Journal of Natural Science Review

Vol. 2, Special Issue, 2024
https://kujnsr.com
e-ISSN: 3006-7804

# Implementing a Sustainable Green Revolution Strategy for Comprehensive Economic Development in Afghanistan

**Safiullah Jauhar**

Department of Food Technology, Faculty of Agriculture, Kabul University, Kabul, Afghanistan

✉Email: safijauhar@gmail.com (corresponding author)

## ABSTRACT

Implementing the Sustainable Green Revolution Strategy in Afghanistan is thoroughly examined in this paper, focusing on how it might boost food security and promote economic growth. The fact that agriculture employs 61.6% of the workforce and accounts for roughly 23% of the country's GDP highlights the importance of this sector to Afghanistan's economy. To ensure greater output while protecting biodiversity, the study presents the idea of "Green Revolution 2.0," which aims to modify past agricultural advances to Afghanistan's particular socio-economic and environmental challenges. Significant prospects for agricultural development are noted, such as various climates, foreign assistance, and the involvement of young people. The paper also discusses urgent issues like poor infrastructure, budgetary limitations, and how climate change affects agricultural productivity. A successful implementation approach is suggested, emphasizing education, climate-smart agriculture, credit availability, and infrastructure development. A Gantt chart involving stakeholders, including the Afghan government, non-governmental organizations, and foreign organizations, provides an organized schedule for the actions required to carry out the strategy successfully. The results highlight the significance of strengthening community involvement, encouraging sustainable farming methods, and creating a supporting governance structure. Ultimately, this paper promotes a multifaceted strategy for agricultural development that seeks to enhance rural Afghanistan's general quality of life and productivity, opening the door for long-term resilience and economic stability.

## ARTICLE INFO

**Article history:**
Received: Feb 12, 2024
Revised: Aug 19, 2024
Accepted: Nov 11, 2024

**Keywords:**
Afghanistan; Economic development; Green revolution; Food security; Sustainable agriculture

**To cite this article:** Jauhar, S. (2024). Implementing a Sustainable Green Revolution Strategy for Comprehensive Economic Development in Afghanistan. *Journal of Natural Science Review*, *2*(Special Issue), 607–642. https://doi.org/10.62810/jnsr.v2iSpecial.Issue.163

**Link to this article:** https://kujnsr.com/JNSR/article/view/163



## Introduction

Decades of conflict, political unrest, and environmental difficulties have severely impeded Afghanistan's economic development. Agriculture, which employs roughly 61.6% of the labor force, contributes about 23% to the country's GDP and remains the backbone of the

economy (Khail & Ahmadzai, 2022; Muradi & Boz, 2018b; NSIA, 2019). Despite this, the agricultural sector is characterized by low productivity and is mainly dependent on subsistence farming practices, which are insufficient to meet the food needs of the expanding population (Samim et al., 2021). The ongoing problems of food insecurity and malnutrition are worsened by poor infrastructure, a lack of water, and the effects of climate change, endangering agricultural productivity and livelihoods (Samim et al., 2021; Sarwary et al., 2023).

The need for a comprehensive plan to improve food security and agricultural resilience is growing as Afghanistan gets closer to 2050. According to World Bank projections, there will be a 70% increase in global food demand by 2050, requiring a change in agricultural practices to guarantee food security in Afghanistan and other regions (Islam et al., 2022). Furthermore, projections suggest that to meet the calorie and protein demands of the expanding population, agricultural production will need to double (100–110%) or roughly triple (176–238%) from 2005 levels (Martin-Guay et al., 2018). Given these obstacles, Afghanistan's economic growth depends on a sustainable Green Revolution approach. The goals of this strategy should be to increase food value chains, support nutrition-sensitive food systems, and increase agricultural output by implementing climate-smart techniques (Babu et al., 2021; Vos et al., 2020).

Historically, the introduction of high-yielding crop varieties, sophisticated irrigation systems, and contemporary agricultural technologies by the Green Revolution has had a revolutionary effect on agrarian development, especially in Asia (Saiti et al., 2018). However, not all areas have benefited equally from the Green Revolution; some, especially in Sub-Saharan Africa, have only seen modest increases (P. Pingali, 2023). The need to incorporate sustainability into agricultural operations to reduce adverse environmental effects and socio-economic inequality is highlighted by lessons learned from previous Green Revolutions (Muradi & Boz, 2018a).

Using a Green Revolution approach adapted to the local environment can significantly increase food production and economic resilience in Afghanistan, where agriculture still has a major economic role. The nation's potential for agriculture and its variety of climate zones offer a unique chance to adopt sustainable methods that raise yields while encouraging environmental care (Akhtar & others, 2024). Afghanistan can tackle urgent problems, including water scarcity, soil degradation, and climate change, while promoting economic growth by emphasizing sustainable agricultural practices like organic farming and precision agriculture (Liu et al., 2020).

To ensure the effective execution of this plan, the Afghan government, in collaboration with foreign agencies and interested parties, needs to provide top priority to funding for farmer education, technology transfer, and agricultural infrastructure. To overcome cultural opposition and guarantee the widespread adoption of contemporary agricultural practices, it will be essential to integrate local knowledge and community engagement (Moorthy & Bibi, 2023). Creating a comprehensive Green Revolution strategy can catalyze sustained economic

growth, increased food security, and improved living conditions for Afghanistan's rural populace as it travels toward recovery and development. This article examines the essential components of implementing such a plan and its possible advantages for Afghanistan's economy going forward.

**The Concept of the Green Revolution Strategy**

From 1943 to the late 1970s in Mexico, the Green Revolution refers to research, development, and technology transfer initiatives. These initiatives profoundly impacted industrialized agriculture production in numerous developing nations. Coined by former USAID director William Gaud in 1968, the term "Green Revolution" reflects the primary objective of enhancing agricultural efficiency to address the increasing demands of growing populations in developing countries. The ultimate aim was to significantly increase crop productivity and contribute to these nations' food security and economic development (Ameen & Raza, 2018).

The Green Revolution achieved high crop productivity by implementing various adapted measures. These measures included expanding the farming area, implementing double-cropping practices, adopting high-yielding variety (HYV) seeds, and the widespread distribution of hybridized seeds, significantly increasing the use of inorganic fertilizers and pesticides, enhancing irrigation facilities, and introducing improved farm implements and crop protection measures. Additionally, substantial investments were made in crop research, infrastructure development, market expansion, and appropriate policy support(Ameen & Raza, 2018; Brainerd & Menon, 2014; John & Babu, 2021a). Breisinger et al. (2011) explain that the green revolution strategy refers to a shift from land expansion-led growth to productivity-led growth in agriculture. This strategy aims to close existing yield gaps and increase productivity, mainly through modern inputs such as high-yielding varieties of seeds and fertilizers. It also requires significant public investments in agriculture, rural infrastructure, and marketing. The green revolution strategy is designed to benefit the whole economy, increase the incomes of both rural and urban households, and reduce poverty rates. It also requires measures to enable farmers to access modern inputs, agricultural extension services, financial services, and markets.

In exploring the historical context of green revolutions, it is essential to acknowledge the significant influence of different cultures and regions throughout history. The Islamic Green Revolution (IGR) represents a paradigm shift in agricultural practices during the Early Islamic empires, with the diffusion of crops and associated agricultural technologies from South and East Asia towards the West. Historian Andrew Watson coined the term "Islamic Green Revolution" based on his analysis of Arabic texts, which suggested the occurrence of an agricultural revolution under Islamic influence. Although the precise timeframe of the IGR remains unspecified, it is commonly associated with the Early Islamic empires. Notably, while the accuracy of this thesis has been scrutinized and debated among historians, no definitive evidence has disproven its existence (Fuks et al., 2020).

Ariga et al. (2019) explore the potential of a Green Revolution in Africa, focusing on the role of improved agricultural technologies, specifically seed and fertilizer delivery systems. It discusses the low agricultural productivity in Sub-Saharan Africa due to factors like rapid population growth, climate change, and the rise of the middle class. The paper suggests sustainable and competitive agricultural input markets must be developed to raise productivity. However, access to affordable seeds and fertilizers remains challenging for smallholder farmers. The paper concludes that investments are needed to expand smallholder access to these productivity-enhancing agricultural technologies.

