agricultural

exports led by a 78 per cent increase in coconut oil exports, followed by pineapples at 33 per cent and bananas at 32 per cent, reflecting a 34 per cent increase in total agricultural exports. Industrial exports to Japan also increased by 35 per cent, led by a 100 per cent increase in semiconductor exports, a 90 per cent increase in Philippine builders' joinery exports and a 57 per cent growth in insulated wires and cable exports (DTI, 2019).

The Philippines is a member of many regional and international trade associations and agreements, including ASEAN, ASEAN Free Trade Area (AFTA), ASEAN Plus 6, ASEAN Trade in Good Agreement and European Free Trade Association (EFTA) (DTI, 2019).

AFTA seeks to reduce tariffs on selected goods to between 0 and 5 per cent through the Common Effective Preferential Tariff (CEPT) Scheme. Only Brunei-Darussalam, Indonesia, Malaysia, the Philippines, Singapore and Thailand have reduced tariffs on 99 per cent of products listed in the CEPT Inclusion List while Cambodia, Lao People's Democratic Republic, Myanmar and Viet Nam have covered 80 per cent of listed products (DTI, 2019).

The ASEAN Trade in Goods Agreement (ATIGA) establishes a sole market and production area as part of the ASEAN Economic Community and is more comprehensive than the earlier CEPT-AFTA scheme. Since its inception, 99.56 per cent of tariff lines have been excluded from import duties in Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore and Thailand while Cambodia, Lao People's Democratic Republic, Myanmar and Viet Nam have increased import duties exclusion from 80 to 98.86 per cent (DTI, 2019).

The ASEAN Plus Six Agreement aims to enhance economic growth and partnership in energy, food and other areas among ASEAN members and Australia, China, India, Japan, New Zealand and the Republic of Korea (DTI, 2019).

The Philippines joined the EFTA in 2016 with EFTA members, including Iceland, Liechtenstein, Norway and Switzerland and the process of ratification and entry into force for each member country is underway. Along with the proposed agreement with the European Union (EU) and the EU Generalized System of Preferences Plus, this is expected to benefit the country's economy (DTI, 2019).

3.4.3.3. Infrastructure and financial development

a. Infrastructure development

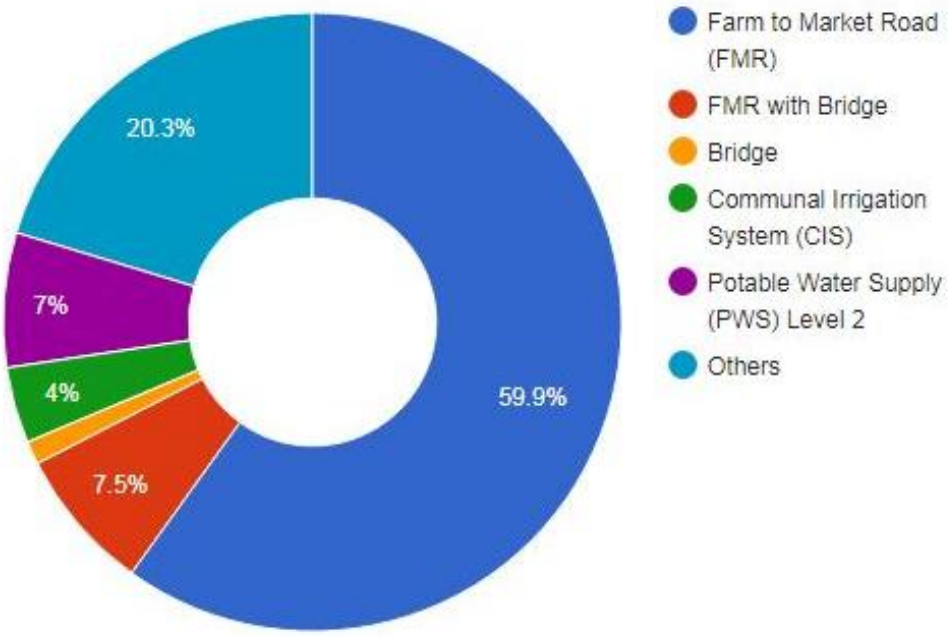
1) The Philippine Rural Development Program (PRDP) was launched in 2013 to promote a modern, climate- resilient and market-driven agricultural and fisheries sector by reforming operations of the Department of Agriculture and enhancing the competitiveness and capabilities of farmers and fisherfolk. The programme aims to (1) increase annual real household incomes of farmer beneficiaries by at least 5 per cent, (2) increase income of targeted beneficiaries of enterprise development by 30 per cent, (3) increase the value of annual marketed output by 7 per cent and (4) increase by 20 per cent the number of farmers and fisherfolk with improved access to DA services. The PRDP Program has the following components: (1) Investment in Agriculture and Fisheries Modernization Program Planning at local and national levels, (2) Intensified Building up of Infrastructure and Logistics for Development (I-BUILD), (3) Investments in Rural Enterprises and Agriculture and Fisheries Productivity (I-REAP) and (4) Implementation Support to PRDP (I-SUPPORT) (PRDP, 2019).

The World Bank has contributed 75 per cent of the PRDP funding of PHP 27.5 billion with the Philippines government contributing about 13 per

cent, local governments accounting for 11 per cent and 1 per cent being a grant from the Global Environment Facility (GEF). Of the total budget, 92 per cent is to deliver the output identified in the I-BUILD and I-REAP components (Figure 3.4.8) (Verdun, 2019).

Figure 3.4.8

Distribution of PRDP infrastructure projects



Source: Verdun, 2019

In the Philippines, with a poverty incidence of 34.3 per cent in rural areas as of 2015 (Bersales, 2017), access to credit is vital for most farmers. Loans extended to farmers and fisherfolk in 2017 amounted to PHP 618.79 billion, an increase of 23.76 per cent over 2016 (Philippine Statistics Authority, 2018). Of this, 56.62 per cent or PHP 350.38 billion was allocated for agricultural production, the highest recorded over a five-year period, representing a 29.20 per cent increase.

Private banking institutions remain the biggest source of funds accounting for 81.32 per cent or PHP 284.95 billion with government banks accounting for the rest amounting to PHP 65.43 billion. Private commercial banks have the biggest share of 48.63 per cent, an increase from earlier years, followed by rural banks with a drop in share to 12.07 per cent, savings and mortgage banks at 8.02 per cent, private development banks at 7.32 per cent and stock savings and loan associations with a share of 5.29 per cent (PSA, 2018).

In terms of the volume of loans, private and government banks showed an increase compared to 2016 of 29.93 and 26.09 per cent, respectively. Private commercial banks recorded the highest lending growth at 56.32 per cent as well as rural banks with an increase in loan volume of 10 per cent. Private development banks and stocks savings and loan associations minimized lending support by 3.94 and 1.86 per cent, respectively. Savings and mortgage banks posted a decrease in credit support of 3.12 per cent. Among government banks, Development Bank of the Philippines (DBP) expanded credit lending by 147.47 per cent and the Land Bank of the Philippines (LBP) posted a 22.88 per cent increase in lending (PSA, 2018). The latter

bank had committed to triple its allocation for credit support up to PHP 115 billion by 2022 from PHP 37.9 billion as part of then's presidential target to promote rural economic growth by enhancing agricultural productivity. To attain this goal, LBP promoted so-called "farmers corporations" through a re-engineered credit support system which encouraged consolidation of farmers' landholdings to create a larger farm to be managed by a corporation having LBP as 40 per cent shareholder, with the remaining shares held by participating commercial banks (Ranada, 2018).

Besides landholdings, farmers also had to provide "manpower to keep their lands profitable". Farmer members get a fair share of 99 per cent of the corporation's profit on a pro rata basis and areas. The remaining 1 per cent will be the corporation's income to be distributed among the participating banks. It should also be noted that the 60 per cent share of the participating commercial banks will eventually be divested to each farmer by taking a portion of the profit of each farmer to purchase equity of the corporation. Farmers can also choose to plant cash crops with high export potential such as banana, coconut, palm oil, cacao and abaca. Rice farmers can enter into a corporative agreement to mitigate the effect of the removal of restrictions on rice imports (Ranada, 2018).

The DA rice programme is one of the most significant government investments in agriculture in recent years. In addition to production support in the form of seeds and other inputs), infrastructure development is integrated in the programme as well as in other agricultural commodity-based programmes. Infrastructure-related services or investment for the rice programme include irrigation development, post-harvest development, establishment of e-trading centres and encouragement of public-private partnerships (http://dafarmm.da.gov. ph/rice-program/).

2) The construction of a well-planned road network to facilitate the efficient and timely flow of goods, services, people and opportunities locally is a priority agricultural modernization initiative as stipulated in Republic Act 8435. A total of PHP 13 billion was allocated during 2001-2017 for the Farm to Market Road Development Projects (FMRDP) of which 63 per cent was funded through the General Appropriations Act (Espiritu, and others, 2019).

Varying interpretations of a Farm-to-Market Road (FMR) promulgated as legal instruments, led to inadequate funding of the FMR projects with it being generally said that "for as long as a proposed road project leads or connects to the market regardless of its Department of Public Works and Highways (DPWH) road classification whether as a barangay, municipal or provincial road, such proposed project was considered and funded as FMR" (Espiritu, and others, 2019).

To address issues in funds allocation and construction of FMR projects, DA-PCAF commissioned a study by Don Mariano Marcos Memorial State University-Institute of Agricultural and Biosystems Engineering (DMMMSU-IABE). The study by Espiritu, and others (2019), titled "Policy Study on Enhancing a National Integrated Farm to Market Road Implementation in the Philippines" proposed a redefinition of FMR for proper allocation of government funds for the agriculture and fisheries sector. It proposed that a"Farm-to-Market Road must be a feeder road within the agriculture and fisheries production sites, coastal landing points, post-harvest or processing facilities link to local roads, national highways and market".

b. Financial support for agriculture and sustainable agricultural mechanization

The agriculture and sustainable agricultural mechanization sectors have various sources of funding but primary financial support is from the

Government Appropriations Act (GAA). The following GAA allocations have been made:

1) Philippine Center for Postharvest Development and Mechanization (PHilMech) of DA

In the 2019 GAA, PhilMech had a total appropriation of PHP 310,126,000 with 72.02 per cent (PHP 223,363,000) allocated for agricultural mechanization and the post-harvest research, development and extension programme. Of this, 32.81 per cent, 49.33 and 17.86 per cent, respectively, were for Personnel Services, Maintenance, Other Operating Expenses and Capital Outlay, respectively (available at https://www.dbm.gov.ph/wp-content/uploads/GAA/ GAA2019/volumei/ da/g.pdf)

2) Agricultural Credit Policy Council (ACPC)

In the 2019 GAA, the total budget for agricultural credit, particularly for the Agricultural Credit Policy Council (ACPC) was PHP 2,543,230,000. Of this, PHP 2,467,041,000 (97 per cent) was for the Agro-Industry Modernization Credit and Financing Program Administration. This included PHP 2,431,886,000 exclusively for fast, convenient, and affordable financing through government financial institutions (GFIs), cooperative banks, rural banks, thrift banks and other private banks for the benefit of small farmers, fisherfolk and micro, small and medium-scale agricultural and fisheries enterprises. The ACPC formulates guidelines for streamlined and equitable access of the credit facility for farmers and fisherfolk (available at https://www.dbm.gov.ph/wp-content/uploads/GAA/ GAA2019/ volumei/da/b.pdf).

3) Rice Tariffication Law of 2019 (RA 11203)

The Rice Competitiveness Enhancement Fund (RCEF) has an annual appropriation of Pt 10 billion for the next six years. Section 13.a. requires 50 per cent of the rice fund to be released and implemented by PhilMech as grant-in-kind to eligible farmers' associations, registered rice cooperatives and local government units. Grant to eligible farmers' group is in the form of equipment such as tillers, tractors, seeders, threshers, rice planters, harvesters, irrigation pumps, small solar irrigation, reapers, dryers and millers for improving farm mechanization (PhilMech, 2019).

4) Financial Support for the DA Banner Commodity Programs

The GAA allocations for the Banner Programs for rice, corn and high value crops and Bottom-up budgeting during 2011-2013 are shown in Table 3.4.14.

Table 3.4.14

Budget for Banner Programs of the Department of Agriculture, GAA 2011-2013

(PHP)

	2011	2012	2013
Banner Programs			
National Rice Program	5,217,216,000	6,181,166,000	7,430,081,000
National Corn Program	483,642,000	950,739,000	1,524,301,000
High Value Crops Development Program	926,867,000	1,336,658,000	1,355,195,000
Bottom-up Budgeting	-	-	8,397,100,000

Source: DBM, 2011-2016 as cited in SEARCA (2019)

The 2014-2016 budgetary share of each Banner Program, specifically for agricultural equipment and

facility support, was 31.62 per cent for rice, 43.98 per cent for corn and 23.31 per cent for high value commercial crops, of the total allocation for the respective national commodity programme (see Table 3.4.15). In 2013, funds were allocated to a new programme, the Philippine Rural Development Program.

Table 3.4.15

Department of Agriculture (budget) GAA, 2014-2016

(PHP)

	2014	2015	2016
MFO 5. Agricultural equipment and facilities support services	2,939,435 000	3 090,857 000	2,921,366,000
National Rice Program	2,141,237 000	850,880 000	806,805,000
National Corn Program	556,285 000	1,203,403 000	1,093,042,000
High Value Crops Development Program	203,794 000	400,747 000	531,052,000
Philippine Rural Development Program	815,456 000	7,328,380 000	9,062,820,000
Bottom-up Budgeting	20,047,964 858	20,905,841 494	24,714,947,714

Source: DBM, 2011-2016 as cited in SEARCA (2019)

Other sources of finance are:

Japan International Cooperation Agency (JICA)

In 2017, the visit of then Japanese Prime Minister led to JICA subsidizing the Philippine mechanization programme by approximately PHP 1.0 billion. The aid covered 10,000 ha and included funding for half the cost of tractors, transplanters, harvesters, drying facilities, storage facilities and rice processing facilities to be purchased by the Philippine Farmers' Association. (available at https://news.mb.com.ph/2017/01/24/a-mechanization-program-for-philippine-agriculture/).

Korea International Cooperation Agency (KOICA)

The Department of Agriculture has completed a project worth PHP 785 million that involves the provision of four rice processing centres (RPCs), which are expected to reduce post-harvest losses in different parts of the country. KOICA is a key sponsor of the project providing PHP 649 million, about 83 per cent of the total project cost (Domingo, 2013).

3.4.4. Summary, conclusions and recommendations

Summary and conclusion

Although the decreasing contribution of agriculture to GDP is an indication of intensifying industrialization in the Philippines, the farming sector still has an important role in sustaining the economy and livelihoods. Agricultural mechanization will continue to substantially contribute to enhancing agricultural productivity,

food self-sufficiency, inclusive growth and poverty reduction.

Over the past decade, there has been steady investment in agricultural development, ranging from infrastructure financing to expansion of credit for producers. Although agricultural modernization and mechanization coupled with agri-fisheries support services has moved at a slower pace compared to other Southeast Asian countries, it may have had some positive effect on increasing mechanization for major crops such as rice, corn and high-value crops in the country.

Common issues and gaps related to mechanization of the commodity value chain of major crops are: small size of farm holdings constraining high volume production; low farmer incomes; low productivity and farm inefficiencies; underdevelopment of other potential sub-chains to serve as stable market; dependence on imported agricultural machinery which does not always suit local conditions; lack of a needs and demand assessment to match technologies to local conditions and farmers' preferences; and low quality of machines and inadequacies of the AMT distribution process (SEARCA, 2019).

Agricultural mechanization is integral to addressing these gaps and issues. With the government promoting contiguous farming in the country as stipulated in RA 10601 or the AFMech Law of 2013, the use of more efficient large machines is expected to accelerate the adoption and promote the trade of large agricultural mechanization technologies. Moreover, global competitiveness requires strengthening trade and investment policy, particularly AFMT import. As stipulated in RA 10601, all imported AFMTs must pass AMTEC testing before entering the local market even if already tested by local and foreign manufacturers. To avoid duplication of efforts and resources and to enhance the trade of AFMTs, all local and foreign stakeholders should collaborate and agree on efficient and cohesive trading of AFMTs in the country.

Furthermore, with the recent enactment of the Rice Tariffication Law and the continued implementation of the Agricultural and Fisheries Mechanization Law of 2013, agricultural mechanization is expected to be part of major policy initiatives, its immediate programme implementation and government fund appropriation priorities within the next six years including the acquisition and distribution of AFMTs all over the country.

Recommendations

In the context of the purposive acceleration of agricultural mechanization in the country, the following can enhance the efficient utilization and trade of agricultural machinery:

1. Grouping small farm plots together will allow efficient use of larger machines and the government's contiguous farm or land consolidation programme is a step in this direction. This will allow use of larger and more efficient AFMTs for higher agricultural productivity leading to food self-sufficiency. Contiguous farming will allow efficient use of agricultural machines through an improved farm layout and easier access to agricultural infrastructure such as irrigation and drainage, farm-to-market roads and post-harvest facilities. Contiguous farming will also facilitate good farm practices such as application of the right amount and quality of seeds, fertilizers and other inputs, thereby reducing costs. Contiguous farming will allow efficient operation of custom hiring services for agricultural machinery, making it easier for farmers to access mechanization technologies.

2. Government support can strengthen the local agricultural machinery manufacturing industry in the production of AFMTs not only for local use but

also for export. The study by Rodulfo, and others (2017) recommended a national road map for local agricultural machinery manufacturing with local assembly and manufacturing of single cylinder engines, starting with localization of engine parts. An intensive agricultural mechanization programme will need a ready supply of locally manufactured machine parts subject to wear and tear.

3. There is a need to develop other sub-chains as an alternative market when the major sub-chain becomes uneconomical and uncompetitive. This will provide another window for the utilization of appropriate mechanization technologies to enhance trade and investment in agricultural machinery.

4. After-sales service and supply of spare parts should be a major requirement for the procurement and distribution of agricultural machines, especially in remote areas where such services are limited.

5. Continued government support for AFMT research, development and extension, especially for advanced know-how such as precision agriculture and smart-farming technologies with potential for trade and investment in agricultural machinery.

6. Implementation of the mechanization programme requires the establishment of a comprehensive and up-to-date management information system that is responsive to the needs of commodity value chains for stakeholders' timely access to relevant information. A repository of data is also essential for trade and investment in agricultural machinery.

