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Policy Note

Evaluation of Farmers' Bottlenecks to Innovate and Adopt New Technologies in Egypt

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Abstract

The objective of this research was to analyze and evaluate farmers' bottlenecks and risks to innovate and adopt new technologies in Egypt. A literature review as well as key informant and focus group discussion were conducted to assess the bottlenecks to technology adoption by farmers in Egypt. Literature review results indicate that several personal, social, economic, institutional and policy-related bottlenecks hinder the adoption of innovation packages by Egyptian farmers in various production contexts. For example, the main bottlenecks that farmers face while using raised-bed technology package for mitigating salinity include insufficiency of raised-bed machines, high production costs, lack of regular maintenance for the available raised-bed machines, lack of chemical fertilizers, poor distribution of improved wheat seeds and lack of good pesticides. The results of key informant and focus group discussions show that price distortions are key bottlenecks for major crops such as maize, rice and wheat due to market inefficiency in the agriculture sector. In addition, the use of agricultural machinery, agricultural extension services and agricultural cooperatives are also key aspects that farmers face bottlenecks in their production and marketing of major agricultural commodities. It is crucial to address these bottlenecks through well-designed agricultural policies to help farmers adopt sustainable agricultural innovation practices in Egypt.

Key words

Agricultural innovation packages, bottlenecks to adoption, farmers, dryland agriculture policy, Egypt.

1. Introduction

Egypt's agricultural sector is one of the vital sectors in the economy in terms of providing a source of employment for a significant proportion of the population, as well as contributing to the country's food security and rural development. In this context, the adoption of agricultural innovations is regarded as a promising alternative that helps mitigate the environmental impacts of agricultural practices. Recently, the need to adopt more sustainable strategies in the agricultural sector has been growing. However, achieving sustainability in the agricultural sector mainly relies on the pursuit of specific farm practices that aim to limit the impacts of human activities on natural resources. Organic farming, precision agriculture, regenerative agriculture, and agroecology are considered effective approaches because they offer innovative solutions to tackle the challenges facing agricultural sustainability, protecting the environment, and ensuring the production of high-quality food. Despite recognizing the benefits of sustainable agricultural practices, the adoption rate of sustainable innovations remains below the level designated by the Sustainable Development Goals (SDGs). Farmers in Egypt, like many countries over the world, face various bottlenecks and risks related to innovating and adopting new technologies. Such challenges might result from a combination of economic, financial, social and infrastructure factors. We reviewed several published articles and research studies to identify, analyze and evaluate farmers' bottlenecks and risks to innovate and adopt new technologies in Egypt.

2. Literature Review

A bottleneck[1] refers to a block or congestion that hampers the smooth operation of a system or a process. It can be seen in production, engineering processes, supply chain, etc. It severely reduces the efficiency and productivity of a process while simultaneously increasing costs and lead time.

Enas *et al.* (2013) explained that salinity represents a continuous challenge in Egypt due to the country's dry climate and that more salt is being carried by the Nile River due to pollution, water shortage, seawater intrusion and human practices. However, with the help of an ICARDA's financed project, farmers in salt-affected regions in Egypt, specifically South El-Husainia Plain, were able to grow crops at an economically efficient scheme, efficiently use irrigation water and cope with soil salinity by adopting sustainable water-saving technologies and land conservation practices. The adopted package involved laser-leveling, agricultural gypsum, subsoiling tillage, improved varieties, and raised-bed farming in their farms. The authors recommended transferring such promising innovations to other farmers in the study area and encouraging them to adopt such sustainable water-saving technologies and land conservation practices to overcome unsuitable soil conditions and irrigation management. They recommended facilitating farmers' access to sufficient knowledge, improving communication channels between farmers and extension agents and training extension agents to be skilled in management practices related to salt-affected areas as highly important factors that affect achieving this goal.

Elsayed and Sabrey (2016) evaluated the recommended technology package that includes improved wheat varieties at a rate of 45 kg/acre, with a planting date set during 15-30

[1] https://www.wallstreetmojo.com/bottleneck/.

November, planting method (raised beds of different types), and nitrogenous fertilization at a rate of 75 kg/acre, and phosphate fertilization at a rate of 15 kg/acre. Results showed that demo farmers reported that the package proved useful due to achieving high yield of high-quality grains, saving irrigation time and costs, saving seeds, easy weeding, saving chemical fertilizers, and disease-resistance crop (e.g. powdery mildew). However, the main bottlenecks that farmers faced while using this package include insufficiency of raised-bed machines, high production costs, lack of regular maintenance for the available raised-bed machines, lack of chemical fertilizers, poor distribution of improved wheat seeds and lack of good pesticides.

