OPEN ACCESS

Kashf Journal of Multidisciplinary Research
Vol:01 Issue:11 2024
P-ISSN: 3007-1992 E-ISSN: 3007-200X
https://kjmr.com.pk

IMPACTS OF GREEN REVOLUTION TECHNOLOGIES ON AGRICULTURAL DEVELOPMENT IN SINDH

Bakhtiar Ahmed*
Assistant Professor, Pakistan Studies
The Shaikh Ayaz University, Shikarpurbakhtiar.kubar@saus.edu.pk

Abdul Rahim
Assistant Professor, Pakistan Studies
Benazir Bhutto Shaheed University Lyari, Karachi, Sindh abdul.rahim@bbsul.edu.pk

Ghulam Mustafa Bozdar
PhD scholar, Department of International Relations, University of Sindh, Jamshoromustafa.bozdar@scholars.usindh.edu.pk
***Corresponding author: Bakhtiar Ahmed** (Shikarpurbakhtiar.kubar@saus.edu.pk)*
DOI: *https://doi.org/10.71146/kjmr112*

Article Info

Received: 31st Oct, 2024
Review 1: 1st Nov, 2024
Review 2: 3rd Nov, 2024
Published: 5th Nov, 2024

Abstract

The Green Revolution was the outcome of famous agro-scientist Norman Borlaug and his team's successful development of new dwarf wheat in Mexico during the 1950s that turned within years the country self-sufficient in wheat. These verities were introduced in Pakistan and India in the 1960s and benefited double production within years. The Green Revolution was introduced when Pakistan was under dictatorship with a one-unit governance mechanism. West Pakistan provincial government was controlled from Lahore with a negligible number of officials from Sindh. The impacts of the Green Revolution were impressive and fruitful in Punjab as compared to Sindh. However, a less advantage was available to the farmers and growers for experiencing the advent of new technologies of green revolution. The impact of modified crops, mechanized agriculture and perennial system helped achieve betterment and development. This research is focused to analyzing the impacts of the Green Revolution on the agricultural development of Sindh and the positive and negative effects of pesticides, herbicides, fertilizers, contamination of water, salinity, water logging and climate change. There is a greater need to address the negative effects and strive for better productivity with sustainable planning and improvement for the future.

Keywords: *Green Revolution, Agricultural Development, Economic Growth, and Climate Change.*

Introductions:

The World War II (1939-1945) brought devastation and destruction all over the world. Those countries were the most hit where the war was fought. Apart from the human catastrophe in terms of military and civilians, it crumbled European, Asian and African continents in shortages of food and other commodities which, created a sense of fear among the nations to feed their population. It was not impossible, although very difficult to rebuild and reconstruct. The inflation in debt ridden economic crisis had remained the most difficult task to control. The rising population of the world was also a great challenge to counter in terms of need for food and better lifestyle. Prediction of massive need for food pushed experts to the limits, and an experimental step was taken up to bring huge change in the agriculture for new varieties of grains. Rockefeller Foundation gathered scientists from all over the world by providing necessary funds for carrying out research for High Yielding Varieties (HYV) of crops (Mahesar, 2012, p-81-82). Subsequently, scientists and institutions joined these efforts. Latin American and Asian countries were provided with subsidized technology and guaranteed prices of produces. This project proved effective in introducing new varieties of rice and wheat. Owing to its success it was called "Green Revolution" in 1968 (Robin, 2010 p-308). Agriculture and industry are the two main sectors of development of any country. Rising population and dearth of production of food, posed a challenge to coop-up for the future. World population is anticipated to rise to 10 billion by 2050 (Gellatly & Dennis, 2011). The industrial revolution (Encyclopedia Britannica, 2022) with advent of science and technology proved very useful for the world development extraordinarily. Scientific inventions and cooperative benefits of the revolution were enormous. Manufacturing technology changed the society tremendously but it could not provide food, which is a primary necessity of life to the s introduced novel ways of working and living and fundamentally transformed society. Green Revolution describes new agricultural technologies that dramatically increased food production in the developing world during the middle of the 20th century. The danger of looming famines and sacristy compelled Rockefeller Foundation allocating substantial funding for agricultural advancement and assembled researchers throughout the world (Wu & P-Butz, 2004, pp. 11–38). The initiatives resulted in high-yielding varieties (HYVs) of cereals, especially wheat and rice. It was associated with us of chemical fertilizers, agrochemicals, and controlled water-supply (usually involving irrigation) and newer methods of cultivation, including mechanization. All these together were seen as a 'package of practices' to supersede 'traditional' technology and to be adopted as a whole (Farmer, 1986). Countries like Egypt, Turkey, Vietnam, Thailand, Indonesia and Korea were the beneficiaries of this revolution apart from Pakistan and India. A retrial management faculty member in India opines, many industrialized countries of today once had agriculture their main contributor towards the economy, whereas almost all the developing countries depend heavily on agriculture. In India, still, 28% of national income comes from this sector The GDP share of agriculture in India is 28% while this sector absorbs country's 62% labor force (Praburaj, 2018). About two years before his death Norman Borlaug, the noble laurate agricultural scientist contended insistently to other countries to learn from India and Pakistan and use the

seeds developed there. (Borlaug, 2007 as ref in Fillips, 2014). Fillips further reiterates that at the end of the twentieth century for than 60% of rice produced in developing countries had been the outcome of research institutes, where Pakistan and India stand in top ten countries that grow rice through biotechnology.