The Green Revolution strategy can contribute to sustainable economic development by improving crop production through technological breakthroughs, improved seeds, irrigation systems, and land suitability assessments. This increases productivity per hectare, making it viable and sustainable to cultivate a given crop in a region. It incorporates aspects like organic agriculture, precision agriculture tools, life cycle analysis, soil and plant health, environmental impacts, water quality, and post-harvest technology to enhance sustainability further. It also considers socio-economic factors such as farmers' perceptions of globalization, value chains, competitiveness, and bioeconomic and biorefineries. The strategy also includes technical advice, training, skills development, technology transfer, and knowledge adoption, fostering a multi-, trans-, and interdisciplinary approach to sustainable development (Aguilar-Rivera et al., 2019).

Pingali (2012) discusses the Green Revolution, a period of significant agricultural productivity growth in the developing world, and its potential contribution to sustainable economic development. It highlights the importance of investing in agricultural innovation and technology adoption to enhance productivity and reduce poverty. The article proposes a "Green Revolution 2.0" strategy integrating environmental and social considerations with agricultural and economic development. It emphasizes the need to address the limitations of the first Green Revolution and tailor solutions to the specific needs of different regions. Overall, a Green Revolution strategy can contribute to sustainable economic development by boosting agricultural productivity and addressing food security challenges while considering environmental and social factors.

**Diverse Perspectives on the Green Revolution**

The Green Revolution has been the subject of extensive academic discourse, with experts offering differing viewpoints on its impact, efficacy, and long-term sustainability. While it is credited with increasing agricultural productivity and reducing hunger in many parts of the world, it has also been criticized for its negative environmental and social impacts. According to a retrospective study published in PNAS, the Green Revolution had achievements and limitations regarding agricultural productivity improvement and its broader social, environmental, and economic impact (Pingali, 2012). Another study published in Human Ecology challenges the conventional wisdom about the Green Revolution, suggesting that it should be reconsidered with an emphasis on diversity and stability in cradle areas of crop domestication (Brush, 1992). Lessons learned from the aftermaths of the Green Revolution

on food systems and health are discussed in a recent article that highlights the unintended but harmful consequences of the Green Revolution on agriculture and human health and suggests that new interventions should be tested and piloted before implementation (John & Babu, 2021a). Renowned Indian environmentalist Vandana Shiva voiced worries in 1991 about the effects of the Green Revolution on biodiversity, agriculture, and rural communities. Shiva attacked the industrial agricultural paradigm of the Revolution, which depended on chemical inputs and crop types with high yields. She contended that this strategy resulted in negative impacts on health, environmental harm, a drop in conventional farming methods, and a loss of biodiversity. Shiva promoted organic farming methods that emphasize ecological sustainability while placing a high value on local knowledge, seed diversity, and the empowerment of small farmers. Her thoughts sparked debates about contemporary agriculture's social and environmental effects by challenging the dominant narrative surrounding the Green Revolution (Shiva, 1991).

The known father of the green revolution, Borlaug, hypothesized that the amount of land used for cereal production would have needed to increase to fulfill the rising demand for food if new agricultural methods had not significantly increased cereal yields. The theory is predicated on the idea that without these technical developments, productivity would stagnate and drive up food costs on the world market. Farmers would cultivate more land to increase production in response to the rising prices (Borlaug, 2007).

Burney et al. (2010) highlight the value of yield enhancements and agricultural research as an affordable method of reducing greenhouse gas (GHG) emissions. It draws attention to the substantial contribution of agriculture to emissions as well as possible mitigating factors. They estimate the net effect of past agricultural intensification, showing that since 1961, emissions of up to 161 gigatons of carbon (GtC) have been avoided due to higher yields. Additionally, it measures the reduction in emissions for every dollar used to increase agricultural output. The objective is to show that, in comparison to other suggested methods, investing in yield enhancements is a beneficial and successful mitigation option. To lower future GHG emissions, they continue to support yield improvements in their conclusion.

## Key Elements of the Green Revolution

### *High-Yielding Cereal Grains*

The Green Revolution, characterized by the widespread adoption of high-yielding cereal grains, has significantly transformed global agricultural productivity. High-yielding varieties (HYVs) of cereals such as wheat and rice were developed through advanced breeding techniques, leading to substantial increases in crop output and food security, particularly in developing countries. According to Pingali (2012), these HYVs played a critical role in alleviating hunger and poverty by enhancing food availability and stabilizing prices. Further, Fischer et al. (2014) underscore that introducing HYVs, using fertilizers, irrigation, and pest control, contributed to a dramatic rise in grain production, which outpaced population growth in many regions. However, the Green Revolution also brought challenges, including

environmental degradation and socio-economic disparities (Fischer et al., 2014; Pingali, 2023). As such, while the high-yielding cereal grains were pivotal in the success of the Green Revolution, ongoing efforts are needed to address its environmental and social implications.

### *Expanding the Farming Area*

Expanding the farming area is of paramount importance for the comprehensive economic development of Afghanistan. With a rapidly growing population and increasing food demands, agricultural production is crucial to ensure food security and economic stability. By expanding the farming area, farmers can cultivate more crops and increase their yields, providing a sustainable source of income and livelihood for rural communities. However, it is essential to implement sustainable farming practices and consider the environmental impact of land expansion to ensure long-term agricultural sustainability and preserve the country's natural resources for future generations.

D'Amour et al. (2017) highlight urban expansion's significant implications on global croplands, particularly in Mega Urban Regions in Asia and Africa. By 2030, urban expansion is projected to result in a 1.8–2.4% loss of global croplands, with 80% occurring in Asia and Africa. This loss will disproportionately affect regions with high poverty rates and potentially strained food systems. The study emphasizes the need for sustainable urban expansion strategies to ensure food security and livelihoods in vulnerable regions.

Laurance et al. (2014) discuss the challenges and impacts of agricultural expansion in tropical regions due to population growth and increasing food demands. The article emphasizes the need to increase agricultural efficiency and optimize land allocation between conservation and agriculture to sustainably meet food, fiber, and biofuel needs. It also addresses the potential benefits and challenges of expanding agricultural lands in the tropics, especially in Sub-Saharan Africa and South America, and the role of new roadways in determining the spatial extent of agriculture.

The expansion of farming areas must be carefully planned and implemented to ensure they meet the growing demands for food and other agricultural products while preserving natural ecosystems and promoting sustainable land management.

### *The Expansion Of Irrigation Infrastructure*

The developing world has issues maintaining food security due to population increase, industrialization, water scarcity, climate change, and mitigation efforts. Less water will likely be available in arid regions, including North Africa, the Middle East, and Asia. Policymakers and planners in emerging nations, particularly those with limited water resources and inadequate irrigation infrastructure capacity, face a growing number of issues in ensuring food security (Hanjra et al., 2010; Schmitz et al., 2013; Temesgen et al., 2012; Tyagi et al., n.d.). The future of Afghanistan's food security is closely linked to basin-level management in its irrigated agriculture, which faces further risks from factors such as water resource scarcity and insecurity, bad policies for managing scarce resources that confuse potential users over their access rights to the most precious commodity (water) or damage conflict-

inflicted infrastructure across irrigation. Its low water storage, exacerbated by climate change, puts Afghanistan at high risk (Gohar et al., 2015).

### *Implementing Double-Cropping Practices*

Adopting double-cropping techniques in Afghanistan offers a noteworthy prospect of augmenting agricultural output and sustainability. Double cropping, or growing two crops in one season, maximizes land use efficiency and increases overall yields. According to research, adding legumes to double cropping systems can increase soil fertility by reducing the requirement for synthetic fertilizers and improving soil health through biological nitrogen fixation (Scordia, 2024; Vatsanidou et al., 2020). Furthermore, it has been demonstrated that implementing conservation tillage techniques in conjunction with double cropping enhances soil organic matter content and structure, which improves water retention and lowers erosion (Tang et al., 2020; Vatsanidou et al., 2020). This is especially important in Afghanistan's semi-arid and arid climates, where soil management techniques can significantly impact crop performance and tolerance to climate fluctuation (Soofizada et al., 2023).

In addition, choosing the right crop kinds for double cropping is crucial to guaranteeing food security and optimizing water usage efficiency. According to several studies, certain crops, especially drought-tolerant ones, can be deliberately selected to reduce water usage during dry spells (Myint et al., 2021). This is essential in an area where water scarcity is an urgent worry. Furthermore, by reducing the need for chemical pesticides and mitigating insect pressures, applying integrated pest control techniques in double cropping systems can support environmental sustainability (Pitchers, 2023). In line with the larger objectives of sustainable economic development, the effective use of double-cropping techniques in Afghanistan may result in higher agricultural production, better soil health, and increased resistance to climate change (Magazzino et al., 2021).

