
Impact Assessment of the ICT Enabled Program on Women's Empowerment in Agricultural Productivity

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Abstract:

Agriculture constitutes a vital component of Pakistan's economy, accounting for approximately 23.5% of the national Gross Domestic Product (GDP). Despite its substantial economic contribution, the agricultural sector is confronted with persistent productivity constraints. In response to climate variability and the escalating demands of a growing population, the adoption of modern agricultural technologies has emerged as a critical strategy for enhancing productivity, ensuring national food security, and promoting efficient utilization of natural resources. Mobile technology has become an essential tool for the spread of agricultural information, farmer advisory services, and market linkages. The Geographic Information System (GIS) and Remote Sensing are modern agricultural technologies that play an important role in crop monitoring, planning, and decision-making in Pakistan. Daharki is confronted by acute socio-economic issues such as child malnutrition, restricted growth, and food insecurity due to the underlying deprivation because of poverty and scant livelihood options. The current study utilizes both mobile technology and modern agricultural technologies to improve the productivity of the farmers at Daharki, Ghotki. The study also aims to encourage female farmers to adopt sustainable agriculture practices, such as crop rotation, organic farming, and integrated pest management, to reduce the environmental impact of food production and implement strategies to reduce food loss and waste at all stages of the supply chain, from production to consumption. This study assesses the performance of the Mari Kissan Dost Program, which has utilized mobile-based agricultural advisory, technology intervention, GIS-based crop monitoring and yield estimation. Alongside remote and on-ground advisories the program also provided subsidies to 100 female farmers through specially designed digital wallet (Agri-Pay). These interventions reduced the input cost and increased the profitability of female farmers. The results show a significant increase in their yield after the adoption of the Mari Kissan Dost Program.

Keywords: Agricultural Productivity, Information communication Technologies (ICTs), Women Empowerment

Introduction: Agriculture is widely recognized as a foundational pillar of Pakistan's economy and remains central to the economic structure of least developed countries (LDCs). In Pakistan, the agricultural sector has historically functioned as a primary driver of economic growth (I. Khan et al.,

2022). At the time of independence, agriculture contributed approximately 53% to the national GDP and employed over 65% of the labor force. However, these contributions have undergone substantial transformation over time due to a combination of social, economic, environmental, political, and climate-related factors (Raza et al., 2012). According to the Pakistan Economic Survey (2023-24), a decline was observed in employment, which is around 37.4% while the GDP share in the country's economy is around 24%, which is a huge difference from the last seven decades. From the reports of the World Bank Open Data (2024), the rural population of Pakistan is about 64% which entirely depends on the agriculture sector. The total area of Pakistan is about 796,096 km², out of which only 30-35 million hectares of land are cultivated, which is roughly around 47% of its total land, which is greater than the global average. While Punjab holds a large share of it, although not all of this land is fully cultivated (FAO 2023). Livestock contributes about 62% to Pakistan's agriculture sector, followed by the cultivation of major cash crops, other crops, forestry, and fisheries (FAO 2023). The availability of food and agriculture entirely depends on the weather conditions, natural disasters, and civil wars, when there is less production of food, the prices of goods rise, which leads to the starvation of the majority of Pakistan's population, as 1/3rd population of Pakistan is below the poverty line, which leads to food insecurity (Jatoi, 2021). Pakistan is facing major climate change threats, which are severely affecting crop production. Despite these problems, Pakistan is one of the largest producers of major crops like wheat, rice, maize, and sugarcane etc. (Pakistan Bureau of Statistics, 2024). In Pakistan, there are two cropping seasons, i.e., Rabi and Kharif. The Rabi season is typically the winter season that starts from October to April, while the Kharif season is the summer season that starts from May to October, which coincides with Pakistan's monsoon period (A. U. Khan et al., 2021). The crops sown in the Rabi season include wheat, mustard, barley, and tobacco, etc. while the crops grown in the Kharif season include rice, cotton, maize, sugarcane, etc. (Pakistan Bureau of Statistics, 2023).