Literature Review:

There is an abundance of published literature on Green Revolution. Ameen & Raza (2017) review Green Revolution as a series of research, development, and technology transfer initiatives, occurred in Mexico from mid 40s to late 70s. These initiatives involved the development of high-yielding cereal grains, expansion of irrigation infrastructure, and distribution of hybridized seeds, synthetic fertilizers, and pesticides. Farmer (1986) views key elements of the Green Revolution include: latest technological and capital inputs, scientific methods of farming, use of high yielding varieties of seeds, chemical fertilizers, consolidation of land holdings and use of various mechanical machines. Farmer credits Ford Foundation and Rockefeller Foundation for involvement in initial developments of these technologies in Mexico. According to Robin (2010 p-308) Henry Wallace, Vice president of the United States of America, who was also co-founder of "Pioneer Hi-Bred International Inc" which also developed hybrid corn, had offered "scientific mission" for increased production of wheat in Mexico in 1943. Owing to its success, the research project was named 'International Maize and Wheat Improvement Center' in Mexico City in 1965. A number of studies (Bharadwaj et al., 2020; Framer, 1986; Stevenson et al., 2013 & Von der et al., 2020) conducted at different times reveal that the Green Revolution contributed extensively reducing poverty and prevented hunger for millions of people and the other species as well. Adoption of Green revolution increased earnings and profits not only at individual but at corporate level as well. Utilization of renewed technologies helped in reduction of greenhouse gases and the maximum land was utilized for agricultural purposes. Moreover, increased yield of crops was detrimental in decline of infant mortality too. Hussain (2012) assesses Green Revolution technology at an increase of three-fold output of food grains between 1967 and 1992 in Pakistan which boosted economic growth owing to timely utilization of High Yield Variety (HYV) of seeds, chemical fertilization and availability of sufficient irrigation water. According to the understanding of Khan (1983) Sindh has benefited agricultural growth through Green Revolution between the period from 1964-65 and 1974-75. The Indus basin, which includes almost all of Sindh where, large farmers have had greater access for water, fertilizers, hired labor, and machines (tractors/threshers and bulldozers) as compared to small farmers who, adopted the package of technology with regard to water, seeds and fertilizers very late. Mahesar, Shuja (2017) opined that Green Revolution brought enormous increase in crop production and major tracts of inarable land came under cultivation due to utilization of agricultural machinery and water management which, took less time consuming, helped level the land and abandoning the use of oxen or camels driven Persian wheels for-uplifting the water to a higher level from 6 to 10 feet for irrigation of land. It brought great level of social change in the rural Sindh and provided extra food which culminated into new avenues of development in industrial sector as well. The main inputs of the Green Revolution were the HYV seeds, fertilizers, pesticides, irrigation and agricultural mechanization. It had great impact on agricultural growth as it is the prime source of income in Pakistan. It engages about 42% of the labor force, as 67.5% population lives in rural areas remain associated with agriculture for their income. Furthermore, it is about 23% of the GDP. The biotechnology improved the agriculture productivity as well (Khan & Gul, 2013). Gaud (1968) opined for record yields through harvests of unprecedented size and crops in the developing world, viewing Pakistan's harvest of wheat from an estimated 3.5 million acres. They will bring in a total wheat crop of 7.5

to 8 million tons - a new record as compared a year earlier to a harvest of 0.6 million acres which could provide an excellent chance of achieving self-sufficiency in food grains in another year. India increases dramatically her wheat crop yield to 6 million tons just from 0.7 million acre in a year and plans for enhancement of plantation of high-yield varieties of rice, sorghum, and millet to 10 million acres, which was a path to self-sufficiency in food grain. Indian cereal produce saw a higher curve to 33% from 70 million tons to 93 million tons in the 60s (Bharadwaj et al (2020). The impact of Green Revolution in India effected the production of food grains hugely and in 1976-77 the country hardly resorted to imports except occasionally (Swaminathan & Bhavani, 2013). Turkey too has raised yields by two and three times in 1968 and set up new record of production in 1968 as compared to yields of 1965. Philippines planned to harvest more rice with new high yielding seeds and achieved self-sufficiency in rice as well. Referring to the agricultural developments as a new revolution, Gaud pointed out that it's neither Red Revolution nor a White Revolution but, I say it's a Green Revolution (Gaud, 1968).

Research Methodology:

The data for this paper has been drawn from both qualitative and quantitative researches. Data collection relies mostly from secondary sources and quantitative data has also been included in forms of tables and graphs. Secondary data is used as existing data to find answers to research questions (Long-Sutehall et al. 2010). Secondary data is very useful in defining data collected by someone other than the user, in other words, secondary data refers to the data, that have already been collected. Such data may be very convenient and beneficent for one's research purposes (Allen, 2017). Secondary data includes any data formerly collected and considered to be used by others researchers for finding answers to new questions. It may have been collected originally for any other investigations too (Vartanian, 2010). A number of people were also contacted for obtaining primary data. Primary data are collected by the researchers directly from respondents for particular questions or propositions. It can be collected in-person or through telephonic interviews, emails with open-ended or focused questions ensuring to collect comprehensive and reliable data. This method has the advantage of being able to address a purposeful study (Kornegay & Segal, 2013). Moreover, in-depth interviews are very useful for obtaining thorough information about the inquiry (Boyce & Neale, 2006). Interviewing is the most common format for obtaining and gathering data in qualitative research (Jamshed, 2014).). Unstructured and open-ended interviews are the appropriate method for data collection that allows respondents to express freely for providing information to the researchers (Corbin & Morse, 2003). Many research methods have been developed to explore an in-depth and extensive understanding of an inquiry or investigation. The most common types are interviewing and observation (Creswell, 2007). Keeping these studies in view, interviewing the respondents was found a better option. Selection of respondents was made through purposive sampling method, also known as judgmental or non-probability sampling. By selecting this group of people, the researcher knew well that the respondents were well acquainted with the topic or the inquiry in hand. Respondents who have small and big landholdings were contacted for interview concerning this research. Members of growers' organizations and associations were also interviewed. Officials from Government of Sindh, department of Agriculture Engineering, Extension, Research and department of Livestock were contacted for interviews about Green Revolution. Before questioning them they were informed that their answers would be used in this research, so their telephonic conversations would be recorded and later transcribed and referred to in this research. Many officials denied recording of their telephonic interviews, but provided some information which was not discarded being authentic as the respondent wanted to remain unidentified. The questions during the course of interview were open-ended and the respondents were allowed maximum time to complete their points. Interviewing is a