3.5. Türkiye

3.5.1. Overview of the Agricultural Sector

3.5.1.1. The Agricultural Economy

Türkiye is at the crossroads of Asia and Europe, at the intersections of the Balkans and the Caucasus, and bordering the Mediterranean and Black Seas; its European side is known as Eastern Thrace and the Asian side as Anatolia. Türkiye had a population estimated at 80.8 million in 2019 (Turkish Statistical Institute, 2019) and a national territorial area of 783,562 km2.

Türkiye has seven geographical regions, namely Black Sea, Mediterranean, Aegean, Marmara, Eastern, Southeastern and Central Anatolia. The country is largely mountainous with 55 per cent land above 1,000 m and 62.5 per cent with a slope of more than 15 per cent. The winds coming from the Black Sea in the north bring large amounts of moist air but cannot pass over the range of mountains to the north and south, which creates different geographical regions and microclimates in Türkiye. There is a positive relationship between land use and geographical and climatic characteristics, with forestry in humid regions, livestock production in high mountainous and arid areas, and vegetable production in all regions. This makes possible the production of specific agricultural products in the different ecological regions.

As a self-sufficient country in terms of agrifood, Türkiye is an important producer and exporter of agricultural commodities. It was estimated by the OECD in 2002 to be the world's 11th largest agricultural producer with agriculture contributing USD 23.7 billion to its GDP. In 2018, the agricultural and food industrial sector's contribution to the overall GDP reached USD 42.5 billion and ranked 7th among global economies (IFAD, 2018). The agricultural sector accounts for 5.8 per cent of the GDP and 18.4 per cent of total employment

(Ministry of Agriculture; General Report, 2019). The size of the arable land, the number of agricultural holdings, production capacity and product diversity provide a large market for agricultural machinery.

Turkish Statistical Institute (Turkstat) data shows that of the total 23.2 million ha of agricultural land, 81.6 per cent are for arable crops, 14.9 per cent for fruit and 3.5 per cent for vegetable production. Despite their areal size being small, fruits and vegetables are intrinsically high-value crops accounting for 35 per cent and 26 per cent respectively of total agricultural production value, compared with the relatively low economic value of arable crops. In other words, more income is being obtained from limited land resources by growing fruits and vegetables. State aid is needed to keep arable farming, particularly dry farming, viable. The negative socioeconomic aspects of arable farming have once again demonstrated the importance of high productivity and efficiency.

In 2018, exports of agricultural commodities from Türkiye amounted to USD 16.7 billion, and imports of agricultural commodities were USD 13.9 billion at current prices, while the trade surplus of USD 2.8 billion that year was USD 69 million higher than in 2017 (International Trade Center, 2019).

In 2018, Türkiye had a per capita GDP of around USD 9,632, which decreased on average by 3.29 per cent each year between 2013 and 2018 after increasing from USD 3,084 in 2001 to USD 12,480 in 2013 (see Table 3.5.1).

Table 3.5.1

Türkiye: Gross Domestic Product (GDP) per capita, 2008–2018

(US dollars)

		In current prices				
YEAR	*Mid-year population (thousands)*	*Turkish lira*	*Change rate (percentage)*	*US dollars*	*Change rate (percentage)*	*Average, US dollar-Turkish lira exchange rate*
2008	71,052	14,001	11.6%	10,931	13.2%	1.29
2009	72,039	13,870	-0.9%	8,980	-17.8%	1.54
2010	73,142	15,860	14.3%	10,560	17.6%	1.50
2011	74,224	18,788	18.5%	11,205	6.1%	1.67
2012	75,176	20,880	11.1%	11,588	3.4%	1.79
2013	76,148	23,766	13.8%	12,480	7.7%	1.90
2014	77,182	26,489	11.5%	12,112	-2.9%	2.18
2015	78,218	29,899	12.9%	11,019	-9.0%	2.72
2016	79,278	32,904	10.0%	10,883	-1.2%	3.02
2017	80,313	38,680	17.6%	10,602	-2.6%	3.64
2018	81,407	45,463	17.5%	9,632	-9.2%	4.81

Source: Turkish Statistical Institute, 2019

Agriculture accounts for 6.1 per cent of the country's GDP (see Table 3.5.2), its contribution decreasing to USD 51.8 million in 2017 from USD 53.4 million in the previous year.

Table 3.5.2

Türkiye: Gross Domestic Product (GDP) at current prices contributed by agriculture, 2009–2017

Year	*Agriculture (millions of Turkish liras)*	*Rate of change (percent-*	*Türkiye (millions of Turkish liras)*	*Rate of change (percent-*	*Agricul-tural share (percent*	*Agriculture (US dollars)*	*Türkiye (US dollars)*	*Average US dollar-Turkish lira*

		age)		*age)*	*- age)*			*exchange rate*
2009	81,234	9.1	999,192	0.4	8.1	52,592,510	646,894,531	1.54
2010	104,703	28.9	1,160,014	16.1	9.0	69,714,325	772,366,615	1.59
2011	114,838	9.7	1,394,477	20.2	8.2	68,491,565	831,691,448	1.67
2012	121,693	6.0	1,569,672	12.6	7.8	67,536,064	871,122,993	1.79
2013	121,709	0.0	1,809,713	15 3	6.7	63,914,163	950,350,602	1.90
2014	134,725	10.7	2,044,466	13.0	6.6	61,604,432	934 855,430	2.18
2015	161,448	19.8	2,338,647	14.4	6.9	59,499,609	861,879,256	2.72
2016	161,305	-0.1	2,608,526	11.5	6.2	53,414,802	862,744,000	3.02
2017	189,000	17.2	3,106,537	19.1	6.1	51,780,869	851,105,959	3.64

Source: Turkish Statistical Institute, 2019

3.5.1.2. The agricultural production system

A fertile soil, favourable climate and abundant rainfall in Türkiye allow for the cultivation of almost all types of crops. The country is a major producer of cereals grown on 19 million ha out of 23.2 million ha of total arable land. Turkstat estimates for 2018 gave wheat a top share of 70 per cent among the production of all cereals, followed by barley with a share of 22 per cent, corn with 6 per cent and paddy with 1 per cent. Turkish agriculture is capable of feeding not only the country's over 80 million people but also 3.5 million registered refugees. Given the political need for a food security buffer, some agricultural products are overproduced even as the supply of other products is lower than required for a comfortable sufficiency level.

Inadequate planning, low yields/losses and climate challenges are the main reasons for the imbalanced production, specifically in:

i) Cereals and other crops: self-sufficient in wheat, potatoes, cotton and sugar but insufficient production of corn, rice, dry legumes and sunflower.
ii) Fruits, hard shell, and drink plants: self-sufficient in pistachios, hazelnuts, apples, pears, apricots, chestnuts, cherries, citrus, figs, grapes and tea but insufficient production of almonds, walnuts, bananas and other tropical fruits.
iii) Self-sufficient in vegetables production.

a) Diversification of production

Wheat is Türkiye's most produced agricultural crop and cereals have the highest value among top agricultural commodities, followed by fruits, beverages and spices, and vegetables (see Table 3.5.3). Cereal production has grown by 9 per cent, vegetables production by 24 per cent and production of fruits, beverages and spice crops by 22 per cent.

Table 3.5.3

Türkiye: value of crop production, 2000-2018

(Turkish liras)

Year	***Total***	*Cereals, other crop products*	*Vegetables*	*Fruits, beverages and spices*
2000	**14,920,079,928**	6,600,892,750	3,674,327,020	4,644,860,157
2001	**20,017,457,178**	8,903,224,755	5,348,220,571	5,766,011,852
2002	**32,264,199,594**	14,566,410,608	7,656,579,092	10,041,209,895
2003	**40,569,390,283**	17,905,772,672	10,154,837,498	12,508,780,112
2004	**45,680,437,627**	21,474,389,148	11,494,033,030	12,712,015,449
2005	**50,939,686,601**	21,523,272,689	12,028 209,415	17,388,204,497

2006	**54,515,463,228**	20,077,340,745	15,053,716,698	19,384,405,785
2007	**56,787,423,266**	19,559,081,985	17,047,085,604	20,181,255,677
2008	**66,010,114,248**	24,043,524,972	18,146,995,561	23,819,593,715
2009	**68,267,485,926**	25,889 625 949	19,528,882,025	22,848,977,953
2010	**80,038,125,617**	28,464,470,262	26,588,512,470	24,985,142,885
2011	**88,979,273,323**	35,708,465,221	25,539,849,103	27,730,958,999
2012	**87,946,988,338**	33,158,241,882	25,523,04, 611	29,265,696,845
2013	**92,452,529,869**	39,124,023,862	25,602,672,282	27,725,833,724
2014	**98,123,089,165**	42,170,007,141	26,099,407,421	29,853,674,602
2015	**120,152,079,316**	49,519,631,343	29,319,015,345	41,313,432,628
2016	**119,237,661,140**	47,985,465,088	31,710,697,143	39,541,498,909
2017	**135,885,135,544**	56,119,498,611	33,845,747,984	45,919,888,949
2018	**158,870,800,188**	61,943,696,761	41,396,513,500	55,530,589,928

Source: Turkish Statistical Institute, 2019

Türkiye's wheat production exhibited fluctuations from 2010 to 2018. Overall, it increased from 19.67 million tons in 2010 to a peak of 22.6 million tons in 2015, with a slight decrease to 20 million tons by 2018 (see Table 3.5.4). Although increasing, the wheat yield of 2740 kg/ha in 2018 was still below the world average. Wheat is widely produced in the Central Anatolia region which was ranked first in bread wheat (Triticum aestivum) production in 2016 with a share of 33.5 per cent of total production. The Marmara Region follows with a share of 17.3 per cent and the Southeastern Anatolia region with a share of 14.3 per cent (Turkstat, 2019). Wheat, barley, and corn production are adequate for domestic demand.

Table 3.5.4

Türkiye: area, production and yield of cereals, 2000-2018

(Decares, tons, kilograms per decares)

Year	*Cultivated area (decares*)*		*Production (tons)*		*Yield (kg /da)*
	Total (cereals)	Wheat	Total (cereals)	Wheat	Wheat
2000	139,626,380	94,000,000	32,248,694	21,000,000	223
2001	139,073,550	93,500,000	29,570,560	19,000,000	203
2002	137,856,500	93,000,000	30,830,650	19,500,000	210
2003	134,136,000	91,000,000	30,806,800	19,000,000	209
2004	138,325,850	93,000,000	34,153,910	21,000,000	226
2005	138,932,410	92,500,000	36,471,600	21,500,000	232
2006	130,415,623	8,4,900,000	34,642,986	20,010,000	236
2007	124,030,395	80,977,000	29,256,990	17,234,000	213
2008	119,899,739	80,900,000	29,287,281	17,782,000	220
2009	120,677,087	81,000,000	33,577,151	20,600,000	254
2010	121,002,714	81,034,000	32,772,550	19,674,000	243
2011	119,034,352	80,960,000	35,202,073	21,800,000	269
2012	112,933,013	75,296,394	33,377,430	20,100,000	267
2013	115,403,221	77,726,000	37,489,268	22,050,000	284
2014	117,265,268	79,192,084	32,714,157	19,000,000	240
2015	117,132,230	78,668,874	38,637,138	22,600,000	287
2016	114,652,688	76,719,448	35,281,164	20,600,000	269
2017	111,080,325	76,688,785	36,132,767	21,500,000	280
2018	108,991,783	72,992,701	34,409,699	20,000,000	274

*1 decares = 1000 m2 = 0.1 hectare

Source: Turkish Statistical Institute, 2019

The main oil crops grown are sunflower, cotton seed, soybean, rapeseed, and safflower with the area of sunflower cultivation remaining between 0.55 million and 0.7 million ha for many years while its total production in 2018 was 1.9 million tons with an average yield of 265 kg/da (see Table 3.5.5).

Table 3.5.5

Oil seeds (selected products): area, production and yield, 2000-2018

(Decares, tons, kilogram per decares)

Years	*Cultivated area (of all oilseeds) (DA)*	*Production (tons)*	*Sunflower cultivated area (da)*	*Sunflower production (tons)*	*Sunflower yield (kg/da)*
2000	6,363,120	2,253,448	5,420,000	800,000	148
2001	6,363,120	2,171,314	5,100,000	650,000	127
2002	6,043,250	2,514,827	5,500,000	850,000	155
2003	6,570,900	2,387,925	5,450,000	800,000	147
2004	6,470,500	2,501,419	5,500,000	900,000	164
2005	6,437,730	2,421,338	5,660,000	975,000	172
2006	6,657,682	2,789,149	5,854,000	1,118,000	191
2007	6,314,526	2,352,383	5,546,778	854,407	154
2008	6,770,077	2,311,432	5,800,000	992,000	171
2009	7,022,475	2,396,044	5,840,000	1,057,125	181
2010	7,688,965	2,969,477	6,414,000	1,320,000	206
2011	7,742,481	3,227,588	6,557,000	1,335,000	204
2012	7,479,677	3,138,361	6,046,160	1,370,000	227
2013	7,742,136	3,299,967	6,097,839	1,523,000	250
2014	8,278,929	3,508,640	6,574,576	1,637,900	249
2015	8,661,011	3,442,098	6,853,174	1,680,700	245
2016	9,044,926	3,480,629	7,201,081	1,670,716	232
2017	9,251,704	3,883,370	7,796,217	1,964,385	252
2018	9,001,788	4,009,495	7,344,651	1,949,229	265

Source: Turkish Statistical Institute, 2019

Türkiye produced 23.2 million tons of maize in 2018, with the output increasing from 6.2 million tons in 2004 to 21.6 million tons in 2017 at an annual average rate of 10.2 per cent (see Table 3.5.6).

Table 3.5.6.

Fodder crops (selected products): area and production, 2000-2018

(Decares, tons)

Year	*Maize (for silage)*		*Cow vetches*		*Alfalfa*	
	Cultivated area (DA)	*Production*	*Cultivated area*	*Production*	*Cultivated area*	*Production*
2000	-	-	-	395,000	2,508,000	1,807,000
2001	-	-	-	420,000	2,490,000	1,830,000
2002	-	-	-	450,000	2,600,000	1,900,000
2003	-	-	-	455,000	2,900,000	2,100,000
2004	1,550,000	6,200,000	2,200,000	540,000	3,200,000	2,300,000
2005	2,000,000	7,600,000	2,500,000	750,000	3,750,000	2,100,000
2006	2,598,913	10,069,968	3,862,882	1,026,324	4,440,296	1,814,990
2007	2,690,132	10,259,595	6,391,774	1,282,441	5,348,965	1,697,645
2008	2,888,829	11,183,290	5,796,842	1,249,948	5,557,215	1,843,961
2009	2,740,031	11,099,653	4,695,529	1,028,610	5,692,958	1,747,676
2010	2,937,336	12,446,450	4,288,400	4,018,984	5,688,107	11,676,115

2011	3,127,946	13,294,380	4,754,756	4,442,017	5,585,525	12,076,159
2012	3,540,882	14,956,457	5,694,254	4,245,417	6,741,832	11,536,328
2013	4,027,160	17,835,115	4,990,430	4,492,466	6,286,419	12,616,178
2014	4,149,529	18,563,390	4,269,348	4,168,085	6,923,055	13,432,968
2015	4,231,233	19,684,599	4,365,182	4,281,259	6,620,459	13,949,958
2016	4,257,753	20,139,033	4,428,378	4,542,042	6,501,107	15,714,381
2017	4,477,354	21,613,101	4,456,256	4,597,600	6,594,319	17 561 190
2018	4,726,428	23,197,536	3,869,465	4,273,945	6,351,052	17,544,946

Source: Turkish Statistical Institute, 2019

Türkiye also produces chickpeas, dry beans, and lentils (see Table 3.5.7).

Table 3.5.7

Dry pulses (selected products): area and production, 2000-2018

(Decares, tons)

Year			*Bean*		*Red lentil*	
	Cultivated area (DA)	*Production*	*Cultivated area (DA)*	*Production*	*Cultivated area (DA)*	*Production*
2000	13,168,070	1,182,487	1,760,000	230,000	3,900,000	280,000
2001	13,208,750	1,327,700	1,750,000	225,000	4,000,000	460,000
2002	13,603,500	1,510,100	1,800,000	250,000	4,200,000	500,000
2003	12,636,500	1,437,050	1,620,000	250,000	3,800,000	485,000
2004	12,263,500	1,453,800	1,550,000	250,000	3,790,000	480,000
2005	11,771,000	1,433,360	1,412,000	210,000	3,867,000	520,000
2006	11,168,802	1,430,578	1,290,515	195,970	3,787,075	580,298
2007	10,577,817	1,264,809	1,092,497	154,243	3,572,328	508,378
2008	9,740,080	855,354	982,326	154,630	2,909,766	106,361
2009	8,009,592	1,101,348	949,280	181,205	1,893,780	275,050
2010	8,221,554	1,235,306	1,033,811	212,758	2,116,000	422,000
2011	7,780,223	1,131,986	946,254	200,673	1,923,225	380,000
2012	7,723,446	1,190,706	931,740	200,000	2,147,875	410,000
2013	8,066,462	1,147,735	847,630	195,000	2,605,000	395,000
2014	7,438,228	1,035,832	911,103	215,000	2,324,461	325,000
2015	6,902,896	1,079,048	935,840	235,000	2,074,690	340,000
2016	7,152,419	1,080,253	898,197	235,000	2,354,743	345,000
2017	7,904,833	1,163,805	897,221	239,000	2,693,181	400,000
2018	8,879,229	1,225,220	848,045	220,000	2,430,652	310,000

Source: Turkish Statistical Institute, 2019

Cotton is the most important industrial raw material produced by agriculture with a cultivated area of 416,000 ha and output of 2.1 million tons in 2016. Cotton area and production increased to 518,634 ha and 2.6 million tons, respectively, in 2018 (see Table 3.5.8).