Azazi *et al.* (2016) concluded that the most important bottlenecks faced by wheat farmers in fish farm samples include rising groundwater basin levels and the difficulty of crop harvesting and threshing. To encourage farmers cultivating wheat in fish farms, it is necessary to train and guide farmers on the importance of integrating wheat cultivation with aquaculture, besides providing production inputs at reasonable prices. This is expected to increase the domestic production of wheat in Egypt and reduce the gap in wheat without affecting the production of fish.

Eman *et al.* (2018) identify socio-economic factors representing bottlenecks to farmers' adoption of mechanized raised bed (MRB) technology in wheat production in the Sharkia Governorate of Egypt. The authors find that the variables tested were significant in explaining wheat farmers' attitudes towards the adoption of the new technology package (MRB). The variables include knowledge of the technology, age, farming experience, education, family size and land tenure. Such results provide important guidelines for policy formulation and decision-making regarding technology adoption drivers.

IFAD (2019) explained that “Climate-smart Agriculture (CSA) aims to facilitate the evolution of agricultural systems in the face of a rapidly changing climate”. Furthermore, IFAD's approach to promoting smallholders’ adoption of CSA focuses on three core objectives: “increasing yields and incomes in a sustainable manner; building adaptive capacity and resilience; and mitigating greenhouse gas emissions”. For Egypt, there is a dire need for climate-smart interventions as they have the potential to mitigate the expected serious impacts of climate change on Egypt’s agricultural sector, where the country is likely to experience gradual increases in annual mean temperature by 2030, 2050, 2085 and 2090, associated with rises in sea level, rendering large portions of the Nile Delta (Egypt's bread basket) unsuitable for agriculture, as well as raising evapotranspiration levels, placing stress on the already limited freshwater resources. One of the IFAD-financed projects in Egypt is the “Sustainable transformation for agricultural resilience in Upper Egypt” which targets three governorates in Upper Egypt; with the main aim of ensuring that 25,000 hectares are farmed using a climate-resilient water supply. Given the fact that finance is the main limiting factor for adopting innovations, the project mainly aimed to grant, or highly concessional finance, irrigation equipment, greenhouses, shelterbelts, protective fencing, and many other climate-smart interventions, deploying the tools of digital agriculture to facilitate sustainability and cost-efficiency.

Khalifa *et al.* (2019) stressed the need to cultivate the newly developed high-yielding seed varieties, use modern technology cultivation methods that increase the productivity per acre, such as laser levelling, deep plowing, and the addition of agricultural gypsum. The authors also underline the importance of using automatic combine harvester to reduce losses during production and harvesting. Adopting the raised bed planting method can also reduce the amount of seeds and the amount of irrigation water per acre by almost 25%, as well as increase production by about 25%.

Dhehibi (2019) highlighted the fact that negative impacts associated with climate change emphasize the pressing need for improved agricultural management. It was also highlighted that Mechanized Raised-Beds Technology (MRBT) is an innovative technology that involves the arrangement of farm fields to enhance water-use efficiency in irrigated systems and increase water productivity, where almost half the water quantity is needed to irrigate the same number of crops using MRBT. Therefore, plenty of water can be saved by adopting such innovative technology. Additionally, the adoption of MRBT by experimental farms resulted in increasing crop production by 10%, net benefits increased by 40% and variable costs declined by 30%. To identify those factors influencing farmers' decision to adopt MRBT, research was conducted to analyze the drivers for MRBT adoption by farmer´s households from various socio-ecological backgrounds. The research employed an Agricultural Livelihood System (ALS) typology-based approach to a random sample of 360 individual household farms in Sharkia and Assiut governorates in Egypt, 180 of which practiced traditional farming methods, while the other half adopted MRBT. Results revealed that to enhance technology adoption by farmers, policymakers and new technology developers must understand farmers' needs as well as their ability to adopt the technology.

Ahmed and Mohamed (2020) revealed that the adoption of silage and compost innovations is predicted to reach a peak level of 98% during 4 and 10 years, respectively. The authors also found that factors related to the design and characteristics of the innovation ranked on top of the factors affecting the adoption of the studied innovations, followed by factors related to agricultural extension. The authors recommended using the Adoption and Diffusion Outcome Prediction Tool (ADOPT) in predicting all agricultural innovations before starting the diffusion process, where it was specifically designed for this purpose, and the achieved results can be used to accelerate reaching the peak level of adoption of the studied innovations by affecting the internal components of ADOPT.