### *Market Expansion*

Market expansion through agricultural innovation has significant economic ramifications. According to research, developing nations can see a 15% boost in GDP per capita with just a 10% rise in the use of HYVs (Gollin et al., 2021). Given Afghanistan's reliance on agriculture and small- to medium-sized businesses (SMEs), expanding the market there is a complex undertaking that requires a thorough grasp of the country's economic environment. The agricultural industry, which employs roughly 61.6% of the labor population and is essential to economic stability and food security, faces numerous obstacles, including unstable political environments, poor infrastructure, and restricted market access (Hamdard et al., 2023). Strengthening the agricultural supply chain, increasing productivity through sustainable practices, and improving access to domestic and foreign markets are essential for market expansion. Since SMEs are acknowledged as important forces behind Afghanistan's economic expansion and employment creation, their incorporation within this framework is essential (Baabdullah et al., 2021). Afghanistan can use its agricultural basis to encourage

broader economic expansion by creating an environment that supports SME development, including training and funding access.

Afghanistan's market expansion strategy also heavily depends on international investment and help. Foreign aid has always had a double-edged effect: while it might provide vital resources, it can also encourage dependency, impeding local initiative and economic self-sufficiency (Deniz & Haidar, 2019). According to recent research, trade and market access might be facilitated by a move toward more strategic and sustainable foreign investment, such as that made possible by China's Belt and Road Initiative, which would improve infrastructure and connectivity (Al Amin et al., 2024). Moreover, expanding trade alliances, especially those with adjacent nations, may create new markets for Afghan exports, such as other agricultural items and medicinal plants that have demonstrated promise in global markets (AM*, 2024). In addition to increasing economic resilience, this diversification lowers susceptibility to outside shocks.

Because labor migration can improve the skills and capabilities of the Afghan workforce, it offers a chance for market expansion. According to research, Afghan workers abroad, especially in Turkey and the Gulf Cooperation Council (GCC) nations, can make substantial economic contributions through remittances and skill development (Smith, 2018). Afghanistan can establish a dual economic growth route by formulating policies that facilitate labor migration and allocate resources toward developing the indigenous workforce. In addition to meeting urgent financial demands, this strategy lays the groundwork for long-term sustainable growth. Afghanistan must comprehensively approach market expansion, incorporating labor migration, foreign investment, and agricultural development to build a strong economic foundation and sustain long-term prosperity.

***Using Appropriate Technology***

The right technology must be incorporated for agriculture to be sustainable and productive. This is especially true in places like Afghanistan, where traditional methods might not satisfy contemporary agriculture's demands. Current research highlights how cutting-edge agricultural technology, such as precision farming and the Internet of Things (IoT), may optimize farming methods. For example, Rasyid emphasizes that by creating farming practices based on sustainable agriculture principles, adopting sustainable agricultural technology can significantly boost productivity and food security (Rasyid, 2024). Similarly, Cernisevs explains how smart agriculture may minimize environmental effects while enhancing economic growth and improving production processes using digital technologies (Cernisevs et al., 2024). This combination of agriculture and technology not only increases productivity but also supports the objectives of global sustainability.

In addition, disseminating agricultural technologies via academic institutions is essential for encouraging sustainable practices. According to Dai's research, university agricultural technology extension can substantially impact sustainable and efficient farming practices, even though the long agricultural production cycles may make the impact difficult to notice

right away (Dai et al., 2024). This emphasizes the importance of sharing knowledge and providing ongoing education to promote innovation in the agriculture industry. Moreover, Kalfas notes that farmers may remotely monitor crop health and environmental conditions thanks to integrating IoT technologies, allowing for timely interventions that improve agricultural sustainability (Kalfas, 2024). Farmers and academic institutions can build a strong foundation for adopting new technology, ultimately improving agricultural results.

Adopting the right technologies in agriculture has significant economic ramifications, especially regarding increasing production and guaranteeing food security. According to (Liu et al. (2020), maintaining agricultural output in South and Southeast Asia, including Afghanistan, requires a rise in investment in technological innovation. Bunkar agrees, highlighting how agricultural extension programs may significantly increase efficiency and sustainability by utilizing cutting-edge technology like artificial intelligence and machine learning (Bunkar, 2024). Moreover, Finco et al. point out that using precision agriculture technologies can result in more informed decision-making, which supports environmental and economic sustainability (Finco et al., 2023). Afghanistan may use these technological advancements to address its particular agricultural difficulties and advance its overall economic development by creating an environment favorable to its adoption.

***Green Revolution and Sustainable Economic Development***

Increasing agricultural productivity by implementing cutting-edge techniques and technology is at the core of the idea of a "green revolution" strategy. Initiated in the 1960s, the Green Revolution sought to considerably boost crop yields and agricultural production to alleviate the problems associated with food security in underdeveloped nations (Gollin et al., 2021). The Green Revolution has, however, also brought about many socio-economic and environmental problems, including growing farmer inequality and environmental degradation from the overuse of chemical inputs (Carter et al., 2019; Dentika et al., 2023; John & Babu, 2021b). This is important to understand. It has also helped to increase food production significantly. The contribution of a green revolution strategy to sustainable economic development is multifaceted.

First, since increasing food security is vital to sustainable development, such measures can increase agricultural production. Improved food security can foster a healthier and more productive workforce, which can help reduce poverty and hunger (John & Babu, 2021b). Additionally, incorporating sustainable farming methods like agroecology and organic farming might lessen the damaging effects that traditional Green Revolution techniques have on the environment. (Kardi et al., 2023; Singh & Yadav, 2022). For example, sustainable methods can improve biodiversity, preserve water resources, and improve soil health, which is critical for long-term agricultural sustainability. (Ahmed & Turchini, 2021). Furthermore, by opening up new markets and employment opportunities in the agriculture sector, the advancement of green technology and innovations can spur economic growth and contribute to a more resilient and sustainable economy. (Li et al., 2021). Therefore, a well-executed green revolution strategy is essential for promoting sustainable economic development and

raising agricultural productivity. Strategies that tackle food security encourage eco-friendly behaviors, and boost economic growth have the potential to build a more just and sustainable future for communities—especially in developing areas like Afghanistan (van Etten, 2022).

*Table 1: Yields of Crops Before and After the Green Revolution (kg/ha)*

| **Crop Type** | **Yield Pre-Green Revolution (kg/ha)** | **Yield Post-Green Revolution (kg/ha)** | **References** |
|---|---|---|---|
| Wheat | 800-1,200 | 2,500-3,500 | (Gollin et al., 2021; Jethva, 2022; Zhang et al., 2014) |
| Rice | 1,000-1,500 | 3,000-5,000 | (Gollin et al., 2021; Han et al., 2020; Jethva, 2022; Zhang et al., 2014) |
| `Maize | 1,000-1,500 | 3,000-4,500 | (Gollin et al., 2021; Tanger et al., 2017) |
| Barley | 800-1,200 | 2,000-3,000 | (Gollin et al., 2021; Jethva, 2022) |
| Sorghum | 600-1,000 | 1,500-2,500 | (Gollin et al., 2021; Jethva, 2022) |
| Millet | 500-800 | 1,200-2,000 | (Gollin et al., 2021; Jethva, 2022) |

Significant gains in productivity across the main cereal crops are shown in Table 1, which compares crop yields before and after the Green Revolution. According to the data, crop yields significantly rose due to the Green Revolution, which was marked by the introducing of high-yielding varieties (HYVs), better agricultural techniques, and higher fertilizer use. As an example of the revolutionary influence of this agricultural movement, rice yields jumped from 1,000-1,500 kg/ha to 3,000-5,000 kg/ha, while wheat yields increased from an average of 800-1,200 kg/ha to 2,500-3,500 kg/ha (Gollin et al., 2021; Han et al., 2020; Jethva, 2022; Takahashi et al., 2020; Zhang et al., 2014).

## The Potential of a Green Revolution Strategy for Afghanistan

Afghanistan's agricultural sector, which offers enormous growth and development potential, is inextricably tied to the country's potential for a Green Revolution approach. The agricultural landscape of Afghanistan is distinguished by a range of climatic zones and crops, such as wheat, fruits, and nuts, that the application of contemporary agricultural techniques can enhance. Productivity and food security in the area might be significantly increased using sustainable farming practices, better irrigation methods, and crop types with higher yields. For example, historical data from the Asian Green Revolution demonstrate that incorporating advanced agricultural technologies, such as precision farming and mechanization, has boosted yields significantly in similar circumstances (Takeshima & Mano, 2023). Furthermore, the issues of climate change and finite arable land highlight the need for sustainable practices and call for creative methods for agricultural management (Hamdan et al., 2022).