Table 3.5.8

Textile raw materials (selected products): area and production, 2000–2018

(Decares, tons)

Year	*Total*		*Cotton (raw)*		*Flax (fiber)*	
	Cultivated area (DA)	*Production (tons)*	*Cultivated area*	*Production (tons)*	*Cultivated area*	*Production (tons)*
2000	6,553,800	881,191	6,541,770	2,260 921	3,200	7
2001	6,856,550	915,421	6,846,650	2,357 892	2,900	17

2002	7,219,870	989,070	7,210,770	2,541 832	2,500	50
2003	6,382,290	920,386	6,373,290	2,345,734	2,500	55
2004	6,406,400	936,583	6,400,450	2,455,071	2,200	55
2005	5,471,210	863,761	5,468,800	2,240,000	1,760	6
2006	5,909,105	976,608	5,907,000	2,550,000	1,460	8
2007	5,303,893	867,760	5,302,528	2,275,000	806	6
2008	4,950,964	673,422	4,950,000	1,820,000	670	1
2009	4,200,086	638,255	4,200,000	1,725,000	20	1
2010	4,806,821	816,718	4,806,500	2,150,000	100	3
2011	5,420,239	954,620	5,420,000	2,580,000	82	4
2012	4,885,026	858,406	4,884,963	2,320,000	0	0
2013	4,508,912	877,501	4,508,900	2,250,000	0	0
2014	4,681,439	846,001	4,681,429	2,350,000	0	0
2015	4,340,159	738,002	4,340,134	2,050,000	15	1
2016	4,160,168	756,008	4,160,098	2,100,000	25	1
2017	5,018,630	882,009	5,018,534	2,450,000	50	2
2018	5,186,447	976,610	5,186,342	2,570,000	50	3

Source: Turkish Statistical Institute, 2019

Grapes are major fresh fruit crops as are pome fruits of which apple is the main crop with a production of approximately 3.6 million tons in 2018 (see Table 3.5.9).

Table 3.5.9

Production of fruits, beverage/spice crops (selected products), 2008-2018

(Tons)

Year	*Grapes*	*Apples*	*Olives*	*Oranges*	*Hazelnuts*	*Green tea*
2008	3,918,442	2,504,494	1,464,248	1,427,156	800,791	1,100,257
2009	4,264,720	2,782,365	1,290,654	1,689,921	500,000	1,103,340
2010	4,255,000	2,600,000	1,415,000	1,710,500	600,000	1,305,566
2011	4,296,351	2,680,075	1,750,000	1,730,146	430,000	1,231,141
2012	4,234,305	2,888,985	1,820,000	1,661,111	660,000	1,250,000
2013	4,011,409	3,128,450	1,676,000	1,781,258	549,000	1,180,000
2014	4,175,356	2,480,444	1,768,000	1,779,675	450,000	1,266,311
2015	3,650,000	2,569,759	1,700,000	1,816,798	646,000	1,327,934
2016	4,000,000	2,925,828	1,730,000	1,850,000	420,000	1,350,000
2017	4,200,000	3,032,164	2,100,000	1,950,000	675,000	1,300,000
2018	3,933,000	3,625,960	1,500,467	1,900,000	515,000	1,500,000

Source: Turkish Statistical Institute, 2019

Tomato is the flagship vegetable perishable crop, and its production reached a massive 12.75 million tons in 2017, accounting for around 45 per cent of Türkiye's total fruit and vegetable production (see Table 3.5.10).

Table 3.5.10

Production of selected vegetables and fruits, 2008-2018

(Tons)

Year	*Tomato*	*Cucumber*	*Melon*	*Watermelon*	*Onion (dry)*
2008	10,985,355	1,682,776	1,749,935	4,002,285	2,007,118
2009	10,745,572	1,735,010	1,679,191	3,810,205	1,849,582
2010	10,052,000	1,739,191	1,611,695	3,683,103	1,900,000
2011	11,003,433	1,749,174	1,647,988	3,864,489	2,141,373

2012	11,350,000	1,741,878	1,688,687	4,022,296	1,735,854
2013	11,820,000	1,754,613	1,699,550	3,887,324	1,904,846
2014	11,850,000	1,780,472	1,707,302	3,885,617	1,790,000
2015	12,615,000	1,822,636	1,719,620	3,918,558	1,879,189
2016	12,600,000	1,811,681	1,854,356	3,928,892	2,120,581
2017	12,750,000	1,827,782	1,813,422	4,011,313	2,175,911
2018	12,150,000	1,848,273	1,753,942	4,031,174	1,930,695

Source: Turkish Statistical Institute, 2019

Türkiye attained 98 per cent self-sufficiency in cereals in the 2017-2018 marketing year with wheat, having the biggest share in total cereal production, reaching a self-sufficiency level of 111.7 per cent (see Table 3.5.11). Self-sufficiency in maize and rice was respectively 73.3 and 67.2 per cent in the same period, while in potatoes it was 103.5 per cent.

Table 3.5.11

Agricultural products: production, area and self-sufficiency, 2000-2018

(Tons, hectares, percentage)

Product	*Marketing year*	*Production*	*Area sown*	*Degree of self-sufficiency*
Cereals	2017/18	35,232,767	10,998,473	98.0
	2010/11	31,912,550	12,001,271	98.8
	2000/01	8,000,000	3,629,000	102.3
Wheat	2017/18	21,500,000	7,668,879	111.7
	2010/11	19,674,000	8,103,400	102.2
	2000/01	21,000,000	9,400,000	106.5
Maize	2017/18	5,900,000	639,084	73.3
	2010/11	4,310,000	594,000	79.6
	2000/01	2,300,000	555,000	73.8
Rice	2017/18	540,000	109,580	67.2
	2010/11	516,000	99,000	90.7
	2000/01	210,000	58,000	41.3
Potato	2017/18	4,801,393	142,963	103.5
	2010/11	4,548,383	140,724	102.3
	2000/01	5,370,000	205,000	101.9
Dried pulses	2017/18	1,163,805	790,484	86.0
	2010/11	1,235,306	822,155	95.8
Sunflower	2017/18	1,964,385	779,622	64.3
	2010/11	1,320,000	641,400	52.4
	2000/01	800,000	542,000	70.1
Cotton (seed)	2017/18	1,470,000	501,843	101.0
	2010/11	1,272,800	480,650	100.7
	2000/01	1,295,066	654,177	89.8
Sugar beet	2017/18			100.0
	2010/11			100.0
	2000/01			100.0

Source: Turkish Statistical Institute, 2019

Chemical fertilizer consumption, including potash, phosphorus and nitrogenous products, was 10.5 million tons in 2018, declining from 13.9 million tons in 2016, which was the highest since 2009 (see Table 3.5.12).

Table 3.5.12

Chemical fertilizer usage, 2009–2018

(Tons)

Year	*Total*	*Nitrogen (21% n)*	*Phosphorous (17% p_2o_5)*	*Potash (50% k_2o)*
2009	**10,278,731**	6,730,852	3,416,978	130,901
2010	**9,592,752**	6,397,089	3,028,666	166,997
2011	**9,074,308**	5,995,500	2,882,296	196,512
2012	**10,148,982**	6,817,217	3,129,299	202,466
2013	**11,415,756**	7,542,247	3,662,099	211,410
2014	**10,694,543**	7,107,106	3,353,104	234,333
2015	**10,777,779**	7,077,214	3,437,368	263,197
2016	**13,925,448**	9,028,793	4,660,032	236,623
2017	**13,089,074**	8,401,087	4,438,096	249,891
2018	**10,567,457**	7,272,531	3,063,902	231,024

Source: Turkish Statistical Institute, 2019

Pesticide usage increased to 60,020 tons in 2018 from 54,098 tons the preceding year, a rise of 11 per cent with fungicides being the most used pesticides in Türkiye, comprising 38 per cent of total usage in 2018 (see Table 3.5.13).

Table 3.5.13

Pesticide usage, 2006-2018

(Tons)

Year	*Insecticides*	*Fungicides*	*Herbicides*	*Acaricides*	*Rodenticides and molluscicides*	*Other*	*Total*
2008	9,251	16,707	6,177	737	351	5,613	**38,836**
2009	9,914	17,863	5,961	1,533	78	2,302	**37,651**
2010	7,176	17,396	7,452	1,040	147	5,344	**38,555**
2011	6,120	17,546	7,407	1,062	421	6,978	**39,534**
2012	7,264	18,124	7,351	859	247	8,766	**42,611**
2013	7,741	16,248	7,336	858	129	7,128	**39,440**
2014	7,586	16,674	7,794	1,513	149	6,007	**39,723**
2015	8,117	15,984	7,825	1,576	197	5,327	**39,026**
2016	10,425	20,485	10,025	2,025	259	6,835	**50,054**
2017	11,436	22,006	11,759	2,452	236	6,209	**54,098**
2018	13,583	23,047	14,794	2,486	309	5,801	**60,020**

Source: Turkish Statistical Institute, 2019

b). Farmlands, farmer organizations and agricultural holdings

Türkiye has 23.2 million ha of farmland, as of 2018

with most land being family owned and small in scale. Land distribution of farms is imbalanced with fragmented farmlands and an average of 5.9 plots in each family enterprise. The average farm holding was 12.9 ha in size as of 2016 (see Table 3.5.14).

Table 3.5.14

Türkiye: Land parcels per agricultural holding and average size, 2016

(Hectares)

Holding size (decares)	*Parcels per holding*	*Average parcel size*
Total	5.9	12.9
< 5	1.5	1.6
5 – 9	2.4	2.7
10 – 19	3.4	3.8
20 – 49	4.7	6.4
50 – 99	6.9	9.4
100 – 199	10.1	12.9
200 – 499	13.7	20.6
500 – 999	21.1	30.3
> 999	36.9	60.3

Source: Turkish Statistical Institute. 2019

Turkish farms are continuously fragmented with the number of enterprise farms decreasing and family farms increasing. In 2016, 80.7 per cent of enterprise farms had fewer than 10 hectares, and 29.1 per cent owned their land (Turkstat, 2019).

Small and fragmented agricultural holdings have major structural problems including lower efficiency and insufficiencies in production and inadequate access to marketing. This, in turn, results in low-level use of farm technologies and poor profitability. Moreover, as the number of enterprises increases, income per holding decreases.

Table 3.5.15

Agricultural land use, 2008–2018

(Thousands of hectares)

Year	*Total*	*Cereals and other crops*		*Vegetable gardens*	*Ornamental plants*	*Fruits, beverage and spice crops*	*Permanent meadows and pastures*
		Sown land	*Fallow land*				
2008	39,122	16,460	4,259	836	-	2,950	14,617
2009	38,912	16,217	4,323	811	-	2,943	14,617
2010	39,011	16,333	4,249	802	-	3,011	14,617
2011	38,231	15,692	4,017	810	4	3,091	14,617
2012	38,399	15,463	4,286	827	5	3,201	14,617
2013	38,423	15,613	4,148	808	5	3,232	14,617
2014	38,558	15,782	4,108	804	5	3,243	14,617
2015	38,551	15,723	4,114	808	5	3,284	14,617
2016	38,328	15,575	3,998	804	5	3,329	14,617
2018	37,964	15,498	3,697	798	5	3,348	14,617

Source: Turkish Statistical Institute, 2019

A total of 37.9 million ha of land was utilized for agriculture in Türkiye in 2018, of which 15.4 million

ha was sown (see Table 3.5.15). About 38.5 per cent of the country's land is arable and fallow land made up about 10 per cent in 2016 (see Table 3.5.16).

Table 3.5.16

Türkiye: Agricultural land use by holding size, 2016

(Percentage)

Holding size (decares)	*Total*	*Cereals and other crops*	*Fallow land*	*Vegetables, strawberries and flowers*	*Fruits and other permanent crops*
Total	100.0	69.3	9.7	2.2	11.9
< 5	100.0	16.8	2.3	9.1	51.8
–50 - 99	100.0	67.5	6.6	2.1	16.2
–00 - 199	100.0	73.1	9.4	2.1	8.8
–00 - 499	100.0	77.5	10.2	1.9	4.8
–00 - 999	100.0	77.6	11.6	2.3	4.7
> 999	100.0	68.8	15.7	1.3	5.6

Source: Turkish Statistical Institute, 2019

The holding size decreases in Türkiye, and fruit and vegetable cultivation increases. Almost 60 per cent of agricultural land is operated by landowner farmers in 2016 and 36.4 per cent is cultivated by those who both own and rent other's lands.

Table 3.5.17

Agricultural holdings and land operated by size and tenure, 2016

(Decares)

			Holdings with own land			
Holding size (decares)	*Total*		*Holdings operating only own land (possession land included)*		*Holdings operating both own and other's lands*	
	A	B	A	B	A	B
Total	100.0	100.0	79.5	59.9	17.1	36.4
< 5	100.0	100.0	96.5	95.5	1.3	2.1–
–50 - 99	100.0	100.0	73.5	72.2	23.7	25.0
–00 - 199	100.0	100.0	63.4	61.8	33.7	35.4
–00 - 499	100.0	100.0	53.5	52.0	43.5	44.9
–00 - 999	100.0	100.0	42.7	41.6	54.1	55.2
> 999	100.0	100.0	45.7	51.9	49.6	41.5

Abbreviations: A, holdings; B, agricultural land.

Source: Turkish Statistical Institute, 2019

The National Farmer Registration System (ÇKS) reported 2,424 enterprise farms with more than 100 hectares each and 61 with 500 hectares each in 2013. One-third of the enterprises had between 2 and 5 hectares each. The number of people employed in agribusiness in 2018 was about 5.3 million, accounting for 18.4 per cent of total employment. The ratio of agriculture to total employment has decreased by 45 per cent in the last 15 years.

As of 2017, the number of farmers registered with

the ÇKS was 213,749 and the area cultivated was 14,870,208 hectares. Türkiye has five types of agricultural cooperatives, dealing with agricultural development, irrigation, aquaculture, beet cultivation and agricultural credit, with a total membership of 3.4 million. There are 891 producer unions with 353,000 members.

Irrigation is estimated to use 72 per cent of the country's total 112 billion m3 water availability, another 16 per cent being used for drinking and other household use, with industry using 12 per cent (Ministry of Agriculture; General Report, 2019). An estimated 7.1 million ha of agricultural land is irrigated, accounting for about 31.4 per cent of the total (see Table 3.5.18).

Table 3.5.18

Distribution of irrigated and non-irrigated land by use, 2016

(Percentage)

	Total	*Irrigated*	*Non-irrigated*
Total	100.0	31.4	68.6
Cereals and other crops	100.0	34.7	65.3
Vegetables, strawberries and flowers (seedlings and land under protective cover included)	100.0	84.1	15.9
Fruits, other permanent crops, beverage and spice crops (nurseries and land under protective cover included)	100.0	37.8	62.2
Poplar- willow grove	100.0	41.5	58.5
Unutilized potentially productive land	100.0	1.3	98.7
Permanent meadow	100.0	29.8	70.2
Kitchen garden	100.0	57.5	42.5
Other land	100.0	-	100.0

Source: Turkish Statistical Institute, 2019

3.5.2. Agricultural mechanization

3.5.2.1. National policy on agricultural mechanization

The Agricultural Reforms Implementation Project (ARIP), initiated in 2002 after Türkiye's Economic Reform Credit Agreement with the World Bank in 2000, aimed to reduce the use of public resources in agriculture and to develop a direct income support system. The related policies and projects now focus on providing area-based support and rural development.

In 2018, USD 6.14 billion was allocated to subsidize programmes, with USD 3.07 billion for agricultural support, USD 2.09 billion for investment grants and USD 0.97 billion for agricultural credit subsidy, intervention purchases, financing of agricultural State Economic Enterprises (SEEs), export and other agricultural support. In 2019, this decreased to 26.5 billion Turkish liras (TRY), TRY 16.1 billion was for agricultural support, TRY 5.1 billion for investment allowances and TRY 5.3 billion for agricultural credit subsidy, intervention purchases, financing of agricultural SEEs, export and other agricultural support.

Other support schemes under the national agricultural incentive include procurement of agricultural machinery either as an agricultural support project or direct acquisition (see Table 3.5.19). Area-based support and subsidies lead the way with the former increasing by 32 per cent and the latter by 16 per cent over 2 years while some support remained unchanged.

Table 3.5.19

Agricultural support by type and year, 2008-2018

(Millions of Turkish liras)

Type	*2008*	*2010*	*2012*	*2014*	*2016*	*2018*
Area-based support	1,953	1,859	2,167	2,406	2,695	3,561
Subsidies	1,647	2,071	2,379	2,691	3,129	3,623
Livestock support	1,330	1,193	2,216	2,589	3,002	3,745
Support related to Agricultural Reforms Project	34	0	0	0	0	1,188
Agricultural insurance	55	81	263	357	704	1,061
Compensation payments	80	77	99	123	168	206
Other agricultural support	93	124	194	274	393	850
Rural development support	109	284	196	313	958	720
Rural Development Program (IPARD) support	0	0	39	303	210	218
Drought support	549	0	0	0	0	0
Freeze disaster	0	128	0	0	0	0
Total	**5,850**	**5,817**	**7,553**	**9,056**	**11,259**	**15,262**

Abbreviations: IPARD, Instrument for Pre-Accesssion Assistance for Rural Development.

Source: Ministry of Agriculture and Forestry, 2019

3.5.2.2. National programmes on agricultural mechanization

Agricultural mechanization support is focused on corporate welfare and public loans rather than direct support. Current agricultural support covers animal production, structural improvement, rural development and environmental conservation. Farmers enrolled in the National Farmer Registration System (ÇKS) receive 30 per cent direct income support. A premium system is practiced and reinforced with a 4-per cent (subsidy support for the purchase of chemical fertilizer and 13 per cent for fuel as well as for training in the latest agricultural equipment and techniques.

(i) Single area payment scheme

Under the single area payment scheme, farmers in the ÇKS receive a flat-rate, per-hectare payment of up to 30 per cent of their income, irrespective of production, as long as their land is maintained in good agricultural condition, in order to encourage small-scale and family-owned businesses. Farmers receive 4 per cent of this for organic and good farming practices and 13 per cent for fuel. Extra support is allocated at various rates for soil analysis.

(ii) Deficiency payments

Premium payments cover the difference between the government's target price and the market price of the agricultural commodity and aim to help increase the production of commodities in short supply. Premium payments are one of the leading government subsidies with an extensive reach. Reimbursement is restricted to 24 per cent of the price deficiency.

(iii) Support for animal husbandry

Livestock breeding incentives are provided up to 27 per cent against expenses to help improve yields, preserve gene sources and generate alternative income. Animal husbandry payments are specifically for rootstock sheep and goats, apiculture, vaccines, male beef cattle, calf, milk premium incentives, GAP-DAP-KOP-DOKAP (fertilizer scraper and milking systems) grants, disease compensation, silk beetles, approved dairy farms, programmed vaccine practices, aquaculture, herd manager employment, milk premium, mohair production and forage crop support. Some schemes under agricultural support pertaining to procurement of agricultural machinery are either

part of a project or a product-based application.