Kirby and El Hadidi (2021) indicate that university-technology transfer does not occur naturally and that policies need to be introduced to promote and facilitate its development. Therefore, there is an important role for Government according to the concept of the Triple Helix. The authors reveal that, as in Saudi Arabia, the Egyptian Government should set a strategy for modernizing the economy by encouraging university-industry collaboration and creating new growth-oriented knowledge/technology-based businesses as a national priority. The authors further emphasized the need to address the role of universities so that they become more entrepreneurial as a first step. The authors pointed out that the first Egyptian university-linked science park was opened at The British University in Egypt in December 2018, followed by several universities that have responded entrepreneurially to the COVID-19 pandemic to play an effective role as incubators of scientific and technology-based entrepreneurship. However, there is no evidence that technology transfer and the Third Mission have been formally adopted by institutions. In this context, the recently introduced international university branch campus program is considered important, as it introduces universities that have experience of the Third Mission and Technology Transfer to those Higher Education Institutions (HEIs) successfully engaged with industry to put in place a series of mechanisms simultaneously, both at the strategic and operational levels, and change or adapt their organizational structure, culture, and mission. The authors concluded that it is not just the policy of education that needs to be investigated, but the success of all specific policy programs to support university-industry collaborations in developing countries, not just in Egypt.

Abumousa and Elnefili (2022) found a positive effect of laser levelling of agricultural land on the production and economic indicators of cereal crop production, such as the decline in the amount of seeds, nitrogen fertilizer, and irrigation water, and the increase in the amount of the main grain crop and by-product in the Dakahlia Governorate. The main bottlenecks of using modern technologies include the small size of land holdings, the high cost of using technology, and the lack of nearby mechanization units.

Abo-Elkhair *et al.* (2022) showed a decline in the area covered with improved seeds of wheat, maize, and rice, which may be due to the weak role of agricultural extension and the high prices of improved seeds. The study stressed the need to work on increasing the quantity of improved seeds produced, whether by the governmental or the private sector, and to provide them at appropriate prices for farmers, as well as activating the role of agricultural extension to raise awareness of the importance of using improved seeds.

Atef (2022) highlighted several key problems, including limited access to finance and credit that hinder agricultural productivity and hampers the adoption of modern technologies and practices. Findings also emphasize the importance of evidence-based decision-making, guiding policymakers, and stakeholders in allocating resources effectively, designing policies and interventions that address major problems, besides performing continuous monitoring and evaluation to track progress, identify gaps and adjust as necessary.

Ashraf and Antoinette (2022) highlighted that Precision Agriculture Technologies (PATs) are encouraged as these can help maximize the economic value and mitigate the environmental impacts of agriculture. They explained that water scarcity and rapid population growth in Egypt endanger economic growth. The authors argued that since agriculture consumes more than 80% of Egypt's total water consumption, it is important to adopt efficient innovative practices that minimize environmental degradation without sacrificing high productivity. Therefore, the authors identify the factors influencing PATs adoption in Egypt. These factors included: (1) socio-demographic - studying the effect of farmer's age, level of education, and years of experience; (2) agroecological - including farm size, type of land tenure, and farmed crops; (3) financial - encompasses farm income, investment cost, perceived economic benefits and perceived environmental benefits; (4) technological - testing the impact of computer and smartphone usage, PATs and PI Usage and perceived ease of use; and (5) institutional - investigating the effect of farm, region, and development pressure. Results also indicated that perceived environmental benefits and development pressure are statistically significant factors affecting farmers' adoption of PATs in Egypt. The authors concluded that the achieved results may provide a better understanding for policymakers to formulate incentive programs and regulations for greater adoption of PATs among farmers. In addition, service providers can use such results to enhance the marketing of PTAs.