qualitative research technique for contact with respondents to explore the requirement of the researchers.

Impact on the Agriculture of Sindh:

According to Pakistan Bureau of Statistics, agriculture constitutes the largest sector of the economy as majority of the population is dependent on agriculture directly or indirectly and contributes about 24% gross domestic product (GDP) where half of the country's labor force is employed. Agriculture is an important sector of Pakistan's economy and directly supports the country's population with a 26% gross domestic product (GDP) of the economy (Rehman et al, 2015). Whereas in other report published by the Ministry of Finance, the gross domestic product share of agriculture towards economy of Pakistan is 18.9% and the agriculture sector engages about 43.2% of country's labor force[1]. The agriculture sector share to the GDP has declined from 53.2% in 1953 to 18.9% as recorded by Pakistan Economic Survey for the years 2017/18 mainly with the development of modern industry and service sectors in Pakistan (Joyo et al. 2020).

Policy makers at agricultural and financial level must consider augmentation of crops like pulses, onion, mango, banana, maize, tomatoes and chilies for profiting in foreign exchange. Mostly these crops are considered domestic consumption but extra production could increase economic importance[2]. The reservoir of large data about Green Revolution has been presented in a PhD thesis limited to district Khairpur Mirs, Sindh, which provides sufficient knowledge about development in agricultural sector and elevation of life style of the inhabitants and farmers as well (Mahesar, 2012). In 1947, agriculture was the dominant sector of the economy. The contribution of the Agriculture Sector to the Gross Domestic Product (at constant prices), though declined gradually since Pakistan came into being from a level of over 59.9% in 1949-50 to 24.5 in 1996-97, it still remains the major source that, generates revenue for Pakistan. Table-1 below shows the peak point of earnings for the country and its gradual decline due to industrialization of the country on her golden jubilee.

Table.1 Share of Different Sectors in GDP (Percent)

Items	Years				
	1949-50	1969-70	1979-8-0	1989-90	1996-97
Agriculture	59.9	39,90	29.6	25-8	24.5
Manufacturing	5.8	16.9	17.0	17.6	18.1
Construction	-	4.2	-	-	3.9
Elect. & Gas Distribution	-	2.0	-	-	4.1
Wholesale & retail Trade	12.0	24,9	15.0	165	16.2
Public Administration. & Defence	4.3	6.4	10.0	7.3	6.4
Transportation, Storage & Communication	5.0	6.8	7.0	9.5	9.6
Ownership of Dwellings	-	3.4	-	-	5.7
Others	13.0	7.3	22.0	23.3	11.5
Source: Federal Bureau of Statistics. Accessed through: www.pbs.gov.pk/sites/default/files/50-years-statistics/vol1/6.pdf					

[1] Accessed on 23 Apr from http://www.finance.gov.pk/survey/chapters_18/02-Agriculture.pdf

[2] Accessed on 23 Apr 2022 from https://www.pbs.gov.pk/content/agriculture-statistics

Agriculture is essential for sustainable improvements in internal and external balances. The total export earnings, the share of primary commodities, processed and semi processed constitute almost 76% of the total exports. The structural changes from time to time have not affected the agricultural products largely. Agriculture is very important for industrial development as well. Out of five hundred industrials units of Pakistan, 58% are based on agricultural supplies. This indicates that agriculture is backbone of the country's economy. The agricultural products export is about 17.0 % that include crops of rice, cotton, citrus fruit, dates, mangoes and sugarcane molasses. Whereas, the agricultural imports comprise almost the same figure of 16.7% that include crops of wheat, pulses, sugar, black tea, soyabean and palm oil. It creates improvements in internal and external balances greatly. The population of livestock, which forms a sub-sector of agriculture in Pakistan consist of 23.34 million buffaloes, 22.42 million cattle, 24.24 million sheep, 49.14 million goats and 0.77 million camels (Afzal & Naqvi, 2004). The animals produce milk, meat, wool, hair, hide and skin. Pakistan has 165.51 million animals which, contribute 13.4% towards GDP (Rehman et al, 2017). On the other hand, the fish industry in Pakistan contributes a negligible 0.4% of GDP, which just earns US$350 million, supposed to be very nominal earnings (Mohamedi, 2021). With such a great economic wealth, self-sufficiency in food production in Pakistan is still a nightmare. However, the ranking position in agricultural produces at the world stage describes that Pakistan ranks in first ten countries that yield production in different categories presented in Table-2 shown below.