(iv) Rural development support

There are three different rural development support schemes. This programme is for young farmers, agriculture-based investments and irrigation projects. The grants are also for the purchase of agricultural machinery included in a special mechanization project. The support is also for machines, including for irrigation such as field sprinklers, drip irrigation systems, linear and centre pivot irrigation systems as well as for livestock and barn equipment like milking machines, feed mixers, farm manure spreading machines and balers. Up to TRY 30,000 is provided to agricultural start-ups to encourage young people to take up farming with 50 per cent for extra investment support for irrigation systems and specific agriculture-based projects.

(v) Insurance support

The state-supported agricultural insurance programme (Tarım Sigortaları Havuzu) implementations are provided as policy tools for risk management and stable producer income. There is also modest support for land consolidation and agricultural insurance to strengthen the agricultural infrastructure and improve producer incomes.

(vi) Specific support

The support programme for rural development investment and environment-oriented agricultural land preservation, CATAK, implemented by the government, also provides up to 70 per cent of grants for agricultural machinery such as stubble direct sowing, stone-picking and farm manure spreading machines and irrigation systems.

(vii) IPARD

The Instrument for Pre-Accession Assistance for Rural Development (IPARD) initiative was created by the European Union (EU) to support candidate and potential candidate countries for EU membership. During 2014–2020, it provided 40-70 per cent grants for agricultural machinery. Indirect support is also provided under the project. IPARD has also provided support for construction and services.

(viii) Subsidized loans

For agricultural loans, the interest rate is reduced by 25–100 per cent for subsidy applications. In 2016, Ziraat Bank, the Agricultural Bank of the Republic of Türkiye and the Agricultural Credit Cooperatives (TKK) provided a total of TRY 34 billion in agricultural loans. Ziraat Bank and TKK have provided subsidized loans for essential agricultural mechanization tools for specific projects. Subsidized loans are also approved for pressurized irrigation systems purchased independently of a project. Subsidy rates are determined by the council of ministers. The current subsidy rate is 75 per cent for equipment, 25–50 per cent for tractors and 100 per cent for irrigation systems. Due to the lengthy procedures, red tape and collateral agreements, loans are mostly used for expensive machinery like tractors rather than low-priced equipment. As a result, 85 per cent of these loans were for tractors. The total amount of subsidized agricultural machinery loans extended by Ziraat Bank in 2018 was 3.2 billion Turkish lira.

(ix) Other support

Another state-aided programme involves the bulk purchase and state tenders for agricultural equipment conducted by different state institutions and has three components: grant programmes to support agricultural mechanization in other

developing countries, procurement contracts for state-institutions and project-oriented special schemes for farmers. State institutions such as the Turkish Cooperation and Coordination Agency (TIKA) initiate machinery purchase tenders to support agricultural modernization in least developed countries. Institutions like the General Directorate of Agricultural Enterprises (TIGEM), the Forest Authority and municipal administrations also have their own budgets to purchase equipment required for public services. Occasionally, investment agencies, provincial directorates of agriculture and special provincial administrations announce tenders to provide machinery for farmers in specific projects. There is no accurate information on the market share of these contractual purchases.

3.5.2.3. Current level of mechanization

According to the Turkish Statistical Institute, about 1.9 million tractors were registered with the traffic registration and supervision bureau in 2019. However, Ministry of Agriculture and Forestry records show 1.2 million tractors with double axles registered with traffic authorities. The main reason for this disparity could be either that tractors used in non-agricultural areas such as municipal, construction and forestry services are not registered in the records of the Ministry of Agriculture and Forestry, or out-of-use tractors are still registered with the traffic registration and supervision bureau. As of 2018, the number of tractors in use per 1,000 ha was 52.5 units and agricultural land per tractor was around 19 ha. The average tractor had a power of 40.2 kW (25 hp and above) and tractor power per hectare was 2.1 kW. Turkish Statistical Institute data shows the average tractor age was 24.3 years in 2018.

In Türkiye, there is no baseline data on other agricultural machines because only tractor and combined harvester registrations are mandatory. There are official statistics about the fleet size and market, but the data is still to be verified.

a) Domestic production

The machinery manufacturing industry in Türkiye ranges from small and medium-sized enterprises (SMEs) to large companies and multinationals. Although the number of companies is quite high, these also include small-scale and unregistered turning and welding workshops.

According to the Ministry of Industry and Technology, in 2017 there were 1,161 companies operating in the sector as agricultural machinery manufacturers registered under NACE code 2830. Agricultural machinery manufacturing has the third highest number of machine industry entrepreneurs and the Ministry of Agriculture estimated there were 1,115 companies in this sector in 2016. The disparity between these two estimates is also reflected in the two ministries' estimates of employment figures of these enterprises. The Ministry of Industry and Technology estimated 18,747 employees in 2017 while the Ministry of Agriculture estimated 22,883 employees in 2014 (19,019 for equipment and 3,864 for tractor manufacturing). The main reason for the disparity is that the two ministries take different product groups into account.

There are about 30 tractor companies in Türkiye of which nine have different indigenization rates with three manufacturing their own engines in Türkiye. Domestic companies with locally licensed production have a market share of about 75 per cent. Türkiye imports complete tractors as well as completely built units (CBUs), and also assembles semi-knocked down (SKD) and completely knocked down (CKD) imports. The market share of CBU tractors is about 15 per cent (see Table 3.5.20).

Table 3.5.20

Imported tractor ratio in internal market, 2016-2018

(Units)

Year	*Domestic sales*	*Domestic products**	*Imported products*	*Imported products ratio (percentage)*
2016	70,178	58,076	11,389	16.39
2017	72,909	61,521	10,341	14.39
2018	48,354	40,259	8,094	16.75

*Including CKD (completely knocked down)/SKD (semi-knocked down)

Source: TARMAKBIR, 2019

Agricultural mechanization is a leading sector among the 22 industrial machinery groups (see Table 3.5.21).

Table 3.5.21

Türkiye: agricultural mechanization in machinery sector, 2017

		Number	Share (percentage)
Production value	2.75 billion US dollars	2	13.9
Add value	0.47 billion US dollars	3	11.5
Domestic market size	2.9 billion US dollars	3	8.9
Production index	218.7 [2010=100]	6	-
Number of employees	18 747	3	8.5
Number of enterprises	1 161	3	8.7

Source: Turkish Machinery Report, MAKFED, 2018

After producing its first plow in 1861 and making its first tractor in 1955, Türkiye now manufactures almost all types of agricultural machinery except tractor-drawn or self-propelled machinery for large terrain, especially self-propelled harvesters and high-tech and highly engineered smart farming machinery because of the lack of requisite know-how. However, poor sales of domestic products do not make local manufacturing lucrative.

Türkiye has made 2.17 million tractors since 1963 with the least production of 6,419 units in 1965 and a record 72,032 units manufactured in 2017 (see Table 3.5.22). Some components are imported but all types of tractors are manufactured in the country. Due to the small-scale land use, most tractors produced are up to 100 hp. Tractors over 100 hp and up to 140 hp are available on request.

Table 3.5.22

Türkiye: tractor production, 1992-2018

(Units)

Year	*Production*	*Year*	*Production*	*Year*	*Production*	*Year*	*Production*
1992	22,011	1999	27,867	2006	44,386	2013	56,407
1993	33,601	2000	37,938	2007	37,623	2014	64,342
1994	25,817	2001	15,052	2008	28,751	2015	66,615
1995	44,482	2002	10,840	2009	17,762	2016	66,915
1996	54,819	2003	29,761	2010	39,134	2017	72,032
1997	58,736	2004	42,511	2011	62,250	2018	47,689
1998	61,868	2005	41,502	2012	53,982		

Source: TARMAKBIR & Ministry of Agriculture and Forestry & Automotive Manufacturers Association, 2019

Milking machines, sail reapers, sprayers, ploughs and trailers are the most produced agricultural machinery (see Table 3.5.23).

Table 3.5.23

Türkiye: agricultural equipment production, 2011-2017

(Units)

Type	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*
Milking machinery	47,643	51,320	42,646	53,111	57,811	61,360	67,336
Sail reaper	1,485	671	198	73,901	73,615	73,192	49,288
Field and garden sprayer	43,105	41,214	48,050	49,980	38,257	49,577	44,209
Mouldboard plough	46,378	49,122	47,987	48,011	48,100	57,032	37,739
Tractor trailer	28,520	24,826	30,526	30,549	31,146	34,449	36,153
Cultivator	22,514	17,025	17,256	18,887	26,218	20,208	23,219
Mower	22,871	21,856	24,375	25,657	22 386	24,359	23,133
Hay rake	2,057	1,105	8,849	9,092	18,109	18,731	17,474
Scraper	59	56	64	92	233	1,150	11,100
Disc harrow- Spike tooth Harrow	14,039	12,129	11,296	12,383	14 989	10,408	9,925
Mineral fertilizer spreader	17,131	18,978	17,678	17,908	9 495	14,507	9,065
Knapsack sprayer	11,510	10,385	9,604	8,776	13 613	15,992	9,000
Inter-row hoeing Machinery	9,577	23,183	39,239	2,215	25 403	9,113	8,544
Combine beet harvester	531	337	513	373	484	1,413	8,409
Rotary tiller	3,035	1,865	6,066	6,452	7 440	8,385	8,320
Feed grinder	4,935	5,483	3,960	4,684	4 526	7,051	6,836
Chisel plough	6,038	5,863	6,399	6,906	5 983	6,920	6,807
Auger conveyor	2,809	1,452	1,324	2,575	1 863	2,642	6,524
Mounted grader	5,100	4,770	4,698	4,985	5 228	6,173	6,320
Mechanic seed driller	10,109	8,886	12,150	12,329	3 814	10,827	6,300
Tractor mounted front Loader	7,167	6,046	6,186	6,768	6 147	6,030	6,239
Thresher	5,175	3,871	2,270	1,787	837	3,309	5,527
Water tanker	3,155	3,966	4,012	4,293	4 804	5,090	5,185

Source: Turkish Statistical Institute, 2018

b) Domestic market

Total agricultural machinery sales of USD 2.9 billion in Türkiye in 2017, comprised USD 1.5 billion in tractors and USD 1.4 billion in equipment sales (Turkstat, 2019). The demand for tractors in Türkiye is quite high and depends on the number of agricultural holdings, machinery usage on these farms and socioeconomic conditions. Türkiye ranked fourth in the global tractor demand of 1.5 million units in 2017, after India, China and North America (International Trade Center, 2019). According to 2019 data from the traffic registration and supervision bureau, there were 1.9 million tractors in Türkiye. However, 46 per cent of these 1.9 million tractors were over 25 years old and had completed their economic working life. There is, therefore, an urgent need to modernize the tractor fleet in the country.

According to Turkstat data, the volume of tractor sales had increased from around 500 units in the early 1960s to 15,000 at the end of 1968. The highest sales were at 77,307 units in 1976, followed by 71,684 units in 1977. Domestic tractor sales were also high in 1997 at 54,731 units, in 2011 at 60,466 units, in 2012 at 50,320 units, in 2013 at 52,285 units and in 2014 at 59,458 units (see Table 3.5.24). Official data records sales of 72,909 tractors nationwide in 2017 as the second highest

annual number of tractor sales in the country.

Table 3.5.24

Tractor sales, 1995-2018

(Units)

Year	*Tractor registrations*	*Year*	*Tractor registrations*	*Year*	*Tractor registrations*	*Year*	*Tractor registrations*
1995	43,706	2001	11,457	2007	34,399	2013	52,285
1996	49,297	2002	6,810	2008	27,022	2014	59,458
1997	54,731	2003	16,636	2009	13,758	2015	66,788
1998	53,922	2004	29,583	2010	36,072	2016	70,178
1999	22,964	2005	40,724	2011	60,466	2017	72,909
2000	29,365	2006	39,706	2012	50,320	2018	48,356

Source: Turkish Statistical Institute, 2019

The average unit price of a 55 hp tractor (basic average power/model) gradually increased from 2006 to 2016 and sharply increased by 30 per cent between 2017 and 2018 due to the devaluation of the Turkish lira (see Table 3.5.25).

Table 3.5.25

Average market price of 55 horsepower tractor, 2006-2018

(Turkish liras)

Year	*Price*	*Year*	*Price*	*Year*	*Price*
2006	39,590	2011	48,778	2016	67,964
2007	40,383	2012	51,263	2017	76,317
2008	42,425	2013	54,105	2018	99,000
2009	43,490	2014	59,984		
2010	44,479	2015	64,625		

Source: TARMAKBIR & Ministry of Agriculture and Forestry, 2019

The agricultural tractor market is segmented by engine power. The 50-59 hp tractor range is the most sold in almost all regions of Türkiye. Other popular segments are models in the 60-69 hp and 70-79 hp ranges (see Table 3.5.26).

Table 3.5.26

Tractor market by power, 2017

(Horsepower)

Power range	*Units*	*Share (percentage)*	*Import (units)*	*Local* (units)*	*Import share (percentage)*
< 50	3,892	5.34	697	3,195	0.97
50 – 59	21,944	30.10	1,617	20,327	2.25
60 – 69	13,135	18.02	510	12,625	0.71
70 – 79	10,442	14.32	755	9,687	1.05
80 – 89	7,279	9.98	1,574	5,705	2.19
90 – 99	7,572	10.39	1,912	5,660	2.66
–00 - 119	6,633	9.09	2,393	4,240	3.33
> 119	965	1.32	884	81	1.23
#N/A	1,047	1.44			
Total	**72,909**	**100.00**	**10,341**	**61,521**	**14.39**

* Including SKD, CKD products
Source: TARMAKBIR, 2019

However, the share of the 50-59 hp range decreased by 9.6 per cent in 2018 from the preceding year (see Table 3.5.27). Domestic sales in this segment comprised 13,578 units in 2018 as against 21,944 in 2017. Total sales in 2018 fell by 50.8 per cent to 48,354 units as compared to 72,909 units in the previous year.

Table 3.5.27

Tractor market by power, 2018

(Horsepower)

Power range	*Units*	*Share (percentage)*	*Import (units)*	*Local* (units)*	*Import share (percentage)*
< 50	2,115	4.37	527	1,588	1.09
50 – 59	13,578	28.08	938	12,640	1.94
60 – 69	7,148	14.78	512	6,636	1.06
70 – 79	7,408	15.32	588	6,820	1.22
80 – 89	5,341	11.05	1,333	4,008	2.76
90 – 99	5,661	11.71	1,839	3,822	3.80
–00 - 119	5,427	11.22	1,720	3,707	3.56
> 119	774	1.60	636	138	1.32
#N/A	902	1.87			
Total	**48,354**	**100.00**	**8,094**	**40,259**	**16.75**

* Including SKD, CKD products
Source: TARMAKBIR, 2019

In 2015, the average horsepower of the sold tractor was 70 hp; there is a trend that tractors with increasingly powerful engines are being sold (see Table 3.5.28).

Table 3.5.28

Türkiye: average power of domestic tractor sales, 1995-2015

Year	*Horsepower*	*Year*	*Horsepower*	*Year*	*Horsepower*
1995	58.3	2005	65.1	2015	70
2000	60.4	2010	68.5		

Source: TARMAKBIR, 2017

Four-wheel drive (4WD) tractors are becoming popular and demand is expected to increase with rising economic growth (see Table 3.5.29).

Table 3.5.29

Ratio of four-wheel drives in domestic tractor sales, 1995-2015

(Percentage)

Year	*Ratio*	*Year*	*Ratio*	*Year*	*Ratio*
1995	2.5	2005	28.6	2015	60.7
2000	5.5	2010	44.9		

Source: TARMAKBIR, 2017

Tractors, milking machines, sickle-sail reapers, tractor cabs, sprayers, ploughs, trailers, pumps and cultivators, had the highest sales in 2017 (see Table 3.5.30).

Table 3.5.30

Agricultural machinery sales, 2017

Product	*Units*	*Product*	*Units*
Tractor	73,133	Disc harrows-spike tooth harrow	9,400
Milking machine	66,234	Knapsack sprayer	9,000
Sickle-sail reaper	59,521	Fertilizer spreader	8,571
Tractor cab	47,279	Combine beet harvester	8,409
Field and garden sprayer	40,163	Rotary tiller	8,258
Mouldboard plough	34,996	Inter-row hoeing machine	8,173
Trailer	34,963	Electrical driven pump	6,426
Irrigation pump	32,592	Feed grinder	6,421
Submersible pump	30,932	Chisel	6,394
Deep well pump	24,134	Atomizer	6,386
Cultivator	22,062	Auger conveyor	6,136
Mower	21,877	Mounted grader	6,022
Hay rake	17,121	Tractor mounted front loader	5,974
Automatic bowl	12,036	Mechanic seed drill	5,932
Scraper	11,060	Chop-thresher	5,443
Irrigation pump	10,096	Water tank	4,941

Source: Turkish Statistical Institute, 2019

Most tractor sales in Türkiye are financed by bank loans and buyers have the option of paying in cash or through deferred payment methods for tractor-drawn implements. Agricultural machinery sales are also financed by banks and cooperative lending.

Two multinational manufacturers dominate Türkiye's tractor market with a 60 per cent share in sales. Incentives for investment in local manufacturing, including low custom duties and taxes have encouraged new foreign investments and Massey Ferguson was the first company to start local production through a factory established by Tafe. During this period the SDF group also invested in Türkiye and the manufacture of some SDF products has exceeded 50 per cent localization. The Italian Landini company partnered with Türkiye's Anadolu Holding Company to manufacture under the Anadolu Landini brand and John Deere has also set up an assembly line while Belarus-based Minsk Tractor Plant has initiated assembly-based production in Türkiye and Azerbaijan. India's Mahindra has also acquired and merged with leading local tractor manufacturers Hisarlar and Erkunt.

Manufacturing of tractor engines has been prominent in Türkiye's tractor industry in recent years. Three major companies produce different types of engines for their models. One of these companies produces under license agreements and the other two produce their own branded engines using the experience of their licensed-production phase. However, there is no independent 4WD tractor front axle supplier in Türkiye manufacturing tractors conforming to international standards.

c) Age profile of tractor fleet

The 1,887,132 tractors in the country have an average age of 24 years, reflecting slower renewal. There are 870,632 tractors aged 25 years and over with an average age of 38.7 years. About 536,000 tractors are over 35 years old. Some tractors are not in use, even though listed in traffic records while some have been logged out from the traffic record

but are still working.