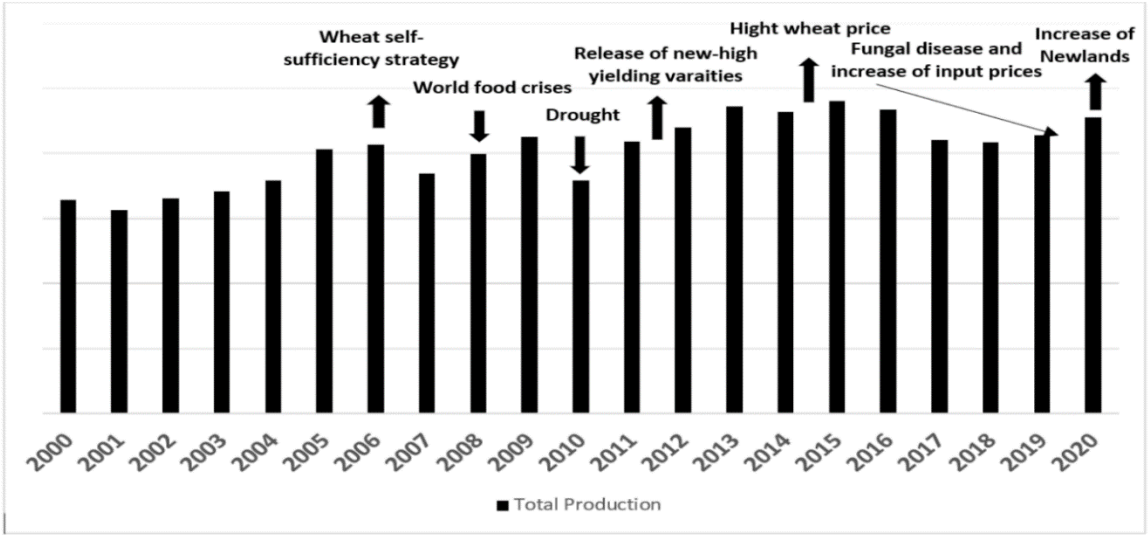
Swelam *et al.* (2022) highlighted the fact that National Agricultural Research Systems (NARS) in Egypt have been facing multiple interlinked challenges due to the dynamic nature of the drivers of change and the complexity of institutional structures and linkages. The authors explained that several efforts are being exerted by Egypt's NARS in the field of agricultural research for development (AR4D) to help develop an integrated and coherent approach to the research and dissemination of proven new technologies and practices. The main findings indicate that Egypt's Science, Technology, and Innovation (STI) System is dominated by public sector institutions and that both public and private sector organizations carry out Agricultural Research for Development (AR4D) in Egypt. The organizational setup and linkage between ARC and other national agricultural research institutions indicate the existence of venues for

interactions through the Regional Council for Research and Extension that was established to coordinate actors in Egypt's NARS. Although extension agents act as a vital link between researchers and farmers, weak communication, shortages in agricultural extension personnel, lack of financial support and the lack of trained and up-to-date informed extension agents represent limiting factors to the proper functioning of extension and advisory services and their links to researchers and farmers. In addition, the lack of adequate logistics to facilitate extension agents' mobility to work with farmers, and farmers' inability to fully benefit from AR4D leads to a lack of access to new farming technologies and improved practices. Despite the fact that AR4D projects in Egypt are aligned with the national strategy, limited financial support for agricultural research in Egypt represents a bottleneck to disseminating new technologies, improved practices and innovations developed by scientific research. The study recommended considering appropriate organizational measures and steps to facilitate collaboration among various actors to enable NARS's effective contribution to agricultural growth and development and suggested that organizations conducting research on agriculture-related issues should establish an intra-network and collaborate, and seek to reach out to other research entities in every matter of common purpose. The study proposed that ARC could take the lead in coordinating AR4D activities of the NARS by establishing research alliances among NARS actors and enhancing coordination between NARS entities through developing and implementing joint projects.

Bezaiet *et al.* (2022) investigated the logic behind farmers' choice of adaptive water management practice due to the importance this factor represents for assessing the opportunities and challenges they face, as well as for effective scaling of the targeted solutions. The paper also aimed to understand the main drivers of change that induce adaptation in water management. Findings revealed that farmers' gender-differential water management choices are influenced, not only by the individual changes in the three spheres of influence, but also their interactions. The authors demonstrated that adaptation choices in water management become more sustainable when farmers' decisions are supported by enabling environments, including local regulations, norms, national institutional frameworks, and policies and when they are also well-informed and responsive to global trends like climate change and markets.

Fatma *et al.* (2022) explained that adapting to the impacts of climate changes on agriculture to feed over 100 million citizens and protect the livelihoods of over 25 million actors in the agro-food industry has become one of the most pressing policy issues. They also mentioned that even though national policies and efforts have long focused on agricultural development, water resources management and irrigation, the ongoing challenges resulted in strategies and policies having limited progress towards effective and efficient implementation. Results and consultations under this policy paper revealed an implementation gap in the agricultural sector, which can be attributed to the situation that, while there is considerable progress in agricultural policies and strategies, and continuous efforts to address water, food, and development challenges, actual implementation of adaptation strategies to climate change has yet to reach farmers and workers in the agro-food industry. The authors pointed out that limited capacities, financing and coordination at the national level have hindered the impacts of efforts exerted to cover the existing projects and prioritize future ones. The paper suggested three policy alternatives as possible options to accelerate the implementation of strategies. These are: a) promoting the adoption of agricultural technological innovation through technology transfer; b) establishing a specialized climate-finance resource mobilization unit; and c) introducing economic/market and structural policy options regarding the agro-food chain.