Table-2 Production and Ranking of Pakistan in the World

Serial	Item	Produce	Ranking
1.	Milk	29.472 million tons	4th
2.	Sugarcane	67.1 million tons	5th
3.	Cotton	4.8 million tons	5th
4.	Mango	2.3 million tons	5th
5.	Onion	2.1 million tons	6th
6.	Dates	0.471 million tons	6th
7.	Wheat	25.0 million tons	7th
8.	Rice	10.8 million tons	10th
Source: FAO, UN Pakistan's production based on the year 2018. https://www.fao.org/faostat/en/#data/QCL			

Sindh is a second largest agricultural sector producer and contributor towards Pakistan's GDP after Punjab as reported in almost all statistics, reports and information gathered, processed or managed at Pakistan Bureau of Statistics. Sindh was a highly advanced urban civilization in the form of Mohen-jo-Daro had a large agricultural surplus product and had settled agriculture for at least 2,000 years prior to the maturation of the Harappan culture (Ahmed, 2004).

The ancient urban society of Mohen-jo-Daro was divided into several classes and strata (Wheeler, 1960: 57). This provides evidence that early peasantry more than 5000 years was functioning there. The land was owned and administered by the priesthood of the great temple and had hold over the peasants, who used to give up their surplus (Kosambi, 1970, pp. 69-70.). The decline of Indus Civilization loosened the hold of urban class on the peasantry. The settlement of Indo-Aryan tribe's patterns observed elsewhere in present day Pakistan and western India, established land tenures. The tribes of Jat and Rajput cultivated land collectively (Ahmed, 2084). The fertile lands rich in produces were the intimidation of Arbs to conquer Sindh. Dependency of revenue was from agricultural produces and its trade. There were skilled people who were experts in different fields and river Indus was the main source of life to the people of Sindh. The dynastical era after Arabs was of Soomras, Samma Jams, Kalhoras and Talpurs (GoS, 2022). They all were natives and worked for the uplift of their subjects. Kalhoras distributed large areas of land in the form of Jagirs to different clans and castes of influence and showed strength. There has been a period of non-natives of Arghuns and Tukhans which was tyrannical and oppressive rule witnessed by the history (Shah, 2016; Naz, 2019). Sindh lost her independence again and remained subjugated by the British rule from 1843 to 1947 (Shaikh, 2021). This period seen allotment of large land tracts as reward to the people in return of loyalty to the British. The British introduced a chair ship among land holders and people of religious cult. There had been competitions of loyalty among the chair ship parwana (permission) holders. However, British took efforts for cultivation of more land in Sindh for revenue augmentation. The land distribution to farmers was very low and the land allotment size of the middle-level farmers between 5-25 acres and above from 25 up to 100 acres was very higher. It indicates that, the British did create of class of middle level farmers or land holders. Table-3, taken from Gazetteer of Sindh of 1907 shows land distribution and holding sizes. It indicates fertility of agricultural land even much more before the construction of Sukkur Barrage, built during the period from 1923 to 1932.

Table-3. Size Distribution of Land ownership-holdings, Sindh-1903-04

Size	**Holdings**	
Acres	**Number of land holders**	**Percentage**
Under 5	37,680	24.3
5-25	74,016	47.8
25-100	31,898	20.6
100-500	9,530	6.2
500 and above	1,801	1.2
Total	154,925	100
Source: Gazetteer of the Province of Sindh, 1907. p-4l4		

Barrages in Sindh:

The Sukkur Barrage brought big change in the agriculture of Sindh. It was supposed the pride of Sindh's irrigation system, later Pakistan, as it is the largest single irrigation network of its kind in the world. It had command area of about 7.8 million acres, out of which 4.6 million acres land was distributed to different people. It also created a landlord class in Sindh. Large tracts of land were allotted for settlement purpose to make the best utility of this mega construction of the era. During the British rule people of other provinces were also allotted lands for cultivation and different settlements were established. After independence much of the remaining land was allotted to migrants from other parts of India to Sindh who settled in different cities along the railway track from Sukkur to Karachi. However, majority of the migrants settled in Karachi, which brought a great demographic change. Land ownership had risen from 154,925 in 1947 to 10,285,021 and a greater rise in landownership was observed in 1976 to 11,684,000. This again indicates fertile lands of Sindh and extraordinary production of wheat, cotton, rice and millets (Ahmed, 1984). Later construction of Kotri Barrage and Guddu Barrage of Indus River brought enormous land under cultivation.

The enquiry of Karim and Bindra about the three barrages in Sindh over Indus River (namely Guddu, Sukkur and Kotri) conclude that, theses barrages divert approximately 59 billion m^3 (A cubic meter (m^3 or CBM) is a just another way of saying a block of space that measures 1m x 1m x 1m, height x width x depth) of water annually to the 14 main canal commands. These canal systems have an aggregate length of 21,445 km, which serve a gross command area (GCA) of 5.6 million ha. There are about 42,000 watercourses (tertiary channels), which have an aggregate length of about 120,000 km. Around 78% of the area in the Province of Sindh is underlain by saline groundwater, which is unsuitable for irrigation. Surface and sub-surface drainage systems are inadequate, resulting in much of the drainage effluent being either retained in the basin or disposed into the rivers and canals. There are 13 existing surface drainage systems in Sindh, which serve a total area of over 2.5 million ha and have an aggregate length of about 6,133 km. In addition, there are two sub-surface drainage systems, which serve an area of 0.04 million ha (Karim & Bindra, 2016).

Introduction of agricultural technologies under Green Revolution made tremendous headway in production of wheat and rice crops. Other crops like sugarcane and mangoes got momentum. Sugarcane saw a rapid rise in production and Sindh has now about 40 sugar mills. Sindh contributes USD 99 billion towards GDP of Pakistan after Punjab that has a share of USD 199 billion. The contribution towards GDP of Pakistan is summarized in the Table-4, which shows provincial or area wise figures.