Table 2 presents the cultivated area, production, and yield of major crops in Afghanistan from 1999 to 2016. This data highlights the country's agricultural landscape, illustrating crop

cultivation and productivity trends over nearly two decades. Understanding these metrics is crucial for assessing food security, economic development, and resource management in Afghanistan, where agriculture plays a vital role in the livelihoods of the rural population. The table explicitly details key crops such as wheat, barley, rice, and vegetables, providing insights into their contributions to the overall agricultural output and the challenges faced in achieving sustainable agricultural practices.

*Table 2: Cultivated Area, Production, and Yield of Major Crops in Afghanistan (1999-2016)*

| Crop Indicator | 1999-2001 | | | 2009-2011 | | | 2014-2016 | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1000 ha) | (1000 tons) | (kg/ha) | (1000 ha) | (1000 tons) | (kg/ha) | (1000 ha) | (1000 tons) | (kg/ha) |
| Wheat | 1,945 | 1,855 | 954 | 2,387 | 4,328 | 1,813 | 2,361 | 4,866 | 2,061 |
| Barley | 130 | 126 | 964 | 223 | 410 | 1,837 | 281 | 409 | 1,453 |
| Rice, paddy | 130 | 261 | 2,000 | 206 | 663 | 3,218 | 168 | 435 | 2,592 |
| Maize | 112 | 172 | 1,533 | 169 | 300 | 1,781 | 142 | 315 | 2,214 |
| Pulses | 46 | 47 | 1,019 | 69 | 57 | 828 | 112 | 83 | 745 |
| Oilseeds | 116 | 108 | 933 | 63 | 58 | 921 | 95 | 82 | 865 |
| Vegetables | 70 | 538 | 7,707 | 86 | 609 | 7,087 | 107 | 964 | 9,016 |
| Melons | 15 | 166 | 10,790 | 56 | 577 | 10,270 | 90 | 858 | 9,515 |
| Fruits & Nuts | 111 | 729 | 6,571 | 134 | 865 | 6,919 | 158 | 1,236 | 7,814 |
| Other crops | 34 | - | - | 29 | - | - | 34 | - | - |
| Total cultivated | 2,710 | 4,065 | 1,500 | 3,412 | 8,011 | 2,348 | 3,548 | 9,325 | 2,628 |

Source: (Fischer et al., 2022)

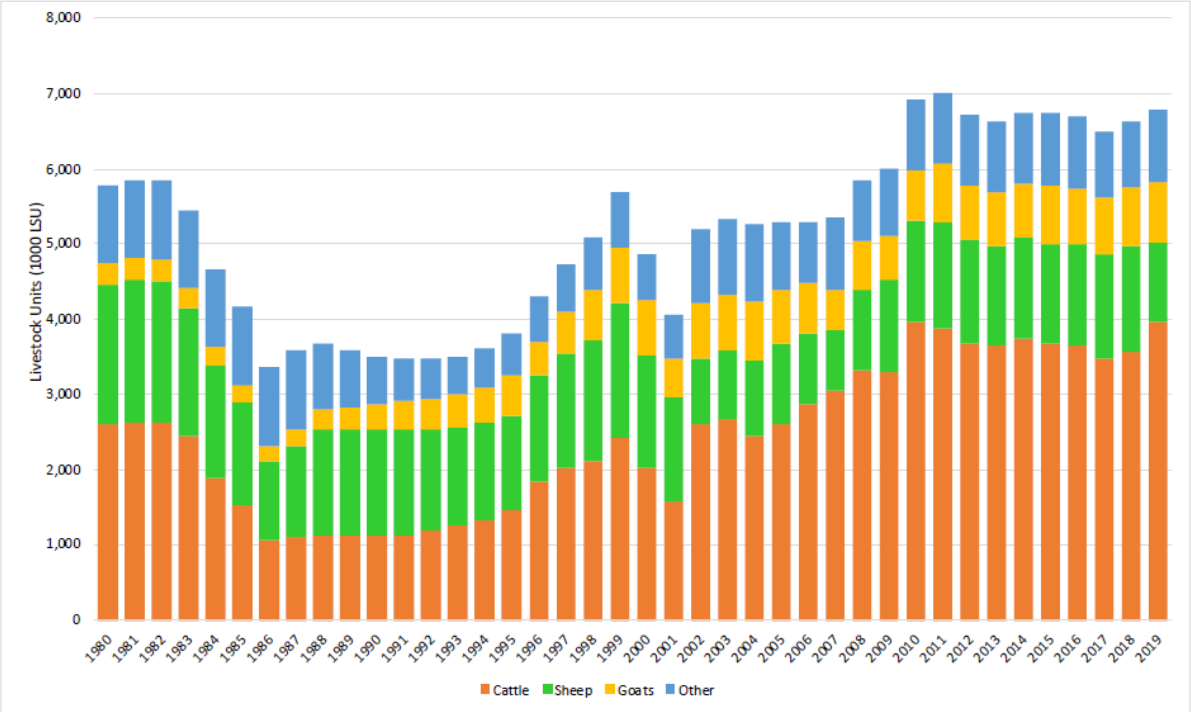


*Figure 1. Afghanistan Livestock numbers (1000 LSU), period 1980–2019 (Fischer et al., 2022)*

For decades, livestock raising has been essential to the livelihoods of Afghanistan's rural population, offering power for agricultural work, food security through milk and meat, and

income from market sales. Farmers typically keep sheep and goats in a predominantly sedentary farming system, while cattle are mainly raised in these areas. Approximately 1.5 million pastoralists practice a nomadic lifestyle, utilizing the country's extensive but low-productive rangelands, which cover 30.2 million hectares—47% of Afghanistan's territory. As (Figure 1), during the last decade, the livestock population (excluding chickens) has fluctuated between 6 to 7 million livestock units (LSU), with cattle, sheep, and goats making up about 85%. For 2016, official reports indicated 5.2 million cattle, 13.3 million sheep, and 7.4 million goats, totaling 5.7 million LSU, while traditional pastoralists managed around 1.3 million LSU, significantly contributing to the national herd (Fischer et al., 2022)

Table 3 shows the severe deficiencies in Afghanistan's agricultural industry. The amount of wheat produced is 4,351 thousand tons, which is 2,270 thousand tons less than the 6,621 thousand tons required. Significant disparities may also be seen in rice and maize, with 400 thousand tons produced compared to 688 thousand tons needed and 363 thousand tons produced compared to 14 thousand tons needed. These numbers demonstrate how urgently the nation needs policies to improve food security.

Afghanistan's agriculture industry can spur more extensive economic growth. According to Huseynov Salik (2018), agricultural systems are under tremendous strain from the growing demand for food brought on by urbanization and population increase, especially in desert regions like Afghanistan. A Green Revolution strategy can be implemented to meet this demand by emphasizing resource efficiency and sustainable practices. The finding that increased agricultural productivity can boost rural incomes, which can spur economic change, adds more credence to the potential for agricultural growth (Umar et al., 2021).

Furthermore, implementing finance methods like salam-based crowdfunding can give farmers the money they need to invest in cutting-edge agricultural technologies and inputs, boosting productivity and resilience to market swings (Saiti et al., 2018). Therefore, implementing a Green Revolution strategy holds significant potential for the growth and development of Afghanistan's agricultural sector. Afghanistan can improve food security and economic resilience by utilizing its vast agricultural potential and tackling sustainability-related issues. The amalgamation of contemporary farming methods with inventive funding approaches can yield a revolutionary influence on the agricultural terrain, culminating in the nation's all-encompassing economic growth.

*Table 3: Afghanistan's Agricultural Production and Deficiency (in thousand tons)*

| **Agricultural products** | **Total production (thousand tones)** | **Total necessity (thousand tones)** | **Total deficiency (thousand tones)** |
|---|---|---|---|
| Wheat | 4351 | 6621 | 2270 |
| Maize | 363 | 377 | 14 |
| Rice | 400 | 688 | 289 |

Sources: (MAIL & NSIA, 2023a, 2023b)

## Challenges and Opportunities for Implementing a Green Revolution Strategy in Afghanistan

Afghanistan faces numerous obstacles to implementing a sustainable Green Revolution plan, impeding economic growth and agricultural development. The lack of adequate infrastructure, financial limitations, restricted access to technology, scarce water supplies, cultural resistance, low educational attainment, problems with market access, the effects of climate change, and the requirement for human resource development are some of the major obstacles.