Abdalla *et al.* (2023) illustrated that total wheat production started to rapidly rise between 2004 to 2005 due to adopting the strategy of enhancing self-sufficiency in wheat, which encouraged smallholders to grow more wheat by providing free machinery for land preparation and subsidized inputs, such as high-yielding seeds varieties and strengthening the role of agricultural extension. In 2005, the Egyptian government partially removed the subsidies for wheat growers, and new financial incentives for growing cash crops for export purposes were put in place. As a result of this policy, smallholder wheat producers increasingly lacked access to machinery, agricultural services were reduced, and many production inputs were no longer subsidized. This led to a significant drop of 11% in the wheat cultivated area in 2007, and consequently, a significant drop of 12% in total wheat production occurred. The world food crisis in 2007, which resulted in a significant increase in international wheat prices, pushed the Egyptian government to increase the national supply prices of wheat to encourage farmers to increase the amount of delivered wheat to national silos. As a direct result, total wheat production in Egypt increased by 8% in 2008. However, in 2009, the farm-gate price of wheat declined again by 37%, which, together with an extreme heat wave in 2010, led to a 16% drop in total wheat production in 2010, besides the significant drop in yield that occurred in the same year, estimated at 12%.



Trends and chronology of events that affected total wheat production in Egypt (2000-2020)
Source: Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of Agricultural Statistics, Various Issues.

Dhehibi *et al.* (2023) indicate the pressing need to amend the existing policies to enhance domestic production for self-sufficiency in basic food items to avoid the negative impacts of frequent changes that occur in the availability and prices of such items in global markets, including the global financial crisis, the outbreak of COVID-19 and the Russo-Ukrainian war. To achieve that, policies need to be formulated and implemented to enhance expansions in grains, oilseeds, fodder, and sugar crop cultivation. Government officials and national and international experts who attended the workshop emphasized the need to design a roadmap that acts as an integrated system for Egypt's agriculture to maximize production and realize optimum use of resources. They explained the importance of national campaigns in teaching farmers how to fully apply recommendations associated with the innovative technical packages, as well as expanding the scope of the national campaigns of grain crops so that one pilot plot is allocated

for each village, which can help achieve a 25% vertical increase in wheat yield without exerting additional efforts.

Abdalla *et al.* (2022) highlighted that technology adoption is critical for improving wheat productivity in Egypt. The article surmised that farmers' adaptive capacity to respond on time to changing demands is related to their access to modern technologies and extension services, as well as to the availability and use of human capital. The authors suggested that future studies should investigate factors influencing farmers' adaptive capacity to adopt site-specifically adapted new technologies.

Abdalla *et al.* (2023) showed that factors influencing farmers' decisions to grow wheat or implement innovative practices vary across different areas. Smallholders struggle with poor access to fundamental production factors and are discontented with the low provision of extension and support services as well as poor market structures. These constraints act as disincentives for smallholders to produce (more) wheat. They need to be addressed and eliminated to increase domestic production and reduce Egypt's dependency on expensive and unreliable wheat imports.

3. Sampling methodology

Five groups of farmers were interviewed. Three of the farmer groups were in the Kafr El-Sheikh and two of the farmer groups were in Dakahlia governorate. The two governorates mainly plant cereal crops, especially wheat in winter and both maize and rice in summer season. Each focus group has 10 farmers from all categories; 5 of them have more than 3 feddan, the rest 2 of them have more than 1 feddan and the remaining 3 of them have less than 1 feddan.

However, the key informant interviews (KII) contain 5 persons from these governorates (3 in kafr El-Sheikh and 2 in Dkahlia) in addition to the head of extension sector, agricultural services sector, agricultural cooperatives, in addition to one of the agricultural Bank of Egypt. All the KII were purposively selected because of the issues of this study has more specific type or nature and need interviewer who has a good background in detail about the policy bottlenecks.

4. Main bottlenecks for the adoption of innovations

Innovations aim to increase yield per unit area while farmers face several bottlenecks to adopt them. Therefore, bottlenecks are not limited to the innovations themselves, but rather all issues related to their dissemination and adoption. Based on focus group discussions and key informant interviews, the following bottlenecks and risks to innovating and adopting new technologies in Egypt were identified:

First: Bottlenecks in Crop Marketing
Despite the Government's announcement of indicative prices for wheat, maize and rice, farmers suffer the following bottlenecks:

1. The case of wheat

- More than 60% of wheat production is concentrated among smallholder farmers, usually for the purpose of self-sufficiency. The surplus production is then sold to traders at prices around 10 Egyptian pounds per *ardab*, ***i.e. L.E 1990 / ardab.*** *(The ardab bushel has been used in Egypt for a long time and* 1 the weight of 1 *ardab* = 150 kg) lower than the announced price leading to a price lower than the actual price. The announced price from the government is L.E 2000/*ardab* which is equal to 150 Kg. In this case, the price of one kilo is 2000/150 = L.E 13.33. If the trader takes the Ardab at 160 kg, then the price of one kg will be = 1990 /160 = L.E 12.4.
- Farmers have no choice but to sell their wheat to traders directly in-field, to avoid the problem of lengthy wait times in front of the *shawna* (storage places) and silos, as well as the costs of transporting the crop. Additionally, selling to traders ensures that farmers receive immediate payment.