Table-4. Estimated figures of GDP of Pakistan as of 2022

Administrative Unit	GDP (Billion USD)	GDP per capita (USD)
Punjab	190	17,27
Sindh	99	2,000
Khyber Pakhtunkhwa (including former FATA	30	875
Balochistan	15	1,062
Azad Jammu and Kashmir	8	1,691
Islamabad (ICT)	5	6,363

Gilgit Baltistan	4	2,722
Pakistan (GDP)	**347 billion**	**1,670**

Source: imf.org › datamapper › PAK World Economic Outlook (October 2020) - Real GDP growth - International Monetary Fund.

Note: IMF has predicted Pakistan's per capita GDP up to 2022 at USD 1,727 as shown above, While World Bank has shown it at USD 1,188.9 up to year 2020. Accessed on 23 Apr 2022 from: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=PK

In a report from Pakistan Bureau of Statistics, it has been presented that the agricultural sector is constantly at decline and industrial and services sectors are increasing. Table- shows these figures from the years 2000 up to 2021.

Table-5. Sectoral Shares % in GDP (at constant basic prices)

Sectors	FY 2000	FY 2005	FY 2010	FY 2015	FY 2020	FY 2021
Agricultural	27.08	23.98	22.03	20.71	23.54	23.08
Industrial	19.31	21.34	21.04	20.67	18.52	18.91
Services	53.61	54.68	56.93	58.61	57.93	58.01
Source: https://www.pbs.gov.pk/sites/default/files//tables/rename-as-per-table-type/Table_7a.pdf						

Whereas, in another data published by State Bank of Pakistan, the figures of the above sectors have been paced differently. Table-6 below shows the figures which differ from that mentioned in Table-5 above.

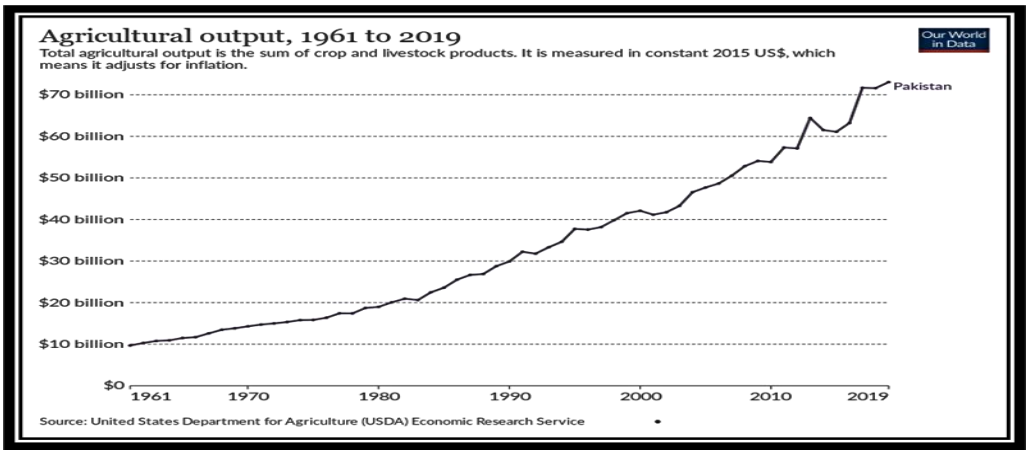
Table-6. Sectoral Share in Gross Domestic Product

Sectors	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021*
Agricultural	19.84	19.27	18.99	18.70	19.41	19.19
Industrial	2-.90	20.77	20.58	19.8.	19.19	19.12
Services	59.26	59.97	60.43	61.45	61.39	61.68
https://www.sbp.org.pk/departments/stats/pakEconomy_HandBook/Chap-1.2.pdf						
***Figures for the financial year 2021 have been shown as provisional.**						

The benefits and profits of Green Revolution are contended heavily in a PhD thesis by Shuja Ahmed Mahesar at University of London titled "Economic and Social Change in Khairpur 1947-1980 (Mehesar, 2012). As it was

limited to the district of Khairpur only, but it could be replicated contending the impacts of Green Revolution in other parts of Sindh. This research takes excessive toll of academic knowledge and information from it as well. The introduction of Green Revolution in Pakistan in 1967, saw tremendous increase in crop outputs (Gaud, 1968). This revolution needed structural changes in manual form work and utilization of newly developed seeds. Construction of three barrages on the river Indus brought large tracts of land under cultivation. There was a greater need for new equipment and machines to benefit from the development of agricultural sector. It brought social change enhanced earnings of large landholding growers but small growers did benefit from it too. Agricultural Machinery replaced the centuries old oxen driven land cultivation. Mechanization paved the way for establishment of new workshops, repairing centers, welding shops and small agro-based industrial units in rural areas and offered jobs for non-agricultural workers as well. Heavy machinery and technical equipment were costly to utilize as it was imported on excessive costs but the technology brought changes in farming patterns. Mechanization also relieved the farmers from heaviest labor and time to harvest the crops. Bulldozers and tractors helped easily in removing wild grass and bushes to bring the land under cultivation. Mechanical equipment helped farmers complete their work on time and increase waste lands under cultivation. It contributed social and cultural transformation. Punjab was the major beneficiary from the new technologies. Sindh, a pioneer of irrigation system of canals and water-courses uplifted farmers poverty and they earn more through cash crops of cotton, maize, rice and sugarcane brough monetary benefits while wheat and rice to some extent provided enough security for food. Economic prosperity allowed people to construct backed bricks houses replacing mud houses. The post barrages period with Green Revolution in place people were able to buy new things for household and cultivation. According to Mahesar, the farmers were provided with chemical fertilizers and pesticides for increasing produce and decreasing pest attack on crops. Fertilizer like urea was available at Rs 26 and Di-ammonium Phosphate (DAP) Rs 28 per bag of 50 Kg at the beginning which has risen tremendously and is touching Rs.3000 and DAP Rs 10,000/- per bag of 50 Kg. It allowed cultivators/farmers leisure time and they could rest for a while and enjoy. It helped in poverty reduction and poor farmers changed their social and economic conditions. The agricultural outputs created new market centers and need aroused for communication facilities (Mahesar, 2012, p. 187). Newly constructed road networks provided easy access to farmers for selling their products in the markets. Lifestyle was changed and non-farming people turned to agro-based businesses. Therefore, Green Revolution offered an opportunity to increase agricultural productivity and it enabled farmers to use available resources in a productive manner. Green Revolution triggered unprecedented technological and economic transformation and growth in Pakistan's agriculture sector. A data obtained from United States of America (USA), Department of Agriculture and Economic Research has figured out Pakistan's agricultural output more than USD 70 billion up to the year 2019. The data is shown in Table-7 below.