### *Challenges*

The (Table 4) outlines the key challenges facing Afghanistan in implementing a Green Revolution strategy. Each challenge is described, highlighting its implications for agricultural productivity and economic growth. The challenges range from infrastructure deficiencies and financial resource constraints to cultural resistance and limited access to education. Each entry is accompanied by a rating that reflects its perceived impact on the agricultural sector, providing a clear overview of the obstacles that must be addressed for successful implementation.

### *Deficiencies in the Infrastructure*

The inadequate infrastructure in Afghanistan is a considerable obstacle to effectively executing a Green Revolution plan. In particular, inadequate irrigation and transportation infrastructure plague Afghanistan's agricultural industry. Inadequate irrigation infrastructure exacerbates water scarcity challenges, limiting farmers' market access and lowering agricultural production (Samim & Zhiquan, 2020). One major obstacle to the nation's food security and means of subsistence has been the underfunding of rural infrastructure (Zaray et al., 2023). Moreover, the examination of Afghanistan's agricultural practices historically indicates that numerous areas do not possess the infrastructure required to facilitate contemporary farming methods, which are critical to the success of the Green Revolution (Bhattacharya, 2024). Nonetheless, there are chances for growth through global collaborations and financial contributions meant to enhance the infrastructure supporting agriculture. The potential for interdisciplinary approaches to improve water resource management, essential for agricultural sustainability, is demonstrated by initiatives such as the Strengthening Water Resources Management in Afghanistan (Pathak et al., 2022).

### *Financial Resources*

Investing in modern agricultural practices is severely hampered by a lack of funds. Due to a shortage of funding and the continued effects of conflict and instability, the Afghan government finds it challenging to support infrastructure initiatives (Zaray et al., 2023). Moreover, novel finance methods, including crowdfunding based on salam (Type of Islamic Finance), have been suggested to improve agricultural output; however, these solutions are still in their early stages of development (Saiti et al., 2018). Farmers' ability to invest in contemporary agricultural technologies and practices is restricted by their dependency on

foreign aid and lack of access to credit (Kock & Turnbull, 2011). According to Kock et al. (2011), most Afghan farmers do not have access to official agricultural extension services, which are essential for offering the education and funding required for adopting new technology (Kock et al., 2010).

*Table 4: Challenges for Implementing a Green Revolution in Afghanistan*

| No | Challenge | Description | Key Insights |
|---|---|---|---|
| 1. | Infrastructure Deficiencies | Inadequate irrigation and transportation systems hinder agricultural productivity. | Rated 9; critical for food security and market access. |
| 2. | Financial Resources | Limited funding and reliance on foreign aid restrict investments in modern practices. | Rated 8; impacts ability to adopt new technologies. |
| 3. | Restricted Access to Technology | Lack of access to modern tools and digital resources, especially for women. | Rated 7; technological gaps hinder productivity. |
| 4. | Economic Constraints | Low investment in the sector and high food insecurity rates affect economic growth. | Rated 8: urgent need for economic reforms. |
| 5. | Cultural Resistance | Farmers' reluctance to change traditional practices impedes innovation. | Rated 6; outreach is necessary to encourage the adoption of new methods. |
| 6. | Low Education Levels | Limited access to agricultural education reduces farmers' capacity to adopt modern practices. | Rated 5: enhancing education is essential for skill development. |
| 7. | Market Access Issues | Insufficient information and infrastructure limits farmers' ability to sell their produce. | Rated 6: improving market access is crucial for income generation. |
| 8. | Climate Change Impacts | Extreme weather events threaten agricultural productivity and livelihoods. | Rated 7: climate-smart practices are needed for resilience. |
| 9. | Human Resource Development | Insufficient training programs hinder the adoption of advanced agricultural methods. | Rated 6: training initiatives can significantly improve productivity. |

### *Restricted Access to Technology:*

A lack of modern instruments and procedures hinders the agriculture sector's productivity. Farmers' capacity to implement effective farming techniques is hampered by their lack of access to technology, especially digital resources and agricultural machinery. This technological gap is particularly prominent among women, who face extra challenges due to cultural reluctance to use technology (Nabizada et al., 2024).

Afghanistan is facing a severe water shortage, which is made worse by ineffective irrigation techniques and the effects of climate change. Farmers find it challenging to maintain their livelihoods due to the direct impact of declining water supplies on crop output (Khan et al., 2024). Improving agricultural resilience in these difficulties requires better water management techniques.

### *Economic Constraints*

Afghanistan's economy is characterized by a lack of funding, which prevents investment in innovative agricultural techniques and technology. Economic reforms are necessary to spur growth because the agricultural sector, which employs a sizable section of the people, contributes roughly 23% to the GDP (Muradi & Boz, 2018c). In addition, the high rate of food insecurity—which affects more than half of the population—highlights how urgently economic development programs are needed (Chaudhuri & Roy, 2024).

***Cultural Resistance***

Farmers in Afghanistan frequently oppose modifying their customary farming practices, which might impede the uptake of cutting-edge agricultural techniques. Ahmadzai et al. (2019) state that cultural inertia is a significant obstacle to implementing sustainable farming practices. Outreach and education initiatives are crucial for addressing these cultural barriers and highlighting the advantages of contemporary farming methods.

***Low Education Levels***

A lack of agricultural education and training weakens farmers' ability to accept innovations. Low productivity and subpar agricultural practices are caused by a cycle of limited access to training and educational resources (Haidari et al., 2021). Improving agricultural education is essential to developing a more informed and proficient workforce.

***Problems with Market Access***

Farmers have trouble selling their produce in both domestic and foreign markets. Their capacity to effectively reach consumers is hampered by inadequate market information systems and infrastructure (Samim & Zhiquan, 2020). Increasing farmers' earnings and fostering agricultural sustainability depends on expanding market access.

***Climate Change Impacts***

Afghanistan's agricultural productivity is seriously at risk from the growing frequency of droughts and other extreme weather events brought on by climate change. These environmental problems need the development of climate-smart farming strategies to promote resilience and assure food security (Khan et al., 2024).

***Human Resource Development***

A sustainable green revolution plan's effectiveness depends on human resource development. Programs for training farmers in contemporary agricultural techniques and technologies have the potential to increase output significantly and yield favorable financial results (Khail & Ahmadzai, 2022).

**Opportunities**

Table 5 presents the various opportunities to enhance agricultural sustainability and productivity in Afghanistan. It details potential avenues such as leveraging diverse agricultural potential, fostering international support, and engaging youth in modern farming practices. Each opportunity is accompanied by a description and a rating, illustrating

its significance in promoting agricultural development. By identifying these opportunities, stakeholders can strategize effectively to overcome challenges and drive positive change in the agricultural landscape.

***International Support***

Collaborations with non-governmental organizations (NGOs) and international organizations can offer much-needed capital and experience to support projects for agricultural development. These kinds of partnerships can support sustainable farming methods and increase the ability of nearby farmers (Chaudhuri & Roy, 2024).

***Youth Engagement***

Given that the population is primarily young, there is much opportunity to educate and include young people in contemporary agricultural methods. In the agriculture industry, this demographic advantage can spur productivity and innovation (Khail & Ahmadzai, 2022).

***Organic Farming Potential***

Afghan farmers can enter new markets by exploiting the rising demand for organic products. Farmers can increase revenue and support environmental sustainability by implementing organic farming practices (Ahmadzai et al., 2019).

***Better Policies***

Initiatives by the government to improve the agricultural environment can attract investment and spur innovation in the industry. A sustainable green revolution requires policy changes prioritizing agricultural growth (Muradi & Boz, 2018c). Decentralizing agricultural policy-making to the provincial level could ensure that local agricultural issues are addressed more effectively.

***Creation of Cooperatives***

According to Saiti et al. (2018), farmer cooperatives can improve access to resources and bargaining power, allowing farmers to exchange resources and knowledge and obtain higher prices for their produce. This group effort can strengthen the agricultural industry.

***Climate-Smart Agriculture***

Using climate-smart agricultural techniques can increase resilience and lessen the effects of climate change. Such techniques are crucial to guaranteeing sustainable agricultural development in light of environmental challenges. (Khan et al., 2024).