Table 3.5.31

Türkiye: number of tractors, 1979–2019

Year	*Units*	*Year*	*Units*	*Year*	*Units*
1979	318,571	1993	870,559	2007	1,327,334
1980	352,427	1994	895,506	2008	1,358,577
1981	382,054	1995	937,528	2009	1,368,032
1982	399,556	1996	988,142	2010	1,404,872
1983	430,563	1997	1,053,381	2011	1,466,208
1984	463,340	1998	1,107,457	2012	1,515,421
1985	502,590	1999	1,131,626	2013	1,565,817
1986	565,945	2000	1,159,070	2014	1,626,938
1987	628,787	2001	1,179,068	2015	1,695,152
1988	683,577	2002	1,180,127	2016	1,765,764
1989	728,481	2003	1,184,256	2017	1,838,722
1990	769,456	2004	1,210,283	2018	1,885,952
1991	794,651	2005	1,247,767	2019	1,887,132
1992	828,580	2006	1,290,679		

Source: Turkish Statistical Institute, 2019

Presently, 53.8 per cent of the tractor fleet is between 1 and 24 years old and 46.2 per cent of these are 25 years old and older (see Table 3.5.32).

Table 3.5.32

Türkiye: age profile of tractors, 2019

Age	*Units*	*Share (percentage)*	*Average age*
1–24	1,011,445	54	11.0
> 25	870,632	46	39.7
Total	**1,882,077**	**100**	**24.3**

Source: Turkish Statistical Institute & Calculated by TARMAKBIR, 2019

Over 50 per cent of tractors are more than 40 years old (see Table 3.5.33).

Table 3.5.33

Tractors over 25 years-old in use, 2019

Age	*Units*	*Share (percentage)*
> 40	461,482	53
35 – 39	139,526	16
30 – 34	139,149	16
25 – 29	130,475	15
Total	870,632	

Source: Turkish Statistical Institute & Calculated by TARMAKBIR, 2019

There were 563,947 tractors registered before 1983 (see Table 3.5.34). The largest number of tractors registered after 1983 was 75,818 in 2012. Registered tractor numbers began decreasing in 1999, reaching the lowest level of 7,325 in 2002 before beginning to increase in 2004.

Table 3.5.34

Number of tractors by model year, 1983–2017

Year	*Units*	*Year*	*Units*	*Year*	*Units*	*Year*	*Units*
1983*	563,947	1992	22,254	2001	23,322	2010	23,415
1984	38,871	1993	29,420	2002	7,325	2011	65,500
1985	30,321	1994	29,522	2003	11,816	2012	75,818
1986	26,273	1995	34,643	2004	29,763	2013	52,000
1987	34,288	1996	46,575	2005	33,013	2014	60,662
1988	30,950	1997	52,535	2006	43,526	2015	71,324
1989	17,461	1998	57,103	2007	34,827	2016	73,525
1990	28,784	1999	36,577	2008	33,531	2017	59,505
1991	20,694	2000	24,114	2009	15,018	**Total**	**1,838,222**

Source: Turkish Statistical Institute, 2019
*Year 1983 and older

At the end of 2018, there were 1.9 million tractors licensed for use on roads, of which 1.2 million had two axles. The most popular power range in Türkiye was 51-70 hp with 505,087 tractors, followed by the 35-50 hp range with 493,134 tractors and there were 162,425 tractors of more than 70 hp (see Table 3.5.35).

Table 3.5.35

Türkiye: number of tractors by axle number and power in agricultural use, 2010–2018

Year	***Total***	*One-axle Horsepower*		*Two-axle Horsepower*					
		1-5	*5+*	*1-10*	*11–24*	*25-34*	*35–50*	*51-70*	*70+*
2010	**1,096,683**	5,235	20,176	5,344	19,997	72,411	471,531	414,977	86,813
2011	**1,125,001**	8,212	27,283	5,578	21,244	72,668	476,010	422,389	91,411
2012	**1,178,253**	9,450	36,188	5,696	20,704	71,989	488,877	438,623	106,522
2013	**1,213,560**	10,889	42,476	5,937	20,153	71,165	493,462	451,292	118,000
2014	**1,243,300**	14,383	51,492	6,247	20,906	69,223	493,914	461,399	126,536
2015	**1,260,358**	14,856	54,604	6,252	21,181	68,074	491,828	468,060	135,297
2016	**1,273,531**	15,736	57,131	6,448	21,274	66,825	489,621	475,665	140,699
2017	**1,306,736**	16,589	59,061	6,432	20,527	65,866	492,343	493,660	152,133
2018	**1,332,139**	17,129	60,707	6,554	20,886	66,104	493,134	505,087	162,425

Source: Turkish Statistical Institute, 2019

Farmers in Türkiye are adapting to farm mechanization at a much faster pace and many prefer powerful engines. The average power of registered tractors has gone up from 48.5 hp in 2000 to 51.8 hp (see Table 3.5.36).

Table 3.5.36

Türkiye: average power of agricultural tractor, 1960–2018

Year	Horse -power	Year	Horse -power	Year	Horse -power	Year	Horse -power	Year	Horse -power	Year	Horse -power
1960		1970	38.8	1980	45.3	1990	47.2	2000	48.5	2010	50.8
1961		1971	39.6	1981	45.4	1991	47.2	2001	48.6	2011	50.5
1962		1972	40.2	1982	45.9	1992	47.3	2002	49.0	2012	50.7
1963		1973	41.4	1983	45.9	1993	47.5	2003	49.4	2013	50.9
1964	35.7	1974	42.3	1984	46.0	1994	47.7	2004	49.7	2014	50.8
1965	35.4	1975	44.2	1985	46.0	1995	47.7	2005	50.0	2015	51
1966	35.9	1976	44.8	1986	46.6	1996	47.8	2006	50.2	2016	51.2
1967	37.0	1977	44.8	1987	46.7	1997	48.2	2007	50.3	2017	51.5
1968	37.6	1978	45.3	1988	47.1	1998	48.3	2008	50.5	2018	51.8
1969	38.7	1979	45.4	1989	47.0	1999	48.6	2009	50.6		

Source: Turkish Statistical Institute & Calculated by TARMAKBIR, 2019

Of the total fleet of 17,266 combine harvesters in 2018, some 5,166 units (29.9 per cent) were aged over 21 years, 3,969 units (22.9 per cent) were between 11 and 20 years old, 3,924 units (22.7 per cent) were between 6 and 10 years old and 4,207 units (24.3 per cent) were between 1 and 5 years old (see Table 3.5.37).

Table 3.5.37

Türkiye: combine-harvesters by age, 2010–2018

Year	*Total*	*Age group (years)*			
		1 - 5	*6 – 10*	*11 - 20*	*21+*
2010	13,799	2,820	3,116	3,721	4,142
2011	13,413	3,038	3,293	3,834	4,148
2012	14,813	3,160	3,483	3,960	4,210
2013	15,486	3,431	3,722	3,882	4,451
2014	15,899	3,604	3,812	3,852	4,631
2015	15,988	3,815	3,750	3,780	4,653
2016	16,247	3,985	3,790	3,813	4,659
2017	17,199	4,167	3,907	4,062	5,063
2018	17,266	4,207	3,924	3,969	5,166

Source: Turkish Statistical Institute, 2019

Trailers and mouldboard ploughs are the most used agricultural machinery in Türkiye after tractors, with an estimated 1,184,193 trailers and 1,079,396 ploughs in the country (see Table 3.5.38). The average growth rate of the equipment ranges from 1.5 to 3 per cent in 2018 as against statistical data of 2017.

Table 3.5.38

Selected agricultural machinery, 2013-2018

Type	2013	2014	2015	2016	2017	2018
Agricultural tractor	1,213,560	1,243,300	1,260,358	1,273,531	1,306,736	1,332,139
Tractor trailer	1,109,917	1,121,371	1,126,166	1,137,709	1,165,873	1,184,193
Mouldboard plough	1,045,122	1,046,048	1,050,237	1,057,870	1,071,553	1,079,396
Knapsack sprayer	612,626	623,190	628,059	633,598	641,819	647,442
Cultivator	503,786	508,218	515,172	520,970	532,508	540,795
Trickle irrigation	318,413	362,033	389,831	412,468	441,366	475,141
Mineral fertilizer, spreader	389,918	392,908	399,451	408,737	419,388	428,545
PTO-driven sprayer	312,651	322,174	329,768	338,625	350,272	358,407
Toothed harrow	343,906	341,050	343,954	345,533	350,126	353,932
Milking plant (stationary)	268,164	282,433	292,405	301,795	319,885	332,595
Sprinkler system	240,253	247,520	248,039	252,215	259,838	267,022
Disc harrows	232,278	235,594	240,303	243,310	247,121	251,439
Combined seed drill	202,915	205,286	208,403	211,348	217,642	221,782
Water tank trailer	208,544	208,538	209,372	210,697	213,393	216,276
Stalk cutter	181,320	173,555	170,836	167,581	160,121	155,600
Seed drill	131,471	134,786	136,846	140,329	142,258	144,927
Tractor drawn hoe	133,608	132,603	135,684	136,942	139,385	139,774
Atomizer	116,789	115,995	116,883	120,402	121,448	123,790
Hay rake	106,668	110,030	113,405	115,169	115,809	119,760
Portable motor scythe	65,013	76,236	84,307	91,865	101,664	111,544

Abbreviation: PTO, power take-off
Source: Turkish Statistical Institute, 2019

3.5.2.4. Agricultural mechanization research and development

Investment in agricultural mechanization R&D started rather late in Türkiye and only picked up in the last decade. Compared with R&D investment of less than 1 per cent of gross national product (GNP) in Türkiye, advanced economies like France, Germany, Israel, Japan, Sweden and the United States of America invest more than 2 per cent of GNP in R&D.

Precision agriculture is becoming popular in Türkiye. The Scientific and Technological Research Council of Türkiye (TÜBİTAK) and the Southeastern Anatolia Project (GAP) Regional Development Directorate have developed map-based precision systems for using variable rate plant nutrients, fertilizing, spraying and harvesting with self-adjusting technology for moisture and soil structure regulation, to increase the efficiency of agricultural operations. The project aims to reduce input use by heterogeneous applications and reduce fertilizer use by at least 25 per cent.

As part of nationalization of technologies to optimize agricultural inputs, TOBB (the Union of Chambers and Commodity Exchanges of Türkiye)

and ASELSAN (a company of the Turkish Armed Forces Foundation) are cooperating with the Weapon Systems and the group of Uncrewed Defense System Technologies to support the following projects:

• Development of Domestic Automatic Tractor Steering and Control (OTAK) System.
• Farm Management System Development.
• Precision Agriculture Applications with Image Processing-Based Uncrewed Aerial Vehicle.

The survey results about R&D activities conducted by the Turkish Statistical Institute in 2000 refers that 11% of the state institutions' spending in machinery and equipment remained unchanged in 2015. From 2000 to 2015, there was a 23-fold increase in total agricultural mechanization R&D expenditure. The same survey found that machinery and equipment had a 5 per cent share in the R&D expenditure of higher educational institutions in 2000 and this share had increased to 6 per cent in 2015. The 2000-2015 period saw an approximately 11-fold increase in R&D activities of higher educational institutions. A total of 435 patent and utility model registration applications of agricultural machinery were made between 2013 and 2017, of which 72 were registered in 2013, another 110 in 2014, another 114 in 2015, another 84 in 2016 and 55 in 2017.

3.5.2.5. Import and export of agricultural machinery

a) Exports

Total agricultural machinery exports from Türkiye in 2018 amounted to an all-time high of USD 830 million (see Tables 3.5.39 and 3.5.40). The value of tractor exports was USD 424 million and that of equipment was USD 406 million. Spare parts and component exports touched USD 904 million in the same period.

Table 3.5.39

Türkiye: value of tractor and equipment exports, 2006-2018

(Thousands of USD)

Year	Tractor	Equipment	Total	Year	Tractor	Equipment	Total
2006	147,903	93,975	241,878	2013	341,080	263,932	605,012
2007	159,501	135,719	295,220	2014	434,241	299,909	734,150
2008	221,535	178,159	399,694	2015	374,472	287,113	661,585
2009	178,697	140,603	319,300	2016	338,701	277,468	616,169
2010	195,428	165,586	361,014	2017	318,678	333,460	652,138
2011	219,413	204,173	423,586	2018	423,603	406,429	830,032
2012	324,849	237,470	562,319				

Source: International Trade Center, 2019

Total tractor exports reached 19,256 units in 2018.
(see Table 3.5.40)

Table 3.5.40

Türkiye: number and value of tractor exports, 2000–2018

(USD)

Year	Units	Value	Year	Units	Value
2000	4,893	45,427,000	2010	10,000	195,428,000
2001	3,791	30,621,000	2011	10,719	219,413,000
2002	4,554	38,767,000	2012	16,191	324,849,000
2003	12,664	156,737,000	2013	15,486	340,679,000
2004	10,376	147,129,000	2014	17,739	434,241,000
2005	8,361	123,938,000	2015	17,533	374,472,000
2006	9,871	147,903,000	2016	15,767	338,701,000
2007	9,376	159,501,000	2017	14,565	320,937,000
2008	10,766	221,535,000	2018	19,256	423,603,000
2009	9,337	178,697,000			

Source: International Trade Center, 2019

Türkiye mostly exports tractors in the 37–75 kW engine power range and these accounted for USD 369 million in exports in 2018. Tractor exports increased by 32 per cent in 2018 from USD 321 million in 2017 (see Table 3.5.41).

Table 3.5.41

Türkiye: number and value of tractor exports by power, 2014-2018

(Kilowatts, USD)

Power	2014		2015		2016	
	Units	Value	Units	Value	Units	Value
< 18	7	42,885	4	54,000	6	84,000
18–37	584	10,296,790	399	5,093,000	269	3,120,000
37–59	7,388	185,587,049	7,787	175,800,000	6,961	152,330,000
59–75	7,174	167,412,201	6,338	135 820,000	5,364	125,437,000
75 – 90	2,082	62,414,473	2,056	53,549,000	2,015	52,270,000
> 90	15	576,190	44	1,106,000	33	754,000
Total	17 250	426 330 000	16 628	371 422 000	14 648	333 995 000

Power	2017		2018	
	Units	Value	Units	Value
< 18	56	676,000	66	301,000
18–37	423	4,925,000	394	3,718,000
37–75	11,848	270,616,000	16,376	368,923,000
75–130	1,896	43,328,000	2,051	48,508,000
> 130	342	1,392,000	369	2,153,000

Total	14 565	320 937 000	19 256	423 603 000

Source: International Trade Center, 2019

International Trade Center data shows the average value for tractor exports was USD 21,998 per unit in 2018, falling from a peak of USD 24,714 in 2014 (see Table 3.5.42).

Table 3.5.42

Türkiye: average unit price of tractor exports, 2006–2018

(USD)

Year	*Value*	*Year*	*Value*	*Year*	*Value*
2006	14,977	2011	20,426	2016	22,801
2007	16,952	2012	19,998	2017	22,034
2008	20,617	2013	22,032	2018	21,998
2009	19,192	2014	24,714		
2010	19,522	2015	22,337		

Source: International Trade Center, 2019

In 2018, tractors were mostly exported to Algeria, Australia, Bulgaria, Iraq, Italy, Mexico, Portugal, Serbia, South Africa and the United States of America. Two out of every three exported tractors went to Italy and the United States with USD 102 million worth of exports to the former and USD 180 million to the latter in 2018 (see Table 3.5.43). Some markets like Ukraine and Sudan have seen a drastic fall while tractor exports to Greece, Indonesia, Ireland, Israel, Japan and the Russian Federation are increasing. Globally, Türkiye ranks twentieth in agricultural machinery exports.

Table 3.5.43

Türkiye: tractor exports to selected countries, 2014-2018

(Thousands of USD)

	2014	2015	2016	2017	2018
Total world exports	434,241	373,281	338,697	320,497	423,943
United States of America	170,723	178,834	167,092	147,899	180,345
Italy	77,378	57,695	49,516	54,937	102,012
Iraq	19,085	10,671	9,708	3,691	15,110
Australia	8,619	7,930	6,327	8,029	12,873
Morocco	5,842	6 494	3,167	7,182	10,333
South Africa	8,888	6,764	9,399	8,620	9,979
Serbia	1,535	3,336	4,489	4,139	7,994
Portugal	4,918	4,834	6,535	6,384	5,260
Bulgaria	2,863	3,188	1,927	2,315	5,227

Source: International Trade Center, 2019

Türkiye exported agricultural equipment worth USD 406 million in 2018 (see Table 3.5.44).

Table 3.5.44

Türkiye: equipment exports, 2001-2018

(USD)

Year	Value	Year	Value	Year	Value
2001	26,444,000	2007	135,719,000	2013	263,932,000
2002	22,703,000	2008	178,159,000	2014	299,909,000
2003	32,237,000	2009	140,603,000	2015	287,113,000
2004	52,270,000	2010	165,586,000	2016	277,468,000
2005	71,501,000	2011	204,173,000	2017	333,460,000
2006	93,975,000	2012	237,470,000	2018	406,429,000

Source: International Trade Center, 2019

Azerbaijan, Iraq and Uzbekistan were the top three destinations for Türkiye's equipment exports in 2018 with markets steadily growing in Algeria, Bulgaria, France, Romania, Russian Federation and Sudan (see Table 3.5.45).

Table 3.5.45

Türkiye: value of equipment exports to selected countries, 2014–2018

(Thousands of USD)

	2014	2015	2016	2017	2018
Total world exports	**293 660**	**278 138**	**269 062**	**321 051**	**393 845**
Azerbaijan	26,533	19,409	22,893	51,960	41,396
Uzbekistan	8,900	8,602	8,343	19,342	36,548
Iraq	29,523	19,168	19,586	21,196	24,679
Sudan	10,720	12,226	12,241	8,027	17,236
France	14,990	11,458	10,091	13,073	16,014
Bulgaria	13,804	11,777	11,600	10,426	12,701
Algeria	22,706	19,835	15,977	9,226	12,651
Russian Federation	11,455	14,560	7,583	6,821	11,997
Italy	15,920	12,918	14,331	8,131	11,084
Romania	5,313	4,713	6,147	7,161	10,141
Iran (Islamic Republic of)	16,341	15,451	15,175	16,951	9,066
Serbia	2,987	3,761	5,185	7,075	8,482
Pakistan	2,186	1,979	3,074	4,115	8,071
Moldova, Republic of	3,046	2,429	3,278	5,117	7,930
Germany	2,509	2,667	3,728	4,364	7,760
Morocco	4,928	4,993	3,687	5,481	7,447
Turkmenistan	4,901	5,519	5,811	6,810	7,345
Saudi Arabia	2,977	8,087	3,819	4,006	6,497

Georgia	4,472	3,000	3,106	2,786	5,762
Libya, State of	4,310	2,636	4,182	1,673	5,223

Source: International Trade Center, 2019

As with tractor exports, the United States of America ranks as the top destination of Türkiye's agricultural machinery exports followed by Italy, with Azerbaijan, Bulgaria, Iraq, Sudan and Uzbekistan emerging as potential markets in the last five years (see Table 3.5.46).