Table-7. Agricultural output 1961 to 2019



Government of Sindh has a robust agricultural management system where different institutes and organizations assigned tasks and responsibilities for facilitating crop production. Major crops on the command areas of all the three barrages are wheat, cotton, rice and sugarcane. Furthermore, under the 18th Amendment of Pakistan's Constitution (July 2010) introduced devolution of many government services, including agriculture, to the provinces. The Government of Sindh has highlighted commercial agriculture and market linkages as priority investments for the sector through different institutions like Sindh Agricultural Growth Project (SAGP), Sindh Irrigated Agriculture Productivity Enhancement Project (SIAPEP).

Institutions in Sindh that transform development:

Following departments/institutes have played a vital role in development of agricultural atmosphere:

1. **On farm water management directorate.** It facilitates growers to increase production with better use of water through lining of watercourses and with latest technologies with drip irrigation system.
2. **Agriculture Engineering, Directorate.** It was established to level the arid land tracts It provides heavy machinery, especially bulldozers to growers on formidable prices. Post and pre-Green Revolution period witnessed development of agricultural activities for sowing different crops in whole of Sindh.
3. **Agriculture Research Sindh** has been playing significant role for introducing new varieties of crops and works on development of sustainable seeds that help farmers to achieve greater production. Technological advancement and collaboration have enhanced the capacity of the farmers for better management of their crops as well.
4. **The Planning and Monitoring Cell** was established 1979 to provide agricultural project planning, monitoring and evaluation. FAO has also collaborated with this cell for improvements and better management of services to the farmers.
5. **Cane Commissioner** established in 1984 to monitor cane development and control sugar mills and saving the growers from any misconducts by the sugar mills owners.
6. **Agricultural Extension** provides advocacy and help to farmers for improving their capabilities by adopting agricultural innovation. This service is available in almost all districts.

7. **Sindh Seed Corporation** was established in the wake of Green Revolution and enhancing the capability of farmers by providing them certified seeds. It opened seed centers in very fertile districts for easy access by farmers. It worked well but owing to inabilities this corporations has collapsed.
8. **Sindh Agriculture University** is an academic and research hub of Sindh for agriculture and livestock was established in 1977 at Tandojam to equip the youth of Sindh with agricultural education in science and technology from graduation to doctoral level. The university has been at its best from its establishment till today. It is pertinent to mention that it has attracted female students from graduation to doctorate in Agricultural and Veterinary sciences as well.
9. **Shaheed Benazir Bhutto University of Veterinary & Animal Sciences** is an academic instructions, research and development of veterinary and animal sciences through modern systems of veterinary and animal sciences and its allied sciences.
10. **Cattle Farms.** There are five cattle farms with a formidable number of animals established prior to the Green Revolution under the Ministry of Livestock and Fisheries. The aim was to carryout scientific research for breeding and cross breeding experiments for increase in milk productivity and maintenance of original characters and to maintain the purity of Sindhi cattle breed. Demonstration of experimental dissemination to farmers for improvement of their livestock. These farms are located at Malir, Karachi (Red Cow), Tando Muhammad Khan (Red Cow), Nabisar Road (Thari White and Grey Cow), Rohri (Kundhee Buffaloes) and Khudabad (Kamori Goats).

Since, the above institutes show betterment of agricultural activities in government files, but on the contrary the growth has started to decline. The 21.6% GDP from agricultural sector is being viewed as diminishing. More recently, agriculture's contribution to Pakistan's GDP has declined; however, it still accounts for 21.6%. The 81% of agricultural GDP comes from Punjab and Sindh. The productivity of agriculture could be enhanced with the better management and maintenance of regulations pertaining to revenue and irrigation department. Reasons for this decline is attributed to negligence and malpractices by the Revenue and Irrigation departments. If, government takes proper action against theft of water and maintains tougher attitudes towards substandard fertilizers and pesticides which instead decrease crop production. The crops could increase produce but blind eye of agriculture department has rendered small farmers in difficulty which invariably leaves them to despair (I, Bozdar. personal comm, March 29, 2022). He further reiterated that agricultural output could go to next high with canal and water courses modification and leaving sanctioned water for utilization by the farmers. An official from the Agricultural Extension department (name withheld) confessed that we are not authorized to seal the artificial pesticide and fertilizer dealer shops. Even the dealers possess very less or no knowledge or skills about crops and sowing seasons. This increases the agony and suffering of farmers. The malpractices and decreasing the sanctioned water through manipulated rotation practices on distributaries and water courses have limited the farmers to cultivate more land and, in many instances, it has been observed that the farmers have prepared the land, sowed the seeds but after that, they are deprived their share of water by one way or the other from the irrigation officials. These instances leave farmers to abandon the crop and they run into debt (M. Mureed, personal comm, April, 15, 2022). The increase in farm output is