***Research and Development***

It is possible to increase significantly agricultural production by creating crop types that are both drought-resistant and high-yielding. Funding for agricultural research is essential to solve the issues brought on by resource scarcity and climate change (Poole et al., 2022).

*Table 5: Opportunities for Implementing a Green Revolution in Afghanistan*

| No | Opportunity | Description | Key Insights |
|---|---|---|---|
| 1. | Agriculture Zoning | Tailoring agricultural practices to regional characteristics can optimize productivity. | Rated 10; enhances resource use and food security through targeted approaches. |
| 2. | International Support | Collaborations with NGOs can provide funding and expertise for agricultural projects. | Rated 8 essential for implementing modern practices and sustainable farming. |
| 3. | Youth Engagement | A young population presents opportunities for innovation and modernization in agriculture. | Rated 7: engaging youth can drive productivity and new ideas. |
| 4. | Organic Farming Potential | Growing demand for organic products allows farmers to access new markets. | Rated 6; can increase revenue while supporting environmental sustainability. |
| 5. | Better Policies | Government initiatives can create a more favorable environment for agricultural growth. | Rated 8: policy changes are necessary to attract investment. |
| 6. | Creation of Cooperatives | Farmer cooperatives can enhance resource access and bargaining power. | Rated 6: collective efforts can improve economic stability. |
| 7. | Climate-Smart Agriculture | Techniques to mitigate climate change effects and enhance resilience in farming. | Rated 7; critical for sustainable agricultural development. |
| 8. | Research and Development | Investment in developing drought-resistant and high-yield crops is essential. | Rated 6: funding research can significantly impact productivity. |
| 9. | Utilizing Local Knowledge | Combining traditional practices with modern techniques can enhance agricultural resilience. | Rated 5: leveraging local knowledge is vital for culturally appropriate practices. |
| 10. | Infrastructure Development | Investments in rural infrastructure can improve market access and agricultural growth. | Rated 7 is essential for promoting economic stability in rural areas. |

### *Utilizing Local Knowledge*

Traditional farming knowledge can help create environmentally sound and culturally acceptable sustainable methods. Agricultural resilience can be increased by combining traditional knowledge with contemporary methods (Ahmadzai et al., 2019).

### *Infrastructure Development*

Improving access to markets and supporting agricultural growth require investments in rural infrastructure. Improved infrastructure can promote economic stability and the agriculture sector's growth (Zaray et al., 2023).

### *Agriculture Zoning*

Agriculture zoning is one of the most important tactics for raising Afghanistan's agricultural sustainability and productivity. Zoning enables the customized use of agricultural practices that correspond with each region's unique requirements and capacities, considering the country's varied meteorological and geographical characteristics. For example, the Southwestern zone, which has warmer temperatures, might concentrate on drought-resistant crop varieties. In contrast, the Northeastern zone, which includes provinces like Badakhshan and Kunduz, might benefit from the introduction of high-yield crop varieties that are suited to its cooler climate (Samim et al., 2021; Sarwary et al., 2023). By ensuring that agricultural techniques align with regional environmental circumstances and socio-economic situations, this strategy not only maximizes resource usage but also improves food security (Khail & Ahmadzai, 2022; Samim et al., 2021).

In order to implement agriculture zoning in Afghanistan, areas are systematically categorized according to their potential for agriculture. Agricultural outputs can be enhanced by utilizing the distinct features of each of the eight zones—Northeastern, Northwestern, Eastern, Central, West-Central, Western, Southeastern, and Southwestern (Figure 2). For instance, the Central zone may concentrate on organic agriculture, encouraging sustainable practices that improve soil health and biodiversity, while the Northwestern zone, with its fertile soils, could be given priority for producing high-yield crops (Ahmadzai et al., 2019; Muradi Boz, 2018b). In addition to facilitating the effective use of resources, this divide makes it easier for new agricultural practices suited to each zone's particular requirements, like integrated pest management and precision farming (Moahid et al., 2021; Walters & Groninger, 2014).

On the other hand, creating zones for organic farming can encourage sustainable methods essential for long-term environmental well-being and climate change resilience (Huseynov & Salik, 2018). Afghanistan can increase agricultural productivity while ensuring the techniques used are sustainable and advantageous to the local communities by strategically implementing these practices across various zones (Najam et al., 2023; Sidiqi, 2023).

Therefore, Afghanistan must establish agro-zoning to maximize agricultural sustainability and productivity. This zoning framework's incorporation of high-yield cultivars and organic farming methods would strengthen the agricultural sector's sustainability and resilience, ultimately advancing the country's overall economic growth.

Each region consists of three to six provinces, detailed as follows in Figure 2 below:

- ***Northeastern (NE)****: Badakhshan, Baghlan, Kunduz, Takhar*
- ***Northwestern (NW)****: Balkh, Faryab, Jawzjan, Samangan, Sar-e-pul*
- ***Eastern (EA)****: Kunarha, Laghman, Nangarhar, Nooristan*
- ***Central (CE)****: Kabul, Kapisa, Logar, Panjsher, Parwan, Wardak*

- ***West-Central (WC)****: Bamyan, Daykundi, Ghazni*
- ***Western (WE)****: Badghis, Farah, Ghor, Herat*
- ***Southeastern (SE)****: Khost, Paktika, Paktya*
- ***Southwestern (SW)****: Helmand, Kandahar, Nimroz, Urozgan, Zabul* (G. Fischer et al., 2022)

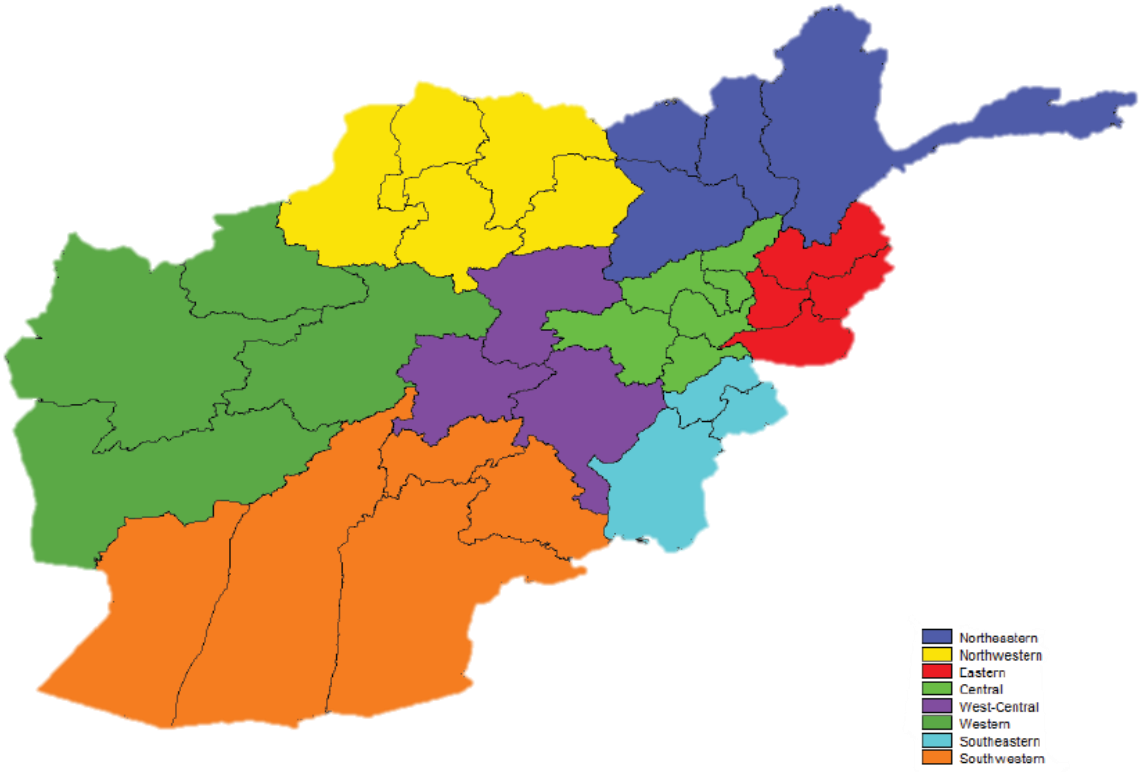


*Figure 2. Illustrates the delineation of eight regions utilized to present the regional results of agro-ecological zones and crop suitability under current and projected climate conditions.*

So, even if Afghanistan's agriculture industry has many obstacles, many chances can still be taken advantage of to carry out a long-term green revolution plan. Afghanistan may achieve comprehensive economic growth by utilizing its opportunities and addressing its obstacles through focused actions.