Table 3.5.46

Türkiye: value of agricultural machinery exports to selected countries, 2014-2018

(Thousands of USD)

	2014	2015	2016	2017	2018
Total world exports	**727 901**	**651 419**	**607 759**	**641 548**	**817 448**
United States of America	172,866	181,745	169,682	150,719	183,510
Italy	93,298	70,613	63,847	63,068	113,096
Azerbaijan	27,974	20,967	23,688	55,385	42,667
Iraq	48,608	29,839	29,294	24,887	39,789
Uzbekistan	9,569	10,105	9,667	21,794	38,679
Sudan	15,263	22,127	19,668	15,306	21,140
Bulgaria	16,667	14,965	13,527	12,741	17,928
Morocco	10,770	11,487	6,854	12,663	17,780
Australia	10,104	9,859	9,287	12,168	17,194
Serbia	4,522	7,097	9,674	11,214	16,476
France	18,178	13,322	11,451	13,734	16,037
South Africa	12,683	11,106	13,242	12,272	13,963
Russian Federation	14,698	15,060	7,583	7,432	13,557
Algeria	31,692	21,010	20,005	9,874	12,651
Romania	6,246	5,915	7,122	9,395	11,226
Moldova, Republic of	3,942	3,057	3,916	5,557	9,337
Germany	4,829	3,897	4,633	4,813	9,137
Iran (Islamic Republic of)	16,426	15,794	15,187	17,070	9,114
Pakistan	2,186	1,998	3,074	4,379	8,834

Source: International Trade Center, 2019

b) Imports

In 2018, Türkiye imported about USD 460 million worth of agricultural machinery of which tractor and equipment imports accounted for USD 162 million and USD 298 million, respectively (see Table 3.5.47). However, this had plunged by 42.7 per cent from USD 657 million in 2017. All essential agricultural machinery tools are manufactured in Türkiye while the share of harvesting machines (HS Code 8433) in equipment imports by year, ranges from 50 to 70 per cent. The share of high-capacity balers, combine harvesters, cotton harvesters and forage harvesters with parts and components of these

harvesters, varies between 35 and 55 per cent.

Table 3.5.47

Türkiye: value of agricultural machinery imports, 2006-2018

(Thousands of USD)

Year	Tractors	Equipment	Total	Year	Tractors	Equipment	Total
2006	210,551	278,626	489,177	2013	244,492	473,276	717,768
2007	148,994	263,223	412,217	2014	276,702	352,219	628,921
2008	161,915	216,843	378,758	2015	396,607	312,940	709,547
2009	90,800	144,668	235,468	2016	390,224	300,209	690,433
2010	200,090	255,524	455,614	2017	343,567	313,925	657,492
2011	345,233	407,618	752,851	2018	162,391	298,174	460,565
2012	259,295	408,722	668,017				

Source: International Trade Center, 2019

Tractor imports, which accounted for 35.2 per cent of total agricultural machinery imports, declined by 47.1 per cent between 2017 and 2018 (see Table 3.5.48).

Table 3.5.48

Türkiye: number and value of tractor imports, 2000-2018

(USD)

Year	Units	Value	Year	Units	Value
2000	982	15,183,364	2010	8,896	200,090,000
2001	137	1,877,000	2011	14,961	345,233,000
2002	279	6,137,000	2012	11,699	259,295,000
2003	988	22,048,000	2013	11,166	244,492,000
2004	4,207	11,899,000	2014	13,634	276,702,000
2005	5,977	163,806,000	2015	20,659	396,607,000
2006	7,345	210,551,000	2016	21,634	390,224,000
2007	4,925	148,994,000	2017	18,107	344,405,000
2008	5,441	161,915,000	2018	8,044	162,391,000
2009	3,803	90,800,000			

Source: International Trade Center, 2019

Tractors in the power range of 37-75 kW account for the majority of tractor imports. In 2018, Türkiye imported USD 72 million worth of this power range out of total tractor imports of USD 162 million, the lowest amount since 2008 (see Table 3.5.49).

Table 3.5.49

Türkiye: number and value of tractor imports by power, 2014-2018

(Kilowatts, USD)

Power	*2014*		*2015*		*2016*	
	Units	*Value*	*Units*	*Value*	*Units*	*Value*
< 18	527	3,633,109	528	2,678,000	516	2,691,000
18–37	2,395	21,680,399	4,219	31,972,000	4,590	3,842,000
37–59	5,461	92,499,196	7,570	104,425,000	7,233	84,620,000
59–75	3,701	96,693,868	5,690	135,950,000	6,233	150,838,000
75–90	603	23,804,298	1,214	48,747,000	1,459	52,683,000
> 90	923	34,931,039	1,405	68,021,000	1,466	62,362,000
Total	**13,610**	**273,242,909**	**20,526**	**391,793,000**	**21,497**	**387,036,000**

Power	*2017*		*2018*	
	Units	*Value*	*Units*	*Value*
< 18	504	2,292,000	431	1,370,000
18–37	5,263	40,731,000	1,460	10,589,000
37–75	9,470	179,060,000	4,611	72,085,000
75–130	2,611	99,732,000	1,301	54,506,000
> 130	259	22,590,000	241	23,841,000
Total	**18,107**	**344,405,000**	**8,044**	**162,391,000**

Source: International Trade Center, 2019

The average unit tractor import price was USD 20,187 in 2018, USD 19,020 in 2017, USD 18,004 in 2016 and USD 19,087 in 2015. The average unit tractor import price has been dramatically decreasing over the last decade (see Table 3.5.50).

Table 3.5.50

Türkiye: average unit price of tractor imports, 2006-2018

(USD)

Year	Value	Year	Value	Year	Value
2006	26,780	2011	22,829	2016	18,004
2007	29,752	2012	21,954	2017	19,020
2008	29,630	2013	21,472	2018	20,187
2009	23,798	2014	20,076		
2010	22,266	2015	19,087		

Source: International Trade Center,2019

In 2018, most tractor imports, comprising 34 per cent of the total, were from Italy, followed by 16 per cent from France, 15 per cent from India and 10 per cent each from Germany and Japan, while maximum equipment imports came from Poland (17 per cent), Germany and Italy (16 per cent each), China (15 per cent), and Belgium (6 per cent) (see Table 3.5.53).

Table 3.5.51

Türkiye: value of tractor imports from selected countries, 2014-2018

(Thousands of USD)

	2014	2015	2016	2017	2018
Total imports	276,702	396,607	390,224	344,405	162,391
Italy	60,207	90,619	100,015	115,075	55,179
France	43,273	62,523	61,892	63,511	26,535
India	90,745	121,528	112,247	69,682	24,316
Japan	14,136	20,046	28,551	29,242	17,009
Germany	11,038	20,091	14,621	26,316	15,443
United Kingdom	5,883	16,642	13,706	11,641	10,757
United States of America	28,138	27,500	34,839	11,566	5,054

Source: International Trade Center, 2019

Türkiye imported USD 298 million worth of agricultural equipment in 2018, which was 12 per cent less than in 2014 and 5 per cent below 2017 with most imports coming from France, Germany, India, Italy and Japan (see Table 3.5.52).

Table 3.5.52

Türkiye: value of equipment imports from selected countries, 2001-2018

(Thousands of USD)

Year	Value	Year	Value	Year	Value
2001	41,983,000	2007	263,223,000	2013	473,276,000
2002	35,178,000	2008	216,843,000	2014	352,219,000
2003	47,081,000	2009	144,668,000	2015	312,940,000
2004	121,979,000	2010	255,524,000	2016	300,209,000
2005	218,143,000	2011	407,618,000	2017	313,925,000
2006	278,626,000	2012	408,722,000	2018	298,194,000

Source: International Trade Center, 2019

About half of Türkiye's equipment imports by value in 2018 were from Europe. Belgium, China, Germany, Italy and Poland are the major exporters to Türkiye. Total equipment imports surpassed USD 447 million in 2014 but have decreased since and amounted to USD 280 million in 2018 (see Table 3.5.53).

Table 3.5.53

Türkiye: value of equipment imports from selected countries, 2014-2018

(Thousands of USD)

	2014	2015	2016	2017	2018
Total imports	**447,462**	**325,929**	**283,712**	**266,783**	**280,044**
Poland	137,048	67,652	48,114	49,196	49,142
Germany	65,630	46,481	53,255	44,453	46,272
Italy	73,801	56,891	56,686	47,226	44,237
China	32,503	40,424	19,141	34,659	41,810
Belgium	24,838	12,152	17,925	9,768	16,769
United States of America	27,720	28,514	20,362	9,854	14,159
Netherlands	28,340	24,304	20,036	20,048	11,390

Source: International Trade Center, 2019

3.5.3. Enabling environment for trade and investment for sustainable mechanization of the agricultural sector

3.5.3.1. Investment environment and policy

Türkiye's investment legislation is simple and complies with international standards while offering equal treatment to all investors. The overall investment legal framework includes the Encouragement of Investments and Employment Law No. 5084, Foreign Direct Investment (FDI) Law No. 4875, the Regulation on the Implementation of the Foreign Direct Investment Law, multilateral and bilateral investment treaties and various laws and related subregulations on sectoral investment. The FDI Law outlines key FDI principles such as freedom to invest, national treatment, expropriation and nationalization, freedom of transfer, national and international arbitration and alternative dispute settlement methods, valuation of non-cash capital, employment of foreign personnel and liaison offices.

a) Public and private sector participation in sustainable agricultural mechanization

It is expected that agricultural machinery enterprises specializing in certain products and producing competitive products in large areas with high production technologies will grow to stay competitive, resulting in increased demand for high-power tractors and high-capacity equipment, which in turn will lead to a rapid increase in large-scale production and specialization. Animal husbandry production techniques and mechanization will also develop rapidly in the coming years along with forage production, and consequently forage production technologies. Agricultural production is projected to be increasingly mechanized as machines with greater capacity are projected to be used in the coming years. With the enactment of the law to prevent the division of land through inheritance, land consolidation efforts have gained momentum. Pilot studies have been conducted on the virtual removal of field boundaries to assess the impact of land consolidation. As a result, agriculture in Türkiye will use high-capacity machines with the increase in average land size.

Information systems and mechatronics applications will also play a significant role in agricultural mechanization over the next decade. The launch of the "Smart Farming Platform" in 2016, using digital systems, is expected to boost the stability and development of farming technologies

in Türkiye. This will encourage new investments in technology and raise awareness of the importance of agricultural technology among public institutions. The production and use of intelligent agricultural machinery, including that used for precision farming, will gradually increase with more companies undergoing a digital transformation. These developments will lead to a reduction in the number of agricultural machinery firms. Companies producing and competitively exporting high-value-added agricultural machines will survive only if they adapt to the digital transformation.

Under these conditions, mechanization R&D has become important. Corporations experience growth through these improvements and in the development of new goods and services. With the current content protection law for copy prevention coming into force, the imitated production rate will be reduced. Many small and mid-sized businesses may choose to outsource R&D because of a lack of budgetary and human resources. Therefore, collaboration among universities, industry and technology centres is essential for ensuring competitiveness in global markets.

b) Role of agricultural machinery manufacturers' and distributors' associations

The Ministry of Agriculture and Forestry and the Turkish Association of Agricultural Machinery & Equipment Manufacturers (TARMAKBIR) are leading agricultural mechanization and transfer of technology while promoting the export of agricultural mechanization tools and equipment produced in the country.

A founding member of the European Association of Agricultural Machinery (CEMA) and ex-Chair of the Global Alliance for Agrievolution Agricultural Machinery Manufacturers' Association, TARMAKBIR is also a member of the Regional Council of Agricultural Machinery Associations in Asia and the Pacific (RECAMA), participating in international expositions like Italy's biggest agricultural machinery exhibition - EIMA, Germany's AGRITECHNICA and France's SIMA fairs.

In 2015, the International Competitiveness Development (URGE) project was started with the support of the Ministry of Trade, to strengthen the production and export-based institutional infrastructure of 21 manufacturing companies and increase export opportunities.

c) Initiatives for manufacturing, distributing and adopting sustainable agricultural mechanization technologies

Türkiye is a big market for agricultural machinery and domestic demand for modern agricultural machinery and related services has been met by local manufacturers. Today, almost all modern machinery used in agricultural production is manufactured in Türkiye.

Türkiye has harmonized some regulations with the EU during its EU candidacy process. Within this framework, primary type approval for tractors has been handled and implemented for many years. Although the certification process is basically the same in terms of legislation, Türkiye is still technically behind EU engine emission norms. For tractors not manufactured in Türkiye, EU regulations require a validated type-approval certificate. The EU legislation (Type Approval of Agriculture and Forestry Tools and Market Supervision and Regulation on Audit, EU/167/2013) has been implemented in Türkiye since 1 January 2020, which covers tractors and other agricultural trailers such as R- and S-class vehicles. There is local legislation for agricultural trailers classified as R-class vehicles and Türkiye has not yet developed adequate market conditions for other R- and S-class criteria specified in the legislation for farm machinery. All tractors and self-propelled farm

machinery in Türkiye are subject to mandatory registration. Tractors are registered by national notaries and the "Türkiye Union of Chambers of Agriculture" is authorized to register all types of self-propelled agricultural machinery. There is no registration system for other agricultural machinery. All locally manufactured or imported agricultural machines must obtain an Agricultural Crediting Certificate from the Ministry of Agriculture and Forestry before they can be sold by way of state-subsidized credit. An 'experiment report' is required to obtain this document and this can only be issued by an accredited experiment institution authorized by the Ministry of Agriculture and Forestry. The aim of the testing is to analyze the compatibility of machines with agricultural techniques and ensure compliance with standards. Tractor tests are conducted according to international Organization for Economic Cooperation and Development (OECD) Tractor Codes. The process is different for plant protection machinery which is subject to licensing from the production stage, whether sold with state-subsidized credit or not. To obtain a license, the machine is subjected to a mandatory test at test centres certified by the Ministry of Agriculture and Forestry. There are certain requirements for the sale of these machines.

All certification processes apply to all organizations from every industry, and they must obtain a capacity report from the Union of Chambers and Commodity Exchanges of Türkiye (TOBB) and an Industry Registration Certificate from the Ministry of Industry and Technology. Another compulsory certification issue is the CE mark which is checked with the EU Declaration of Conformity at the import stage.

3.5.3.2. Trade environment and policy

a) Risk management

Türkiye remains the second largest FDI recipient in West Asia, behind Israel (UNCTAD, 2019). After a record high of USD 22 billion in 2007, FDI flows decreased to USD 12.94 billion in 2018 although edging up from USD 11.48 billion in 2017 (see Table 3.5.54).

Table 3.5.54

Türkiye: foreign direct investment (FDI) flows

(Millions of USD)

	2016	*2017*	*2018*
FDI inward flows	13,705	11,478	12,944
FDI stock	150,023	196,470	134,524
Number of greenfield investments	154	223	216
FDI awards (percentage of GFCF)	4.7	n/a	n/a
FDI stock (percentage of GDP)	15.5	n/a	n/a

Abbreviation: GFCF, gross fixed capital formation
Source: International Trade Center, 2019

Türkiye has enacted a series of legal reforms to facilitate foreign investment, such as the creation of the Investment Support and Promotion Agency of Türkiye (ISPAT). FDI inflows have improved with the development of public-private partnerships for major infrastructure projects, measures to streamline administrative procedures and strengthen intellectual property protection, the end of FDI screening as well as structural reforms as part of the EU accession process. The challenges to FDI include the instability of the Turkish lira as seen in the currency plunging to record lows in August 2018, high inflation levels and the geographical proximity of geopolitical tensions. Nevertheless,

Türkiye's rank in the World Bank's "Ease of Doing Business Report 2020" improved to 33 out of 190 economies, up by 10 spots from the preceding year. This was due in particular to improvements in tax payments (Societe Generale, Investment Risk of Türkiye 2019).

Strengths

• Türkiye's EU accession process helped establish European regulations and trade standards, which have substantially liberalized the economy.
• The government is working to attract FDI into technology, textiles, services (health, education, public transport), telecommunications, shipbuilding, electronics and biotechnologies.
• A young, consumption-oriented middle class with increased purchasing power.
• Relatively low labour costs.
• A strategic geographical location makes it a regional hub between Europe, Asia and the Middle East and North Africa (MENA) economic zone.
• A market of 70 million consumers.

Weaknesses

• Cumbersome bureaucratic procedures.
• Frequent changes in the legal and regulatory environment.
• Strong dependence on exports and hydrocarbon imports.
• Economic and political reforms slowed recently.
• High inflation, an uncertain foreign exchange rate and a constantly rising public debt.
• Proximity to geopolitical conflicts
• Increasing political unrest.

b) Regional trade agreements

Türkiye has free trade agreements with third countries in parallel with the EU. Together with the EU Common Customs Tariff, preferential trade regimes constitute the most important part of Türkiye's trade policy. The EU decided to focus on bilateral trade with the introduction of its new trade strategy called "Global Europe" in 2006. In line with this strategy, to maintain its competitiveness in the world markets, the EU started to negotiate FTAs with specific provisions on services, investment, public procurement, and intellectual property rights. Türkiye is preparing itself for such a changing environment. Having initiated negotiations parallel to the EU, Türkiye also adapts itself to the wide range of topics covered in the Agreements and negotiates new generation FTAs with its prospective partners.

Türkiye has Free Trade Agreements (FTAs) with 36 countries of which 11 were repealed due to the accession of these countries to the EU. There are 20 FTAs in force with Albania, Bosnia and Herzegovina, Chile, Egypt, the European Free Trade Association (EFTA), Faroe Islands, Georgia, Israel, Macedonia, Malaysia, Mauritius, Moldova, Montenegro, Morocco, Palestine, Republic of Korea, Serbia, Singapore, Syria and Tunisia. Free trade agreements are being ratified with Kosovo, Lebanon, Qatar, Sudan and Venezuela. Türkiye is also negotiating to deepen the scope of the FTAs in force and negotiations with Bosnia and Herzegovina, EFTA, Montenegro and Serbia are concluded while negotiations with Georgia and Malaysia are to be finalized. (Türkiye Investment Office, 2019).