not a single person's job. There many persons and departments of government involved who care for the farmers for producing better results. The new technologies through Green Revolution provided the manual cultivation methods a chance to modernize farming even to small landholders (M, Shah, personal comm, March, 18, 2022). Sufficient planning and monitoring of Fisheries and Livestock farms can generate huge revenue to the department and it may even not ask the government for funds to run the department. The department could emerge self-sufficient. Its dividends could be far reaching and may lead to improvement in the cattle sector and provide better earning to the rural population who own a small number of animals. Medical treatment to cattle owners at the farms or villages will enhance their confidence and it would facilitate control of animal diseases (G. Jiskani, personal comm, March 19, 2022). Agriculture and Livestock sector have flourished and private farms have appeared in to be beneficial for their owners. Sustainable efforts at all tiers of hierarchy would increase productivity and efficiency in terms of outputs.

Conclusion:

American scientist Norman Borlaug was entrusted with development of new seeds of wheat which could produce high yields. He started his experiments on wheat in Mexico during the 1950s. Rockefeller Foundation gathered scientists from all over the world by providing necessary funds for carrying out research for High Yielding Varieties (HYV) of crops. The experiments were successful and an increase was observed in Mexico in wheat production. Later, experts from other countries joined for research in development of wheat and maize varieties. The administrator of USAID in 1967 termed this development as Green Revolution. This technology later was provided to other countries. South Asia was the recipient of this technology as well. Pakistan and India both experimented and introduced new varieties of wheat. In Pakistan it was introduced in 1967 and within a year cultivated area rose manyfold. The impact of modified crops, mechanized agriculture and perennial system helped achieve better results in crop production. The development in agricultural infrastructure brought more and more land under cultivation. The impacts of green revolution on the agricultural development of Sindh had positive and negative effects of pesticides, herbicides, fertilizers, contamination of water, salinity, water logging and climate change. There is a greater need to addressed the negative effects and strive for better productivity with sustainable planning and improvement for the future.

The green revolution period increased surface water availability, installation of tube-wells and import of machinery like tractors, threshers, bulldozers, spray machines brought greater development. Sowing of high yielding varieties of seeds with ample use of fertilizers for crop sustainability and use of pesticides increased agriculture productivity. Farmers were lured through subsidiary measures for adopting new technologies. The technological improvements effected agricultural sector and it grew tremendously. Agriculture and industry are the two main sectors of development of any country. Rising population and dearth of production of food forms a challenge to coop for the future. The top agriculture producing provinces in Pakistan are Punjab and Sindh, which account for 81 per cent of agriculture GDP. Poverty was higher in rural area and lower in urban centers of the country. It decreased with the advancement of newer technologies and microfinance which allowed poorest farmers chances for getting better life. Green Revolution effected poverty at a greater level. It could also be reduced by the government with implementing water management and bringing more arid land under cultivation.

References:

[1] Afzal, M & Naqvi, A. (2004). Livestock Resources of Pakistan: Present status and future trends. *Quarterly Science Vision*, 9(1-2)

[2] Ahmed, F. (1984). Agrarian change and class formation in Sindh. Eco*nomic and Political Weekly*, 19(39), A149–A164. http//www.jstor.org/stable4373620

[3] Allen, M. (2017). *The sage encyclopedia of communication research methods* (Vols. 1-4). Sage. http//doi: 10.4135/9781483381411

[4] Ameen, A & Raza, S. (2017). Green Revolution. A review. *International Journal of Advances in Scientific Research*, 3(12), 129-137.

[5] Bharadwaj, P., Fenske, J., Kala, N., & Mirza, R. A. (2020). The Green revolution and infant mortality in India. *Journal of Health Economics*, 71, 102314. https://doi:10.1016/j.jhealeco.2020.102314.

[6] Boyce, C & Neale, P. (2006). *Conducting in-depth interviews: A guide for designing and conducting in-depth interviews for evaluation input*. Pathfinder international tool series monitoring and evaluation series. Accessed on 23 Apr from https://nyshealthfoundation.org/wp-content/uploads/2019/02/m_e_tool_series_in depth_interviews-1.pdf.

[7] Britannica, T. Editors of Encyclopedia (2022, March 13). Industrial revolution. *Encyclopedia Britannica*. https://www.britannica.com/event/Industrial-Revolution

[8] Corbin, J. & Morse, J.M. (2003). The unstructured interactive interview: Issues of reciprocity and risks when dealing with sensitive topics. *Qualitative Inquiry*, 3(3), 35-54.

[9] Creswell, J.W. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. Sage.

[10] Farmer, B. H. (1986). Perspectives on the 'Green Revolution in South Asia. *Modern Asian Studies*. 20 (1): 175–99. http//doi:10.1017/s0026749x00013627

[11] Gellatly, K & D.T.Dennis, D.T. (2011). Plant Biotechnology and GMOs. *Comprehensive Biotechnology*, Vol. 4, pp-9-22. https://doi.org/10.1016/B978-0-08-088504-9.00272-5.