**Impact of Climate Change and Trade Policies on Afghanistan's Green Revolution Strategy**

Several opportunities and problems are associated with implementing a Green Revolution strategy in Afghanistan. These include external issues like international trade policies and climate change. Afghanistan's agricultural output is severely threatened by climate change, making the country already susceptible because of its unique geographic and climatic features. Droughts and floods, becoming more frequent extreme weather phenomena, can seriously upset agricultural cycles, lowering crop yields and increasing food poverty. Studies reveal that agricultural trade patterns are impacted by climate change as nations adjust to changing weather patterns, potentially intensifying pre-existing vulnerabilities in areas such as Afghanistan (Friel et al., 2020).

Furthermore, the agricultural landscape of Afghanistan is significantly shaped by foreign trade policy. Afghanistan's agrarian exports may benefit or be impeded by World Trade Organization (WTO) agreements and other trade frameworks. Trade liberalization, for example, might open up bigger markets for Afghan farmers, boosting their earnings and encouraging environmentally friendly practices. However, the same measures might jeopardize local farmers due to competition from wealthy nations for subsidized agricultural goods, weakening their position in the market (Li et al., 2021). The delicate balance between preserving regional agriculture and participating in global trade necessitates careful policy formulation.

Furthermore, encouraging sustainable farming techniques requires incorporating climate issues into trade agreements. Numerous studies have shown a rising understanding of the necessity of trade policies that address environmental sustainability, food security, and maximizing economic gains (Balogh & Jámbor, 2020). This means that clauses supporting climate-resilient agricultural methods should be included in international trade agreements to ensure that Afghan farmers can adjust to changing conditions and maintain their competitiveness in international markets. In this environment, the participation of international organizations like the United Nations Environment Programme (UNEP) and the Food and Agriculture Organization (FAO) is critical. These groups can help Afghanistan confront the effects of climate change on agriculture and help design policies that align with sustainable development goals (Khurram et al., 2024). These groups can help lessen the adverse effects of climate change and increase the resilience of Afghan agriculture by supporting community-based approaches to resource management and offering technical support. So, addressing the external variables of climate change and international trade policies is necessary to implement a Green Revolution strategy in Afghanistan successfully. Fostering sustainable agricultural development in the nation requires a multimodal strategy backed by international cooperation incorporating climate resilience into trade frameworks.

## Recommendations for Implementing a Green Revolution Strategy in Afghanistan

### *Implementation Strategies*

- Develop a plan addressing challenges and leveraging opportunities.
- To formulate a thorough plan for executing a Green Revolution strategy in Afghanistan, it is imperative to tackle the diverse hurdles while capitalizing on the discerned potential. The strategy should include several tactical elements that align with Afghanistan's socio-economic and environmental circumstances.

### *The Development of Infrastructure and Technology Access*

Improving agricultural infrastructure, such as irrigation systems, storage facilities, and transportation networks, is an essential first step. Improving rural roads and water management systems is critical, given the current infrastructure shortcomings. International assistance and collaborations, which have demonstrated promise in other settings, can help (Moahid et al., 2021). Furthermore, it is critical to address limited technology access.

Productivity can be increased by facilitating the adoption of contemporary agricultural methods and instruments through partnerships with technology suppliers and local training programs (Samim et al., 2021).

### *Credit and Financial Assistance Systems*

Financial restrictions severely hamper farmers' ability to invest in better farming practices. Putting in place a strong system of agricultural loans can enable farmers to obtain the technologies and inputs they need. Research shows that agricultural loans can improve economic results by allowing farmers to use higher-quality farming inputs (Moahid et al., 2021; Samim et al., 2021). Moreover, establishing cooperatives can aid in joint negotiating for resources and financing, enhancing market accessibility and cutting expenses (Samim et al., 2021). Given Afghanistan's precarious social and economic situation, "salam finance" offers a unique chance to execute a sustainable Green Revolution approach. Given the nation's reliance on agriculture for food security and economic stability, this financing approach may make acquiring resources needed for agricultural development easier. Incorporating novel financing mechanisms, including cash transfer programs and community health funds, has demonstrated promise in improving service accessibility in Afghanistan, indicating that comparable strategies may be modified for agricultural finance (Kim et al., 2016; Noh et al., 2021).

### *Climate-smart Agriculture and Water Management*

Due to the severe water scarcity there, it is imperative to employ climate-smart agriculture methods in Afghanistan. This entails encouraging crop cultivars to resist drought and effective watering methods. Farmers have already adjusted using techniques like early sowing and crop diversity (Faizi et al., 2024). Resilience against climate variability can be further strengthened by training programs centered on sustainable water management techniques (Sarwary et al., 2020).

### *Human Resource Development and Education*

Implementing a Green Revolution approach successfully is hampered by low levels of knowledge. Creating educational initiatives that emphasize sustainable farming methods, financial literacy, and best agriculture practices is essential. By including young people in these initiatives, we can maximize their potential to promote agricultural innovation (Samim et al., 2021). Moreover, training initiatives can become more relevant and practical by incorporating local knowledge into their curricula (Sarwary et al., 2020).

### *Encouragement of Sustainable and Organic Agriculture*

Afghanistan has much promise for organic farming because it can decrease reliance on chemical inputs and enhance soil health (Ghosh et al., 2019). Encouraging organic agricultural methods satisfies the expanding demand for organic products and fits in with worldwide ecological trends. This can be accomplished by launching awareness campaigns and offering

assistance to farmers switching to organic farming practices, which have been demonstrated to improve ecosystem health and biodiversity (Hashimi et al., 2020).

### *Governance and Policy Framework*

A Green Revolution approach cannot be implemented successfully without a favorable policy environment. The main goal of policymakers should be to foster an environment conducive to agricultural investment. This includes supporting cooperative organizations and offering incentives for sustainable practices. Furthermore, stronger infrastructure and trade policies can help alleviate market access difficulties and enable Afghan farmers to be more effectively integrated into regional and international markets (Essar et al., 2022; Hashimy & Magoge, 2023). The Afghan government's top priority is creating a robust governance structure that promotes agricultural development. This entails forming a special committee with members drawn from the top government ranks, including the president and pertinent ministers, to supervise the execution of agricultural programs and guarantee coordination across ministries. Neyazi et al. (2024) have endorsed this strategy in several areas, including health, where multisectoral cooperation effectively addresses complex issues. The government can adopt similar governance frameworks for agriculture to guarantee that agricultural policies are aligned with more general objectives for social and economic development.

### *Making Use of International Assistance*

International support is essential for agricultural policies to be successfully implemented in Afghanistan. Working with foreign organizations can help provide the resources, know-how, and technology transfer needed to overcome regional obstacles (Essar et al., 2022). Interacting with international agricultural networks can also help to exchange best practices and knowledge that can be adjusted to the Afghan situation. It is recommended that the Afghan government manipulate and collaborate with global financial institutions to create inventive finance systems that facilitate credit availability and investment prospects for farmers. NGOs-backed microfinance programs can enable farmers to invest in cutting-edge agricultural methods and technologies. Although there are no particular references to microfinance programs in Afghanistan, the idea that microfinance can help agricultural development is widely known (Wani et al., 2017). Moreover, forming cooperatives can assist farmers in pooling their resources and expanding their market reach, enhancing their economic resilience.

### *Qosh Tepa Canal*

In line with the more general objectives of a Green Revolution plan, the Qosh Tepa Canal offers Afghanistan's agriculture industry a revolutionary potential. With its 285-kilometer length and capacity to divert 6,500 cubic meters of water per second from the Amu River, this massive irrigation project has the potential to transform large arid lands into productive agricultural areas, greatly increasing the region's food security and self-sufficiency. By generating jobs, luring investments, and enhancing export capabilities, efficient canal

management might promote sustainable economic growth and solve pressing problems like poverty and water scarcity (Mushtaq, 2024; Sarbiland & Stanikzai, 2024). As a result, a thorough plan for putting the Green Revolution into practice in Afghanistan needs to be multidimensional, considering the nation's agricultural potential and outside assistance while tackling infrastructure, financial, educational, and policy obstacles. Afghanistan can increase food security, boost agricultural output, and promote sustainable economic development by concentrating on five key sectors.