3.5.3.3. Infrastructure and financial development

a) Infrastructure development

Türkiye had 68,633 km of roads in 2019 and 38 per cent of these were dual carriageways, according to estimates by the General Directorate of Highways (KGM). There are also 3,523 km of motorways and these are to be extended to approximately 9,680 km by 2035. In keeping with the growing economic performance, total installed electricity generation capacity has seen a dramatic rise from 31.8 Gigawatt (GW) to 88.5 GW within 17 years and electricity consumption from 132.6 Terawatt hour

(TWh) to 305.5 TWh as of end 2018. Current capacity is expected to reach 110 GW by 2023 through further private sector investment as underlined in the 11th Development Plan for 2019-2023 (Türkiye Investment Office, 2019). As in most developing countries, agriculture accounts for maximum water use in Türkiye. Of the total 23.2 million ha of agricultural land, 7.1 million ha are irrigated (see Table 3.5.18). Türkiye is expanding and modernizing its irrigation infrastructure, along with other investments for increasing agricultural productivity. According to the World Bank, Türkiye ranks third globally in infrastructure projects with a total investment value of USD 165 billion between 1990 and 2015. With a successful track record of over 220 investments across a diversified portfolio of infrastructure assets, Türkiye has completed about 80 per cent of these over the past decade. The investment climate has been strengthened by domestic and international laws protecting investments and providing international arbitration. (Türkiye Investment Office, 2019).

b) Financial sector involvement in agriculture and sustainable agricultural mechanization

The most common payment option for tractor buyers in the country is borrowing as few farmers can afford to pay the full price in cash. About 90 per cent of buyers take conventional bank loans which usually take 5 to 6 years to pay off. All loans are against collateral that allows the lender to take over the borrower's assets in case of non-repayment. Tractor loans are often issued against pledged collateral, requiring the buyer to pay 25 per cent of the price at the time of purchase with lenders funding the remainder. Farmers prefer government-subsidized loans and the state-run Ziraat Bank's subsidized credit scheme offers eligible farmers loans subsidized at 25-100 per cent of the current interest rate, with the Treasury covering the income loss of the bank, if any. Tractors are allocated 75 per cent of agricultural mechanization loans. Ziraat Bank had a share of about 60 per cent in the agricultural lending market despite its monopoly in subsidized loans. Many private banks are also involved in the agricultural lending market due to their long-term growth potential and profitability. In recent years, the share of commercial banks has reached 40 per cent becoming an important source of agriculture finance.

Table 3.5.55

Türkiye: disbursement of agricultural credit by public and private banks, 2008–2016

(USD)

Year	*Public banks*	*Share (percentage)*	*Private banks*	*Share (percentage)*	***Total***
2008	2,288,756	66.2	1,169,882	33.8	**3,458,638**
2009	2,843,971	64.1	1,589,628	35.9	**4,433,600**
2010	3,617,676	70.2	1,539,131	29.8	**5,156,807**
2011	5,762,615	73.3	2,103,304	26.7	**7,865,919**
2012	7,923,929	74.3	2,741,861	25.7	**10,665,790**
2013	7,844,235	69.8	3,399,429	30.2	**11,243,664**
2014	8,018,389	63.8	4,557,143	36.2	**12,575,532**
2015	10,154,971	64.2	5,660,659	35.8	**15,815,630**
2016	13,538,849	66.7	6,772,325	33.3	**20,311,174**
Average	6,888,154	67.7	3,281,485	32.3	**10,169,639**

Source: BDDK (Turkish Banking Regulation and Supervision of Agency), 2019

Most manufacturers sell agricultural equipment directly to consumers, bypassing distributors and dealers and the usual payment options are cash-against-goods and deferred payment plans rather than bank loans. Traditionally, this type of sale is either directly by the manufacturer's parent company or an authorized dealer. The seller reimburses all legitimate costs and acts like a third party financial institution making a loan. Obviously, this financing model has significant financial risks for the seller and in case of a dispute or default, the seller will be liable for all exposure. The maturity of these payment plans is mostly contracted for installments of 18 to 24 months.

Ziraat Bank and the farmers' owned TKK supported by the government are the main source of loans for agricultural equipment. Most loan agreements contracted with Ziraat Bank for equipment sales are subsidized credits. The Bank is an important financing institution for equipment and implement sales with a share of 10 per cent in the agricultural machinery credit market in which private banks have a negligible share. TKK and some cooperatives, such as the Sugar Beet Growers Association (Pankobirlik), are major formal credit sources.

Among these lenders, TKK is an important source of formal production credit for farmers, especially small-scale producers, with an estimated 4-6 per cent share in the agricultural machinery credit market. The TKK member cooperatives have had a small but steadily growing share, increasing their lending from USD 180 million in 2002 to USD 1.8 billion in 2010 and USD 2.4 billion in 2015 (Activity Report, 2017). Many agricultural credit types and policy applications are used in the agricultural sector in Türkiye. Pankobirlik, related to sugar processing, is another source of agricultural funding with an estimated market share of 2-4 per cent in agricultural machinery. Various state institutions, producer cooperatives and agricultural chambers also have support programmes to encourage farmers to purchase equipment. The market share of equipment sales supported by the Ministry of Agriculture's aid programme is around 2 per cent.

Ziraat Bank loans for irrigation projects usually make up a higher share of bank lending than loans for equipment. These loans are interest-free, and the difference is five-fold in favour of irrigation. Irrigation loans are also an important part of TKK and Pankobirlik funding schemes.

3.5.4. Conclusion and recommendations

Türkiye is the home of Anatolia, which is well-known for its fertile soil and agricultural abundance. There are 30 different agricultural regions in Türkiye. The country's strategic geographic location and favourable investment policies have created a conducive business environment. Production and exports, in high-technology sectors, including agricultural machinery and equipment, have increased substantially in recent years.

Agricultural mechanization in Türkiye is growing with increasing demand from national and international markets. The country manufactures all types of agricultural machinery except some self-propelled models. A major problem facing the local agricultural machinery industry is the lack of internationally well-known "made in Türkiye" machinery. However, a variety of agricultural machines and equipment compatible with the different agricultural conditions in Türkiye are available. Moreover, some agricultural machines such as cotton harvesters are not manufactured in Europe but in Türkiye, because such crops cannot be cultivated in Europe. The level of agricultural mechanization in Türkiye is comparable to average EU levels. However, the country needs the capacity for manufacturing high-technology machines conforming to international environmental and

safety standards. There are 1.9 million tractors registered in the country with an average age of 24 years. There is no baseline data on the make-up and quantity of the equipment fleet, but the data is assumed to be similar to that for tractors, making Türkiye one of the world's largest tractor and equipment markets. There is a huge market potential and modernization of the aging fleet can make the industry attractive to investors.

Recommendations

Suggestions for enhanced utilization of agricultural machinery in Türkiye are outlined below (see Table 3.5.56).

Table 3.5.56

Türkiye: agricultural machinery industry problems and proposed solutions

	Problem	*Proposed solution*	*Course of action*
1	Small and fragmented agricultural land.	Promoting the use of shared machinery. Virtual removal of land boundaries.	Identifying regionally appropriate models.
			Delegation of family land for single-person sustainable use.
			Financial support for contract system of farming
			Regional solutions for joint acquisition of machinery.
2	Inefficient use of machines.	Increased training of farmers/technical personnel.	Training centres for producers (Deula/Germany example of formalizing mechanization training centres).
			Public spots for more efficient machinery use.
3	Limited financial access for farmers and manufacturers.	Continued rural development support.	Impact analysis of support provided by independent institutions and general directorates of Ministry and units of Ziraat Bank and Agricultural Credit Cooperatives Act to address financing problems of producers.
		Continued subsidized credit.	
		Continued EU fund support.	Special incentives to promote fuel economy and environment-friendly machines.
		Offsetting value added tax (VAT) problem for manufacture.	VAT refunds to manufacturers within one month.
4	Lack of periodic inspections of plant protection and milking machines.	Updating regulations for all food contact surfaces.	All Agricultural Mechanization department operations to be established within Ministry and setting up an independent analysis laboratory for residue analysis.
	Milking and food processing machines and components not produced in accordance with regulations for food-suitable surfaces and inadequate controls.	Preventing unfair competition.	Activating market surveillance and product auditing.

5	Inadequate traceability of manufactured machines.	Implementation of QR codes.	Cooperation between Turkstat, Ministry of Agriculture and relevant institutions.
6	Providing support without considering business scale.	Matching support to mechanization planning.	Studies from other countries especially China and India.
7	Low public-private R&D cooperation.	Scheduling cooperation in projects to create added value in short time.	Conducting the projects to be cooperated with a manufacturer
			Website for manufacturers and research organizations.
8	Lack of an agricultural mechanization research centre within the ministry.	Establishing a specialized agricultural mechanization research institute.	Studies on establishing the research institute by the relevant unit within the ministry.
9	Inadequacies in agricultural mechanization committee.	Improving efficiency of the agricultural mechanization committee.	High-level participation by the Board of the committee acting on decisions taken.
			Converting existing structure into a committee for efficiency.
10	Dispersion of agricultural mechanization duties and authority.	Coordination of Ministry of Agriculture work from a single source by a single authority	Establishing Department of Agricultural Mechanization within the Ministry.
11	Inadequate data on agricultural machinery.	Determination of current status of agricultural mechanization.	Inventory monitoring to determine status of agricultural mechanization.

IV. Summary of findings, conclusions and recommendations

4.1. Summary of findings

4.1.1. Agricultural profile

The five countries included in this study haveabundant land, water and sunlight for agricultural production. They also have large populations of more than 100 million people each, making the sustainable increase in food production a priority. Agriculture will continue to be vital for their socioeconomic well-being and mechanization is becoming a prerequisite for producing food, feed, fiber and fuel and achieving sustainable agricultural development.

Agriculture is a major component of the GDP of each of the five countries, but its contribution to the national economy is decreasing in Bangladesh because of the declining size of farm holdings. The Philippines also experienced a decreasing trend of agriculture's contribution to GDP over an eight year period and a similar decline was observed in Türkiye. In all three countries, the industrial sector's contribution to GDP has been increasing. On the other hand, agriculture's share in the economy is increasing in Indonesia and Pakistan because of growing agricultural exports. Higher yields, attractive output prices, supportive government policies and improved supply of agricultural inputs have also helped increase the sector's share of GDP in these two countries.

In Bangladesh, Indonesia and the Philippines rice and corn are the staple food but self-sufficiency is yet to be achieved. In Pakistan, wheat, rice, sugarcane and maize are the major crops while wheat, barley and maize are the major agricultural products in Türkiye which has achieved self-sufficiency in these staples. Most of the surplus agricultural produce in Pakistan and Türkiye is exported and all five countries export agricultural products, particularly fruits, vegetables and nuts.

Smallholder farmers have a vital role in agricultural production in all five countries, but most farm holdings are fragmented, scattered and small, ranging between 0.5 and less than 5 ha. Smallholders in Bangladesh, Indonesia and the Philippines use small farm machinery, and these countries import agricultural machinery, especially large-scale machines because of limited local manufacturing capacity for large and complex machines like four-wheel tractors and combines. As most smallholder farmers in these three countries sell produce immediately after the harvest to traders and intermediaries, post-production and processing machinery is not a priority for them. Pakistan and Türkiye manufacture large agricultural machines. All five countries have established value chains for major crops.

Custom hiring is also available in all countries where larger machinery is used. As farming depends on family and hired labour, with labour shortages during peak cultivation season, mechanization technologies are crucial for sustainable crop production. All five countries practice wetland and dryland crop production, especially for rice, and have irrigation systems for wet paddy production, ranging from big dams built and managed by the

government to small-scale irrigation networks owned and managed by individual farmers. Dryland crop production is highly dependent on rainfall and water is key to enhancing agricultural production.

Farmers in all focus countries, except Bangladesh, are members of farmers' organizations, whether farmers' associations, irrigators' associations, small water irrigators' system associations and multipurpose cooperatives. These organizations play a very important role in grassroots implementation of government policies, programmes and extension services, including those of the private sector. These organizations also increase farmers' bargaining power in obtaining governmental support.

4.1.2. National policies and programmes, research and development, import and export of agricultural machinery and level of mechanization

All five countries have developed roadmaps for sustainable agricultural mechanization aligned with the 2030 Agenda for Sustainable Development. Along with laws and policies directly or indirectly promoting agricultural mechanization, all have liberalized the import of agricultural machinery, giving themselves better mechanization options suited to their specific needs. Except for Bangladesh, all countries in the study have some kind of quality checks on both imported and locally manufactured machinery.

Agricultural development and mechanization are national priorities in all five countries, backed by government policies and programmes such as price support for agricultural products, subsidies for farming inputs and credit support for the procurement of agricultural mechanization technologies for sustainable food production. Subsidies schemes cover reduced interest rates on loans and full price support or dole-out programmes for farmers' organizations. Price support for agricultural produce is particularly important in Türkiye and the Philippines. Additionally, governments provide essential infrastructure such as irrigation facilities, road networks and extension services, among others.

All five countries have strong research and development programmes in agricultural mechanization, ensuring continued production of innovative and cutting-edge technologies and agricultural machinery. The well-established government research development institutions in these countries are supported by higher education institutions in conducting agricultural mechanization R&D. There are strong R&D networks for developing, designing, producing and promoting agricultural mechanization technologies not only for domestic use but also for neighboring countries. Recent R&D initiatives in these countries include precision agriculture, alternative and renewable farm energy and aquaculture mechanization in Indonesia, Pakistan and the Philippines, and land consolidation for efficient utilization of machinery in agricultural production systems. Land consolidation aims to improve efficiency in farm operations, optimize land use, labour and crop productivity for maximum farm income. Small farm holdings limit the use of large machinery and consolidation into larger farms enables synchronized farming and efficient use of large machines. This also creates R&D opportunities for developing new technologies for the consolidated farms. It will also enhance trading and investment activities related to larger and more sophisticated mechanization technologies.

Bangladesh, Indonesia, Pakistan and the Philippines rely on agricultural machinery imports. The domestic machinery sector in Bangladesh and the Philippines mostly produces small to medium-size machines due to the limited capacity of the small to medium-scale manufacturing industry. Most large machines are imported, including small cylinder

engines ranging from 5 to 20 hp which are the main power source of most agricultural machinery in these countries. They lack capability of manufacturing high-power and more sophisticated machines like four-wheel tractors, ride-on-type planters, self-propelled/tractor, mounted or tractor trailer type, crop protection equipment, reapers and combines. Instead, they have machinery associations with importers, distributors and dealers of high-power rating mechanization technologies. Indonesia and Pakistan, although dependent on imports, also produce and export four-wheel tractors and other high-power machines. Pakistan has three manufacturers of four-wheel tractors producing about 5,000 units every year. Of the five countries, Türkiye has the most advanced manufacturing capacity. It trades with about 150 countries, exporting four-wheel tractors, implements, milking machines, tillage and planting machines, threshing machines and feed grinders. These machines have power ratings ranging from 37 to 75 kW. Türkiye is the top exporter of machines with power ratings of between 37 and 75 kW, supplying two out of every three 4-wheel tractor in this power rating group, which are mainly exported to Italy and the United States of America.

Mechanization levels vary across the five countries. In Bangladesh mechanization is limited to land preparation, which is 90 per cent mechanized through the use of power tillers. Irrigation is 80 per cent mechanized using pumps, and 75 per cent of threshing operations are mechanized, but crop care and harvesting remain predominantly manual. Mechanization is rapidly increasing throughout Indonesia and the government is committed to increasing productivity and production to ensure food security and replace fossil fuel use with bioenergy based on agricultural crops such as cassava, sugarcane and palm oil. The use of pre-harvest and post-harvest machinery, ranging from small to large machines, is continuously increasing with a fast-growing manufacturing industry. In Pakistan, farm operations use manual, human-animal and human-machine systems with a machine power share of about 66 per cent. Average farm power use in Pakistan is 1.63 kW/ha with most power provided by medium and large tractors. The share of tractor power is about 91 per cent and with 95 per cent tractors available for cultivation, an average of one 50 hp tractor is available for 32.6 ha of cultivated area.

The Philippines has seen a rise in human-machine systems with its farm power use level increasing from 1.72 kW/ha (2.31 hp/ha) in 2012 to about 2.63 kW/ha (3.53 hp/ha) in 2017 in rice and corn production systems. This has been brought about by the government's campaigns of subsidies to farmers' organizations to promote the use of medium and large tractors and combines. The rice production system is still predominantly powered by small power tillers and medium power tractors, ranging from 36 to 65 hp. The country developed a Modified Agricultural Mechanization Index (MAMI) in 2017 which is now used by the Department of Agriculture to determine the agricultural mechanization level in the country and is expected to provide an accurate basis for decision-making for the acquisition, distribution and utilization/adaption of agricultural mechanization technologies.

Türkiye is the largest user of medium- to large-powered machinery. The country's agricultural machinery sector comprises manufacturing of tractors, equipment and irrigation systems. The machinery industry is the third largest entrepreneurial sector in Türkiye, including a robust manufacturing industry for medium- to large- and high-power tractors, implements and other agricultural machines for domestic sale and export. Although there is no exact estimate of the mechanization level in Türkiye, the abundance of high-powered agricultural machines indicates a higher level than the other four countries.

4.1.3. Trade and investment

Investment environment and policy

All five countries have a conducive environment for public-private partnerships in pursuit of agricultural development through the provision of appropriate mechanization technologies in different production systems. The governments facilitate increased domestic and foreign investment in agricultural machinery manufacturing and encourage the domestic private sector to partner with foreign investors in the field of agriculture mechanization.