2. **The case of rice and maize**
   No official entity buys maize and rice from farmers, and therefore traders do not adhere to certain prices, and farmers are forced to sell to traders at lower prices. At the same time, traders increase the maize weight by 15-20 kg per *ardab* (one *ardab* of maize by stalks = 190 kg) to offset the moisture ratio, where no standard or devices are available to measure.

Second: Bottlenecks related to Improved Seeds

1. The Ministry of Agriculture's decision to stop distributing agricultural inputs has led to severe market bottlenecks. This decision has negatively impacted farmers, especially smallholders, and increased the rates of commercial fraud in production inputs. Discussions with farmers revealed that due to the poor quality of distributed seeds, the wheat has low branching, thus farmers expect low productivity this year.
2. There is an insufficient quantity of improved seeds, currently covering only 40% of the total wheat planted area.
3. High levels of loss and waste, estimated at 10-15% of total production, are due to the increasing use of certain varieties such as Gemiza 9 and Gemiza 11.
4. Some wheat varieties, while high in productivity, produce flour that does not meet consumer preferences as the color of the flour tends to be yellow, like that of Masr 1 variety.
5. The rhythm phenomenon is prevalent in white maize (varieties 321 and 2031) and yellow maize (class 2066) due to the length of the plant stems and irrigating at inappropriate times.
6. Failure to adhere to the wheat variety map has led to farmers planting wheat varieties recommended for Upper Egypt in the governorates of Lower Egypt. Farmers prefer these varieties given that their qualities are suitable for local bread making (like Gemmaiza 10 variety). However, this practice has led to high rates of rust infection due to the high humidity in Lower Egypt, which negatively affects these varieties.
7. It is well known that wheat seeds, unlike corn hybrids, can be planted for two consecutive years without a noticeable decline in productivity. This fact motivates farmers to plant the same variety for two consecutive years. However, this behavior represents an obstacle to developing a solid plan to cover the areas intended to be planted with such improved wheat varieties, resulting in unused quantities of seed being returned or thrown away because they are not suitable for planting in other fields.
8. Th price of corn seeds is very high, ranging from LE400 up to LE1,000. As a result, farmers often resort to cheaper seeds that suit their financial capabilities.
9. The emergence of high-yielding rice varieties during the past two years, like Sakha Super 300 whose productivity ranges between 5 and 5.5 tons per acre and is drought tolerant compared to traditional varieties, has led to cost-effective agricultural operations. These varieties have also shortened the agricultural season to 105 to 120 days at the most.

Beginning cultivation in June and July is preferable since it increases the expected profitability by the end of the season. However, planting this variety in farmers' fields has revealed several problems, including its weak resistance to diseases like blight and smut, and the associated risk of such diseases being transmitted to local rice varieties. A scientific committee has been formed to evaluate the situation and find treatment methods. It is common knowledge that when a crop variety is developed, it may have high productivity for one or more seasons, leading to significant adoption. However, over time, there may be a decline in yield or a breakdown in resistance to a specific disease for various reasons. In such cases, the breeder either retests the variety or completely excludes it to maintain the integrity of the crop variety map.

10. A new rice cultivation method, known as dry seeds in dry land, has been developed, which gives higher productivity compared to planting rice seedlings. However, this method is still in its infancy, and further guidance and direction are required for its wider dissemination and adoption.

Considering the problem that has been raised regarding Sakha Super 300 rice variety, the following is crucial:

It is necessary to introduce the integration of research plans executed by relevant institutes such as Gene Bank, Crop Research Institute, Land and Water Research Institute, Plant Diseases Research Institute, Agricultural Economics Research Institute, and Agricultural Extension Research Institute when carrying out any such innovations by forming a multidisciplinary team that works according to organizational rules that clearly define the role and responsibilities of each institute within the innovation system. This team should continue its efforts even after the innovation is published to facilitate farmers' access, adoption and application of the innovation.