Furthermore, because the canal is crucial to Central Asia's hydro-political landscape, its development is more than just an infrastructure project; it represents historical significance that could promote regional cooperation and stability (Abdurazzokov, 2024). The Qosh Tepa Canal could facilitate the implementation of a comprehensive Green Revolution strategy in Afghanistan by combining sustainable water management techniques with modern agricultural practices. This would ultimately help the country achieve a number of Sustainable Development Goals (SDGs) by 2030 (Mushtaq, 2024; Sarbiland & Stanikzai, 2024).

### *Involvement of Academic Institutions in Agriculture*

There is a great chance to use a Green Revolution strategy in Afghanistan through the engagement of academic institutions in agriculture. Academic institutions may play a crucial role in the agricultural innovation ecosystem by encouraging cooperation between business, government, and research organizations. In order to lower transaction costs and increase the efficacy of agricultural innovations, this partnership can promote resource sharing and the creation of complementary advantages (Hou et al., 2023). In order to close the gap between research and real-world application, universities can also serve as technology transfer facilitators, teaching farmers how to apply new agricultural technologies and practices (Ayisi-Nyarko et al., 2023). Additionally, forming alliances between educational institutions and farming businesses helps foster entrepreneurship and innovation, both essential for the long-term growth of Afghanistan's agricultural industry (Sorama, 2020). Through action research, these collaborations can develop customized educational initiatives that improve agricultural professionals' abilities and encourage student involvement in actual agricultural problems (Amgain, 2022). Institutions can help create a strong agricultural framework that promotes food security and economic prosperity by fusing academic research with regional agricultural demands (Butorin, 2018). In order to successfully execute a Green Revolution strategy in Afghanistan and guarantee that agricultural techniques are both inventive and sustainable, a strategic focus on the role of academic institutions in agriculture is essential.

### Gantt Chart: An Organized Approach to Putting the Green Revolution into Practice

An essential tool for managing and visualizing the execution of a sustainable Green Revolution strategy in Afghanistan is the Gantt chart. The Gantt chart (Table 6) makes it

easier to plan, carry out, and monitor agricultural projects that are intended to promote overall economic development by breaking the project down into discrete phases.

***Phase 1: Planning and Evaluation***

The trip starts with a comprehensive analysis of Afghanistan's agricultural environment, paying particular attention to essential elements, including crop diversification, soil health, and current farming methods. This phase strongly emphasizes stakeholder involvement to ensure local farmers' opinions are heard and included in the planning process. Effective governance and oversight also depend on building a solid team of government authorities. This fundamental phase is anticipated to take six months to complete, laying the groundwork for further measures.

***Phase 2: Building Capacity***

Farmers and agricultural workers' capabilities must be increased for the Green Revolution to succeed. This stage entails planning training programs that present sustainable agricultural methods and creating instructional resources specific to regional settings. Creating mentorship programs can improve farmer support and information sharing even further. This six-month phase will give stakeholders the know-how required for contemporary farming methods.

***Phase 3: Putting Innovations into Practice***

During the implementation phase, enhanced irrigation methods and agricultural technologies, including drought-resistant and high-yield crop types, are introduced. Effective project management is necessary during this crucial two-year period to guarantee on-time execution and efficient use of resources. To assess these innovations' effects on sustainability and productivity, it will be crucial to track their uptake.

***Phase 4: Observation and Assessment***

Monitoring and evaluation (M&E) are essential for determining how well methods work. To gather information on crop yields, farmer incomes, and environmental effects, this phase will set up a strong M&E structure. Regular evaluations over three months will allow adaptive management, guaranteeing that interventions are improved in response to immediate input and outcomes.

***Phase 5: Sustainability and Scaling Up***

The significance of scaling effective methods and guaranteeing the sustainability of the Green Revolution projects is emphasized in the last phase. This phase seeks continued support and resources by forming alliances with regional groups, governmental entities, and foreign organizations. Promoting community-led projects that support long-term agricultural growth and economic resilience will be the main goal of the 15-month program.

*Table 6: Gantt Chart for Implementing a Green Revolution in Afghanistan*

| Project Phase | Task | Start Date | End Date | Duration (Months) | Dependencies | Milestones |
|---|---|---|---|---|---|---|
| Phase 1: Assessment and Planning | Conduct a comprehensive agricultural assessment | January 2025 | June 2025 | 6 | - | Completion of agricultural assessment |
| | Engage local stakeholders through workshops. | January 2025 | March 2025 | 3 | - | Stakeholder engagement completed |
| | Develop a strategic plan based on assessment findings | April 2025 | June 2025 | 3 | Conduct a comprehensive agricultural assessment | Approval of strategic plan |
| | Form a strong government authorities' team. | January 2025 | March 2025 | 3 | Engage local stakeholders | Government team established |
| Phase 2: Capacity Building | Organize training sessions on sustainable practices | July 2025 | December 2025 | 6 | Develop a strategic plan | Completion of training sessions |
| | Develop educational materials tailored to local needs | July 2025 | September 2025 | 3 | Organize training sessions | Educational materials distributed |
| | Establish mentorship programs linking experienced farmers | October 2025 | December 2025 | 3 | Develop educational materials | Mentorship programs launched |
| Phase 3: Implementation of Innovations | Introduce high-yield and drought-resistant crop varieties | January 2026 | December 2027 | 24 | Completion of capacity building | New crop varieties introduced |
| | Implement irrigation and water management systems | January 2026 | December 2027 | 24 | Introduce crop varieties | Irrigation systems implemented |
| | Monitor and evaluate the adoption of new practices | January 2026 | December 2027 | 24 | Implement irrigation systems | First evaluation report |

| Project Phase | Task | Start Date | End Date | Duration (Months) | Dependencies | Milestones |
|---|---|---|---|---|---|---|
| Phase 4: Monitoring and Evaluation | Establish a robust M&E framework | January 2028 | March 2028 | 3 | Implement agricultural innovations | M&E framework established |
| | Conduct regular assessments of agricultural productivity | April 2028 | June 2028 | 3 | Establish M&E framework | First productivity assessment completed |
| | Adjust strategies based on evaluation findings | July 2028 | September 2028 | 3 | Conduct regular assessments | Strategy adjustments made |
| Phase 5: Scaling Up and Sustainability | Develop partnerships for resource mobilization | October 2028 | March 2029 | 6 | Adjust strategies | Partnerships established |
| | Create a framework for scaling successful practices | April 2029 | September 2029 | 6 | Develop partnerships | Scaling framework developed |
| | Promote community-led initiatives for ongoing development. | October 2029 | December 2029 | 3 | Create a framework for scaling | Community initiatives launched |

The Gantt chart's methodical methodology improves resource efficiency and stakeholder alignment while offering a clear road map for executing a sustainable Green Revolution strategy in Afghanistan. This program aims to contribute substantially to the country's overall economic development by tackling the particular difficulties faced by Afghan agriculture and prioritizing local expertise and community involvement.

## Conclusion

There is a significant chance for both improved food security and overall economic development in Afghanistan through adopting a Sustainable Green Revolution Strategy. Since more than 60% of Afghans are employed in agriculture, which plays a significant role in the country's economy and generates a sizable portion of GDP, this strategic framework is essential for matching agricultural methods to the particular socio-economic circumstances of the nation.

The Green Revolution's historical background demonstrates its achievements and setbacks, calling for a customized strategy known as "Green Revolution 2.0." This strategy combines social justice, environmental sustainability, and agricultural advances to ensure

solutions are tailored to Afghanistan's unique requirements while promoting greater food production and protecting biodiversity.

To overcome current obstacles, it is crucial to implement important suggestions, including building irrigation and storage infrastructure, establishing financial support networks, and encouraging climate-smart farming methods. Furthermore, encouraging innovation and flexibility in the agricultural industry depends on improving education and training programs for farmers, especially the younger generation.

The suggested Gantt chart highlights the roles of several stakeholders, such as the Afghan government, non-governmental organizations, and foreign agencies. It acts as a roadmap for the prompt execution of these policies. Afghanistan can create an agricultural environment that not only increases productivity but also raises the standard of living for rural communities by placing a high priority on cooperation and efficient government.

In the end, overcoming the difficulties posed by climate change and unstable economies will require a thorough and sustainable strategy for agricultural development. The Sustainable Green Revolution Strategy offers a route to improved resilience, food security, and socio-economic advancement as Afghanistan works to fulfill its agricultural potential, paving the way for a more secure and prosperous future for the country.

**Conflict of Interest:** The author(s) declared no conflict of interest.

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