[12] GoS, (2022). *History of Sindh.* Government of Sindh https://www.sindh.gov.pk/history#:~:text=The%20British%20had%20conquered%20Sindh,minority%20in%20Sindh%20was%20followed.

[13] Guad, W.S. (1968). *Address to the Society for International Development by Administrator USAID on March* 8, 1968. Retrieved on Apr 30 from http://www.agbioworld.org/biotech-info/topics/borlaug/borlaug-green.html.

[14] Hussain, A. (2012). The Green Revolution. In Aysha, J. (ed), *The Oxford Companion to Pakistani History*. Oxford University Press, Karachi

[15] Jamshed S. (2014). Qualitative research method-interviewing and observation. *Journal of basic and clinical pharmacy*, 5(4), 87–88. https://doi.org/10.4103/0976-0105.141942

[16] Joyo, AA; Jariko, G.A & Channa, Z.H. (2020). Impact of Green Revolution policy on rural poverty in Pakistan: A Case Study of District Shaheed benazirabad Sindh. Pak. *J. Agri., Agril. Engg., Vet. Sci*., 2020, 36 (1): 34-41. Accessed on 23 Apr from https://doi.org/10.47432/pjaaevs.2020.36.1.6.

[17] Karim, M. M. & Bindra, N. (2016). Cumulative impact assessment for Sindh barrages. *Impact Assessment and Project Appraisal*, 34(4), 346–358. doi:10.1080/14615517.2016.1228341.

[18] Khan, M.H. (1983). Green Revolution and redistribution of rural incomes Pakistan's Experience. A Comment. *The Pakistan Development Review*, 22(1). pp_47_56

[19] Khan, M.Z. & Gul, H. (2013). Impacts of Green Revolution variables on agriculture productivity in Pakistan. *Sarhad Journal of Agriculture*, 29(3), 45-460.

[20] Kornegay C, Segal, J.B. (2013). Selection of data sources. In: Velentgas et al., (Eds.). *Developing a Protocol for Observational Comparative Effectiveness Research: A User's Guide*. Rockville (MD): Agency for Healthcare Research and Quality (US). Chapter 8. Available from: https://www.ncbi.nlm.nih.gov/books/NBK126195/

[21] Kosambi, D.D. (1970). The Culture and civilization of ancient India in historical outline. Vikas Publishing House.

[22] Long-Sutehall, T., Sque, M., & Addington-Hall, J. (2010). Secondary analysis of qualitative data: a valuable method for exploring sensitive issues with an elusive population? *Journal of Research in Nursing*, 16(4), 335–344. doi:10.1177/1744987110381553

[23] Mahesar, S.A. (2012). *Economic and Social Change in Khairpur* 1947-1980. PhD thesis. University of London.

[24] Mahesar, S.A. (2017). *Impact of Green Revolution in Sindh. Paper presented in 1st International Conference on Sindh Studies arranged by Institute of Sindhology*. University of Sindh, Jamshoro held from 21-22 November 2017.

[25] Mohamedi, M. (2021). *Pakistan needs to evolve ways to increase fish export*. Accessed on 23 Apr 2022 from Daily the News (November 19, 2021). From https://www.thenews.com.pk/print/909861.

[26] Naz, H. (2019). Sindh under the Mughals. Some glimpses from Tarikh-i-Masumi and Mazhar-i-Shahjahani. *Pakistan Perspectives*, 24(2), 12-23.

[27] Phillips, R.L. (2014). Green Revolution past, present, and future. *Encyclopedia of Agriculture and Food Systems*, Vol 3, 529–538. https://doi: 10.1016b978-0-444-52512-3.00208-4

[28] Praburaj, L. (2018). Role of Agriculture in the economic development of a country. Shanlax *International Journal of Commerce*, 6(3), 1-5. https://doi: 10.5281/zenodo.1323056.

[29] Rehman, A., Jingdong, L., Chandio, A. A., & Hussain, I. (2017). Livestock production and population census in Pakistan: Determining their relationship with agricultural GDP using econometric analysis. *Information Processing in Agriculture*, 4(2), 168–177. https://doi: 10.1016/j.inpa.2017.03.002

[30] Rehman, A., Jingdong, L., Shahzad, B., Chandio, A. A., Hussain, I., Nabi, G., & Iqbal, M. S. (2015). Economic perspectives of major field crops of Pakistan: An empirical study. *Pacific Science Review B: Humanities and Social Sciences*, 1(3), 145–158. http//doi: 10.1016/j.psrb.2016.09.002

[31] Robin. M.M. (2010). *The World According to Monsanto. Pollution, Corruption and the Control of Food Supply*. The New Press.

[32] Shah, B. (2016). Sack of Nagar Thatta and Arghoon rule of Sindh in Medieval period. *Research gate*. https://www.researchgate.net/publication/341066202.

[33] Shaikh, M.A. (2021). History: The British conquest of Sindh. *Dawn News*. https://www.dawn.com/news/1655098

[34] Swaminathan, M. S., & Bhavani, R. V. (2013). Food production & availability--essential prerequisites for sustainable food security. *The Indian journal of medical research*, 138(3), 383–391.

[35] Vartanian, T. P. (2010). *Secondary data analysis*. Oxford University Press.

[36] Wheeler, R E M. (1960). *The Indus civilization*. Cambridge University Press.

[37] Wu, F., & P.Butz, W. (2004). *The Green Revolution. In the future of genetically modified crops lessons from the green revolution*. RAND Corporation. https//www.jstor.org/stable10.7249mg161rc.11.