Third: Bottlenecks in Agricultural Extension

- Currently, there are no agricultural extension services. As a result, farmers rely on pesticide shop owners to diagnose plant disease. Farmers bring samples of infected plants to the pesticide shop owners, who diagnose the injury and recommend the required pesticide and dosage.
- Sometimes some of the farmers who have a portable spraying machine determine the therapeutic or composting dose (in case of leaves composting or nutrient addition) and spray the entire crop, including uninfected plants that do not need such doses. Then they hold farmers responsible for paying for the service.
- The results of National campaign for the advancement of crops showed that there are large discrepancies in per-acre productivities of wheat, corn, and rice between what has been achieved in the demonstration fields and what has been achieved in the farmers' fields. Differences in yields per acre are estimated 10 *Ardab* for wheat, 15 *Ardab* for corn, and about one ton for rice. Despite the Ministry of Agriculture's efforts to establish demonstration fields in each village and implement field schools in some villages, the desired goals have not been achieved, and the productivity gap persists.
- Agricultural associations, agricultural departments, and agricultural directorates are experiencing a significant decline in the number of workers in general, and extension agents in particular. It is expected that these agencies will lose more than 90% of workers by 2030.
- Efforts to apply electronic extension as a solution to the shortage of extension personnel are still modest and have not yielded any results regarding any of the three crops (wheat, corn, and rice).

Fourth: Bottlenecks in Agricultural Cooperatives

Ali (2019) finds that agricultural cooperatives do not play any role anymore. The study demonstrated the weakness of the material and technical capabilities of cooperatives involved in seed production, and that cooperatives only perform the multiplication of seeds.

Fifth: Bottlenecks related to Agricultural Machinery

Implementing any package of technical recommendations related to seed innovations requires good preparation of the soil to make it suitable for planting at the recommended rates. This typically involves subsoil tillage, the addition of agricultural gypsum in some regions, and laser levelling. However, the use of these machines faces several bottlenecks, as outlined below:

1. **Subsoil Tillage and Laser Leveling Machines**
   - Insufficient number of machines at the time of planting, as most farmers plant their crop at the same time.
   - The high cost of renting such machines, considering the low rate of return from their use.
   - Currently, some farmers have purchased high-capacity laser levelling machines and tractors for subsoil tillage and rent them to other farmers. However, the rental fees are higher than those offered by their counterparts in the mechanized agriculture sector.
2. **Raised-Beds Machines**
   - After proving the success of wheat cultivation on raised beds, the Ministry of Agriculture engaged the Military Production Association to manufacture Raised-Bed Machines (RBM) for distribution to farmers. However, these machines were initially problematic due to their large size and weight, making them difficult to operate with regular tractors (60 horsepower). Although modifications have been introduced to overcome this obstacle, the widespread adoption of these machines is hindered by their high cost and the fact that they are used for only two weeks per year. To encourage broader use, further developments are needed to adapt the machines for growing summer crops like corn and rice, particularly the rice variety that is grown by broadcast seeding using the “dry seeds in dry land” method.
   - Many farmers still believe that plant density declines when cultivated on raised beds compared to cultivation on strips using ordinary mulches. However, it is crucial to disseminate the knowledge that the fallow parts between raised beds allow for the even passing of irrigation water. This helps increase the branching rate and compensates for the decline in plant density. To achieve this, it is recommended to expand the establishment of demonstration fields where farmers can see these results in person.

Sixth: Bottlenecks related to Soil Maintenance

Most of the old agricultural lands currently suffer from the problems associated with poor drainage (covered drainage), caused by neglecting to perform regular maintenance. These serious problems have led to the deterioration of soil characteristics, resulting in a decline in productivity per acre because of the high level of ground water. This is particularly problematic as wheat, corn, and rice cultivations are concentrated in the old lands.

Seventh: Bottlenecks related to Financing

It is well known that the cultivation of cereal crops such as wheat, corn, and rice is primarily done by smallholder farmers who grow them to meet their daily food consumption needs.

These farmers typically belong to low-income groups, as they struggle to cover their daily basic expenses of food, drink, clothing, and other necessities. Therefore, implementing agricultural innovations in their fields requires a special credit package tailored to their circumstances that should incorporate three key mechanisms named "The Development Triangle (innovation comes from research, transferred by extension, and bought via credit)". To get this innovation accessible and easily applied by small farmer, it must design a soft loan through specific credit line that lead those small farmers to apply these innovations. However, obstacles that hinder the application of special credit package include (i) the complete absence of the role of cooperatives, which traditionally played a significant role in supporting smallholder farmers and (ii) the Agricultural Bank's shift away from its original development-focused mission towards a more profit-oriented approach, operating more like a commercial bank.