Bangladesh encourages information and knowledge sharing between the private sector and the government and has established a legal framework and enabling environment for public-private collaboration. Indonesia and Pakistan are strengthening agricultural machinery manufacturing, including marketing and servicing, and also setting up central manufacturing facilities for specialized/critical machinery components. Indonesia is initially following a semi-mechanized model for agricultural development and supporting land consolidation for fully mechanized lowland paddy farming in future. In the Philippines, the private sector takes part in policy formulation, supplies local and imported AFMTs, collaborates in mechanization R&D and serves as the extension agent addressing gaps and issues in agricultural mechanization. Farmers, fisherfolk, the public sector and the government partner up in promoting sustainable agricultural mechanization. Land consolidation or contiguous farming is in its initial stage in the Philippines, facilitating the use of larger and higher power agricultural machines. In Türkiye, the investment legislation is simple and complies with international standards, offering equal treatment to all investors, while manufacturing of large scale, high-power machines and implements is being promoted. The growth of the agricultural machinery industry in the country indicates the growing trend in use of larger capacity agricultural machinery. Production and use of intelligent agricultural machinery, including precision farming equipment and related software, is gradually increasing with more companies undergoing a digital transformation. Agricultural mechanization, including production and post-harvest technologies will create skilled job opportunities and lead to the growth of an independent rural agro-industry.

All five countries have machinery manufacturers' and distributors' associations. In Bangladesh, the machinery manufacturers' association disseminates local and foreign machinery based on farmers' preferences. It also supports government policies and initiatives for sustainable agricultural mechanization. Indonesia has some 40 associations of national agricultural machinery manufacturers and their branch associations with hundreds of local workshops. The development of local workshops is being supported by the government. The manufacturers' association leads in providing machinery rental services, generating jobs and making machines accessible to farmers. Pakistan has over 600 local agricultural machinery manufacturers, producing more than 40 types of agricultural machines and implements. The government, in collaboration with agricultural machinery manufacturers, financial institutions, federal and provincial autonomous bodies, provincial directorates of agricultural engineering and agro-services providers, is promoting local production and dissemination of agricultural machinery. The Philippines has a main private manufacturers' association, representing 95 per cent of the largest farm machinery manufacturers and distributors in the country. Their products range from large to small machinery, although large and medium power tractors, planters and combines are all imported while small- and medium-size machinery is locally manufactured. The government, in collaboration with the manufacturing industry, has explored starting domestic production of single

cylinder engines for agricultural and fisheries mechanization use. In 2001, there were 354 small-to-medium scale local manufacturers although the data has not been updated. In Türkiye, the government and the agricultural machinery and equipment manufacturers' association are spearheading agricultural mechanization exports of locally produced machines, tools and equipment. Starting in 2015, the manufacturers association, supported by the government, has strengthened production and the export-based institutional infrastructure of 21 companies, increasing sustainable export opportunities.

Trade environment and policy

The agricultural machinery trade is exposed to risks linked to natural disasters, climate change, foreign trade policies, national security, bureaucratic cultures, economic and political reforms and the legal and regulatory environment. All countries in this study have countermeasures in place to protect their agricultural machinery trade from risks. They are all parties to a number of bilateral and multilateral trade agreements and most are implementing these agreements for mutual benefit.

Infrastructure and financial development

All five countries are developing rural physical infrastructure, building road networks and farm-to-market roads for the efficient and timely flow of goods, services, people and opportunities in the agriculture sector. Irrigation and energy generation and distribution networks are being developed to support agricultural production systems. Seaports, agricultural processing zones, trading centres and economic zones are being set up to support agricultural development. All five countries are developing information technology and communications, including human resource development in support of agricultural advancement. A recent example is land consolidation/contiguous farming with physical alteration of farmland, construction of irrigation and drainage facilities, farm road networks, machinery service and post-harvest processing centres and plans to use precision and smart farming technologies.

Agricultural mechanization development requires substantial financial support. Agricultural and private banks' soft loans to farmers for purchasing agricultural machinery, along with government subsidies and incentives, play an important role in promoting mechanization. The government also offers import tariff exemption for machinery and equipment and other financial incentives. Informal financial organizations also provide agricultural credit with the advantages of easy accessibility, easy liquidity, low administrative and procedural costs, little or no collateral/mortgage requirements and flexible interest rates and repayment schedules. Farmers' cooperatives, rural development banks and non-governmental organizations are also a major credit source for farmers.

4.2. Conclusions

Successful dissemination and use of sustainable agricultural mechanization technologies requires active participation by all key players in the agricultural machinery value chain. The government sets the policy direction and provides support through subsidies, incentives, infrastructure, research, development and extension (RDE) and a conducive environment for trade and investment in mechanization technologies. The manufacturing industry collaborates with RDE institutions to

produce modern and innovative machinery suited to farmers' needs. Farmers utilize mechanization technologies to improve operational efficiency and production sustainability.

In all five countries, collaborative efforts between governments, the private sector and manufacturers' associations have established policies, infrastructure, networking and quality control mechanisms to facilitate investment and trade in agricultural machinery to ensure a supply of sustainable agricultural mechanization technologies. This has accelerated adoption of appropriate technologies to promote sustainable agricultural growth and the well-being of farmers through increased productivity and income.

While some policies may differ in each country according to socioeconomic and geopolitical circumstances, their experience is useful for other countries, especially as best practices in geographically similar farming environments. Regional cooperation shall lead to better trade and investment options.

4.3. Recommendations

Policy level

1) Implementation of laws and national policies on agricultural mechanization as envisioned

While all five countries have laws, policies and national guidelines related to agricultural mechanization, these are not strictly implemented. Moreover, trading and investment policies, specifically for agricultural machinery, lack clarity in some countries. Hence, policies on agricultural machinery trading and investment should be strengthened.

2) Strengthening local agri-machinery manufacturing

Four out of the five countries need targeted programmes to strengthen domestic agri-machinery manufacturing. This includes establishing local machinery assembly units, indigenizing economically viable farm mechanization technologies, local assembly and manufacturing of single cylinder engines and promoting machinery pools for custom hiring services with government support. This will not only reduce dependence on imports but also lead to the export of agricultural machinery.

3) Land consolidation or clustering for efficient mechanization

Land consolidation, contiguous farming and corporate farming can enable the efficient use of agricultural machines by improving farm layout and facilitating infrastructural access, including irrigation and drainage, farm-to-market roads, and post-harvest facilities. Grassroots farmers' organizations need to be strengthened to increase farm productivity through synchronized crop production and efficient use of water resources and agricultural machinery. Machinery pooling is also a viable option to increase access to mechanization. Bangladesh, Indonesia, the Philippines and Türkiye have ventured into land consolidation to enable the pooling of large and high-power machinery.

Technical level

4) Continued research and development

Research and development covering all agricultural

subsectors should be strengthened, to include on- and off-farm agricultural applications and processing technologies. Moreover, in-house agricultural machinery R&D should be initiated in all research and development institutes. Agricultural mechanization research institutes should be established in countries where agricultural R&D activities are only a part of the work of other government agencies.

5) Prioritization and modernization of after-sales services

After-sales services assure the full economic life of machinery. Access to after-sales services and spare parts is a major requirement for effective agricultural mechanization, especially in remote areas. Its provision should be seen as a profitable venture and not merely as a support service, as it can enhance trading and investment in imported and locally produced agricultural machinery.

6) Promotion of precision agriculture and smart farming

Most of the countries in this study recommend the prioritization of innovative and sophisticated technologies like precision agriculture machinery, the application of precision agriculture for profitable production and the promotion of innovative practices. Research, development and extension related to precision agriculture and smart farming technologies should also include automation and robotics. This can promote opportunities for agricultural machinery trading and investment ventures.

Institutional level

7) Establishing and strengthening machinery standards and testing

The agricultural mechanization experience of Indonesia, the Philippines and Türkiye shows the importance of the standardization and testing of imported and locally produced machinery to ensure quality. These countries can still strengthen their capabilities to ensure the availability of quality machines to farmers. In Bangladesh and Pakistan, there is a need for dedicated agricultural machinery testing and evaluation centres with provincial satellite institutions. The development of regionally harmonized standards, aligned with agri-machinery trading protocols, can reduce the redundancy in machinery testing in each country.

8) Strengthening capacity-building and training for farmers

All the five countries have identified a need for increased training facilities and capacity-building for farmers, machinery operators and mechanics through their increased involvement in various activities such as production, water utilization and use of machinery and equipment.

9) Credit facilitation for farmers and service providers

There is a commonly identified need in all countries for easy access to credit for trained farmers, service providers and traders, and the continued availability of subsidized credit for small farmers.

10) Centralized R&D agricultural mechanization network

There is a need in all five countries for a national institute for agricultural machinery research, a national network to coordinate agricultural mechanization R&D, and the implementation of a mechanization programme that includes a modern and comprehensive management information system responsive to the needs of commodity value

chains, which should provide stakeholders timely access to relevant information.

In general, there should be continuous support and strengthening of incentives for the advancement of sustainable mechanization. This will enhance trading and investment in sustainable agricultural machinery in the region and benefit farmers by increasing their capacity to choose and acquire machinery suited to their farming activities.

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Table

Figures

Acronyms

ABEI	Agricultural and Biological Engineering Institute
ACPC	Agricultural Credit Policy Council
AEC	ASEAN Economic Community
AEI	Agricultural Engineering Institute
AFMA	Agricultural and Fisheries Modernization Act
AFMeC	Agricultural and Fisheries Mechanization Committee
AFMech	Agricultural and Fisheries Mechanization
AFMTs	Agricultural and Fisheries Mechanization Technologies
AFTA	ASEAN Free Trade Agreement
ALEP	Agricultural Light Engineering Program
ALSINTANI	National Private Agricultural Machinery Association
AMD	Agricultural Machinery Division
AMDAC	Agricultural Machinery Distributors/Manufactures Accreditation Committee
AMDP	Agricultural Mechanization Development Program
AMI	Agricultural Mechanization Index
AMMA-B	Agricultural Machinery Manufacturer's Association–Bangladesh
AMMDA	Agricultural Machinery Manufacturers and Distributors Association Foundation, Inc.
AMMPI	Allied Motors Manufacturing Phils. Inc.
AMO	Agriculture Machinery Organization
AMRC	Agricultural Mechanization Research Cell
AMRI	Agricultural Mechanization Research Institute
AMTEC	Agricultural Machinery Testing and Evaluation Center
APSEA	All Pakistan Solvent Extractors Association
APTA	Asia-Pacific Trade Agreement
ARIP	Agricultural Reforms Implementation Project
ASEAN	Association of Southeast Asian Nations
ATI	Agricultural Training Institute
ATIGA	ASEAN Trade in Goods Agreement
BAC	Bids and Award Committee
BADC	Bangladesh Agricultural Development Corporation
BAFS	Bureau of Agriculture and Fisheries Standards
BAI	Bureau of Animal Industry
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BAR	Bureau of Agricultural Research
BCCSAP	Bangladesh Climate Change Strategy and Action Plan

BDDK	Turkish Banking Regulation and Supervision of Agency
BFAR	Bureau of Fisheries and Aquatic Resources
BFIU	Bangladesh Financial Intelligence Unit
BIMAS	Mass Guidance
BIOMECH	Center for Agri-Fisheries and Biosystems Mechanization
BJRI	Bangladesh Jute Research Institute
BMDA	Barind Multipurpose Development Authority
BOC	Bureau of Customs
BOI	Board of Investment
BPI	Bureau of Plant Industry
BRRI	Bangladesh Rice Research Institute
BSP	Bangko Sentral ng Pilipinas
BSRI	Bangladesh Sugar-crop Research Institute
BSWM	Bureau of Soils and Water Management
BWDB	Bangladesh Water Development Board
CDMP	Comprehensive Disaster Management Programme
CEAT	College of Engineering and Agro-Industrial Technology
CEMA	The European Agricultural Machinery Industry Association
CEPC	China Pakistan Economic Corridor
CEPT	Common Effective Preferential Tariff
CEWRI	Climate, Energy and Water Research Institute
CHED	Commission on Higher Education
CIMMYT	International Maize and Wheat Improvement Center
CIP2	Second Country Investment Plan
CKD	completely knocked down
ÇKS	National Farmer Registration System
CLSU	Central Luzon State University
CNC	computer numerical control
CSAM	Centre for Sustainable Agricultural Mechanization
CSISA-MI	Cereal Systems Initiative for South Asia in Bangladesh –Mechanization and Irrigation
DA	Department of Agriculture
DAE	Department of Agricultural Extension
DBM	Department of Budget and Management
DBP	Development Bank of the Philippines
DEULA	The German School of Agricultural Engineering
DFID	Department for International Development of the UK government
DMB	Disaster Management Bureau
DMMMSU	Don Mariano Marcos Memorial State University

DOST	Department of Science and Technology
DPWH	Department of Public Works and Highways
DTI	Department of Trade and Industry
ECRRP	Emergency Sidr Cyclone Recovery and Restoration Project
EFTA	European Free Trade Association
EPZ	export processing zone
FA	farmers' association
FAO	Food and Agriculture Organization of the United Nations
FDI	foreign direct investment
FFWC	Flood Forecasting and Warning Center
Fis	financial institutions
FMI	Farm Machinery Institute
FMPE	Farm Machinery and Postharvest Process Engineering
FMRDP	Farm to Market Road Development Projects
FMTDDP	Farm Machinery Technology Development and Dissemination Project
FSRP	Financial Sector Reform Program
FTA	Free Trade Agreement
FY	Fiscal Year
GAA	General Appropriations Act
G2G	Government to Government
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GoB	Government of Bangladesh
GOP	Government of Punjab
GST	general sales tax
GNP	gross national product
HMSCs	Hi-Tech Mechanization Service Centres
IAARD	Indonesian Agency for Agricultural Research and Development
IABE	Institute of Agricultural and Biosystems Engineering
IAPP	Integrated Productivity Project
I-BUILD	Intensified Building up of Infrastructure and Logistics for Development
ICSID	International Centre for Settlement of Investment Disputes
IDRA	Insurance Development and Regulatory Authority
IMF	International Monetary Fund
IP	intellectual property
IPARD	Instrument for Pre-Accession Assistance for Rural Development
IPP	Investment Priorities Plan
I-REAP	Investments in Rural Enterprises and Agriculture and Fisheries Productivity

IRRI	International Rice Research Institute
ISPAT	Investment Support and Promotion Agency of Türkiye
I-SUPPORT	Implementation Support to PRDP
JICA	Japan International Cooperation Agency
KGM	General Directorate of Highways
KOICA	Korea International Cooperation Agency
KPK	Khyber Pakhtunkhwa province
LBP	Land Bank of the Philippines
LDC	Livestock Development Council
LGED	Local Government Engineering Department
LGU	Local Government Unit
LLDA	Laguna Lake Development Authority
LLP	low lift pump
MAF	Million-acre feet
MAMI	Modified Agricultural Mechanization Index
MENA	Middle East and North Africa
MIGA	Multilateral Investment Guarantee Agency
MIRDC	Metals Industry Research and Development Center
MNFS&R	Ministry of National Food Security and Research
MoA	Ministry of Agriculture
MoDMR	Ministry of Disaster Management and Relief
MPDP	Multi-Purpose Drying Pavement
MRA	Microcredit Regulatory Authority
NAFC	National Agricultural and Fishery Council
NAFMP	National Agriculture and Fisheries Mechanization Program
NAMP	National Agricultural Mechanization Policy
NAP	National Agricultural Policy
NAPA	National Adaptation Programme of Action
NARS	National Agricultural Research System
NBR	National Board of Revenue
NCTAM	National Center for Testing of Agricultural Machinery
NDRRMC	National Disaster Risk Reduction and Management Council
NEDA	National Economic and Development Authority
NFA	National Food Authority
NGO	non-governmental organization
NIA	National Irrigation Administration
NTC	National Technical Committee
OPIC	Overseas Private Investment Corporation

ORM	operation, repair and maintenance
OTCA	Overseas Technical Cooperation Agency of Japan
PAMIMA	Pakistan Agricultural Machinery and Implements Manufacturers Association
Pankobirlik	Sugar Beet Growing Association
PARC	Pakistan Agricultural Research Council
PCA	Philippine Coconut Authority
PCAARRD	Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development
PCAF	Philippine Council for Agriculture and Fisheries
PCC	Philippine Carabao Center
PCIC	Philippine Crop Insurance Corporation
PCIEERD	Philippine Council for Industry, Energy and Emerging Technology Research and Development
PDB	Power Development Board
PDP	Philippine Development Plan
PGPC	Philippine Geothermal Production Company
PhilMech	Philippine Center for Postharvest Development and Mechanization
PhilRice	Philippine Rice Research Institute
PJABE	Philippine Journal of Agricultural and Biosystems Engineering
PJEPA	Philippines-Japan Economic Partnership Agreement
PPP	Public-Private Partnership
PRDP	Philippine Rural Development Program
PSA	Philippine Statistics Authority
PSDP	Public Sector Development Program
QR	Quantitative Restriction
RAED	Regional Agricultural Engineering Division
RCEF	Rice Competitiveness Enhancement Fund
RDE	Research, Development and Extension
RDA	Rural Development Academy
R&D	Research and development
REB	Rural Electrification Board
ReCAMA	Regional Council of Agricultural Machinery Associations in Asia and The Pacific
RMU	Rice milling unit
RNAM	Regional Network of Agricultural Machinery
RNAM	Regional Network for Agricultural Machinery
RSCC	Rural Supply Cooperative Corporation
SAARC	South Asian Association for Regional Cooperation
SCE	Small cylinder engine
SDB	Specialized Development Bank
SDG	Sustainable Development Goal

SEAM	SCE Assembling and Manufacturing
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SKD	Semi-knocked down
SME	Small and Medium-sized Enterprise
SOCB	State-Owned Commercial Bank
SRA	Sugar Regulatory Administration
SSIP	Small Scale Irrigation Project
STE	Super Trade Enterprises
STW	shallow tubewell
SWIP	Small Water Impounding Project
TARMAKBIR	The Turkish Association of Agricultural Machinery & Equipment Manufacturers
TDA	Thal Development Authority
TESDA	Technical Education and Skills Development Authority
TIFA	Trade and Investment Framework Agreement
TIGEM	General Directorate of Agricultural Enterprises
TIKA	Turkish Cooperation and Coordination Agency
TKK	The Agricultural Credit Cooperatives
TOBB	Union of Chambers and Commodity Exchanges of Türkiye
TÜBİTAK	Scientific and Technological Research Council of Türkiye
Turkstat	Turkish Statistical Institute
UET	University of Engineering and Technology
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UPJA	Agricultural Machinery Service Business
UPLB	University of the Philippines Los Baños
URGE	International Competitiveness Development
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VAT	Value added tax
VNR	Voluntary National Review
VSU	Visayas State University
WARPO	Water Resources Planning Organization
WIPO	World Intellectual Property Organization
WTO	World Trade Organization
Ziraat Bank	Agricultural Bank of the Republic of Türkiye
ZTBL	Zarai Taraquiati Bank Limited

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