Eighth: Bottlenecks related to Agricultural Policy

To encourage farmers to cultivate wheat, the Ministry of Agriculture linked farmers' access to fertilizers needed for growing all crops throughout the year to the area of wheat planted. This led to:

- Farmers, in cooperation with the employees at agricultural associations, falsely register holdings that grow clover or potatoes as wheat-growing holdings to obtain their fertilizer share. This practice poses a challenge to estimating accurately wheat yields at both the national and variety-specific levels. This consequently hinders efforts to plan, monitor, and record the result of disseminating the applied technologies.
- Not obtaining the required fertilizer rates for corn, which is a highly fertilizers consuming crop (especially the hybrids), negatively affects achieving the desired results from improved seeds intended to be planted.

Ninth: Bottlenecks related to Agricultural Price Policy

a. Wheat: Estimating the price of the final crop is the main determinant of the expected return from growing the crop. There is no point in having a large production without a good price for this product. It is worth mentioning that wheat procurement prices are determined considering four axes:

First Axis: covering production costs while adding an appropriate profit margin for farmers.
Bottlenecks facing this axis involve:

- continuous increases in costs due to rising fertilizer and energy prices and labor wages.

Second Axis: Keeping up with the international prices of the crop.
Bottlenecks facing this axis involve:

- Global prices of wheat, corn and rice have more than doubled because of the COVID-19 crisis and the Russian-Ukrainian war.
- The dual exchange rate of US$ in Egypt, where the official rate is LE 30.90, while the rate is higher in the parallel market, poses a challenge to formulating an appropriate price.

Third Axis: achieving parity between wheat price and the prices of competing crops like clover and sugar beets.
Bottlenecks facing this axis:

- For clover, it is difficult to achieve this goal because it is a feed for dairy cattle, whose products directly respond to rising market prices, thereby increasing the profitability of clover.

– As for sugar beets, sugar manufacturing companies can amend the contract price for sugar beets by adding price incentives. This flexibility is not possible for the government when determining the supply price of wheat due to the lack of necessary financial allocations in the government's general budget.

Fourth Axis: Maintaining stable incomes for wheat producers.
Bottleneck facing this axis:
- Achieving this goal is difficult considering the high inflation rate currently affecting Egypt's economy.

b. Maize: a significant increase in crop productivity has been achieved despite the high cost of the innovation package associated with cultivating high-yielding hybrids and the expenses required for production inputs (land preparation, fertilizer, and pesticides). These innovations have led to farmers bearing high production costs. However, corn marketing faces several bottlenecks, the most important of which are:
1. Absence of a marketing body responsible for purchasing the crop, despite the existence of the "Center for Contract Farming" that can play an effective role in this field.
2. Competition in uses of the final product, where white corn is used for human food and as animal feed, and there is a growing trend of using the crop as silage, and animal fodder. Farmers usually harvest the white corn almost one month before crop maturity to use their land for growing other crops, thereby increasing the overall revenue.

c. Rice: rice is often marketed as paddy rice, which is usually sold to merchants in the villages since no official entity exists to purchase the crop, despite the presence of the "General Authority for Supply Commodities" in the Ministry of Supply and Internal Trade. This authority could buy rice from farmers the same way as wheat and mill it in affiliated mills, but this system is not in place.

5. Conclusion

Using literature review, focus group discussions, and key informant interviews, this policy note identifies key bottlenecks to the adoption of sustainable agricultural innovations among farmers in Egypt. Bottlenecks related to agricultural inputs like improved seeds, agricultural machinery, agricultural financing, agricultural extension, and agricultural price policy are identified. Lack of sufficient quantity of improved seeds, poor disease-resistant varieties and failure to adhere to the variety map for wheat are key bottlenecks related to improved seeds. The key bottlenecks related to agricultural machinery such as Subsoil Tillage and Laser Leveling Machines include lack of a sufficient number of machines and the higher cost of renting these machines. Agricultural financing is also a challenge in Egypt because lack of sufficient credit and agricultural banks become profit-oriented and unable to serve farmers who are their primary targets. Agricultural extension is quite limited because of the decline of extension workers in most institutions, electronic extension service is in its infancy and consequently, there is a huge discrepancy between the yields of pilots and farmers' fields. Finally, bottlenecks related to agricultural price policy need to be addressed. These include increasing the costs of production inputs such as fertilizer, seeds, energy etc. while profits are marginal. Wheat prices are also rising due to global market disruptions and a weak Egyptian pound currency exchange rate. These bottlenecks have big policy implications for the adoption of sustainable agricultural production in the dryland of Egypt. The Egyptian government needs to address these

constraints by designing and implementing appropriate policies targeted to farmers to increase their farm productivity and improve the efficiency of agricultural marketing.

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