Despite its importance in the national economy, Pakistan's agriculture sector faces significant productivity challenges. The acquisition of modern agricultural technologies emerged as a significant strategy in combating climate variability and increasing population demand, which leads to increasing productivity, ensuring food security, and improving resource efficiency. Internet and mobile technology adoption are increasingly playing a significant role in agricultural advancement, such as internet users among wheat farmers, the crop productivity revealed the technical efficiency score of 0.62, surpassing that of non-internet user wheat farmers (Ahmad et al., 2024). The Geographic Information System (GIS) and Remote Sensing are other modern agricultural technologies that play an important role in crop monitoring, planning, and decision-making in Pakistan. These geospatial technologies provide an extraordinary tool in real-time crop monitoring, resource assessment, and precision management (El Gayar & Singh, 2024). The incorporation of GIS technology with remote sensing technology can serve as a critical tool that enables farmers, extension agents, and policymakers to analyze the spatial information about soil, crop health, and water resources, which leads to sustainable agricultural practices through evidence-based decision-making (Toromade & Chiekezie, 2024). In Pakistan, mobile technology has become an essential tool for the spread of agricultural information, farmer advisory services, and market linkages. The use of mobile technology serves as the instrumental tool that bridges the gap between farmers and critical agricultural information by enabling real-time weather forecasts, serious disease and pest identification, and extension advisory directly through smartphones (Fayaz & Kaundal, 2025). Mobile-based agricultural advisory services have been widely used by rural farmers in Pakistan. In the Faisalabad region, 77% of the farmers are using these mobile-based agricultural advisory services provided by telecom companies and the private sector (N. A. Khan et al., 2020). Agro advisory mobile applications have been developed in Pakistan, which provide many different tools to help and assist the farming community, and the farmers are more likely to use these applications when they

see the impact of these applications on crop productivity and start trusting these applications (Soodan et al., 2023). Mobile applications also play an important role in the management of diseases and pests like Plantix, which have shown an accuracy of 90-100% in the identification of diseases and pests on staple foods (Akinyemi et al., 2023).

Rice (*Oryza sativa*) is one of the major cereal crops that is consumed by more than three and a half billion people around the world (Anonymous, 2017). The aroma, cooking quality, and flavor of the rice make it favored by most of the human population. Most countries of Asia and the Pacific, North and South America, and Africa rely on rice as the staple food, which makes it a 1/5th contribution to the global dietary energy supply (Gadal et al., 2019). In Pakistan, in terms of the area of cultivation, rice is the second largest crop and plays a vital role in foreign exchange earnings, along with cotton. The area under cultivation occupied by rice in Pakistan is about 2.89 million hectares. Pakistan is the fourth largest producer of rice and contributes 0.6% to its GDP and about 3.1% contribution to the value-added products in the agriculture sector (Government of Pakistan, 2018). Asia is the largest producer of the rice crop, which is about 89% of the total world's production, whereas China has the major contribution, which is about 55% of the total world's production, while Pakistan secures 4th position in terms of rice exports (FAO, 2024). In Pakistan, 98% of the total rice production comes from the two provinces, i.e., Punjab and Sindh, where Punjab is the largest producer, and Sindh is the second largest, with an average yield of approximately 2.68 tonnes per hectare (Sindh Investment Department, 2010). Major rice-producing areas in Sindh include Badin, Dadu, Ghotki, Hyderabad, Jacobabad, and Larkana (Sindh Agricultural Statistical Report, 2020). Ghotki is considered the agricultural hub of Sindh that produces rice along with cotton, wheat, and sugarcane, which is mainly irrigated through the Guddu Barrage System (Shah & Ai, 2025).

BaKhabar Kissan (BKK) is a leading Agri Tech company and digital agriculture platform, which aims to help and provide advisory and fulfillment services to the farming community through their SMS, IVR, mobile application, and call center services. These services provide facilities like weather forecasting, cropping calendars, pest and disease alert, market rates, and irrigation and fertilizer guidance, which strengthen the farmers through informed production and marketing decisions that lead to overcoming the problems and limitations of traditional extension services. According to the reports GSMA Mobile for development program, BKK is serving millions of farmers across Pakistan by providing climate-smart information, market linkages, and full crop and livestock cycles support. Mari Energies Limited, formerly known as the Mari Petroleum Company Limited, is one of Pakistan's leading energy companies, which aims for exploration, production, and development of hydrocarbons working in Pakistan's largest gas reservoir Mari field, in Daharki, District Ghotki, Sindh (Desk, 2025). In 2024, Mari Energies initiated the socially oriented Project named Mari Kissan Dost Program, which aims to promote modern and sustainable agricultural practices and the livelihoods of the farmers of Daharki (Fatima, 2025).

Daharki is confronted by acute socio-economic issues such as child malnutrition, restricted growth, and food insecurity due to the underlying deprivation because of poverty and scant livelihood options. The majority of households depend on small and deteriorating land holdings affected by salinity and sodicity, which are diminishing crop yield and stability in household income. In these circumstances, women who are integral yet frequently invisible in terms of agricultural labour, animal husbandry, and household food provision suffer the greatest impact. Low productivity and production from the farm impose on women domestic responsibilities, which in turn limit their ability to make decisions and confine them to a lack of education, proper nutrition, and economic activities. BKK recognizes the role of agriculture and related factors in exacerbating poverty and inequality. By equipping communities with actionable weather-based agricultural advisory, the study empowers vulnerable populations to better manage agricultural risks, enhance food security, and reduce livelihood vulnerabilities, thus contributing to poverty alleviation efforts. Through the

collaborative efforts of BKK and MARI, the study aims to empower local communities, especially female farmers, with valuable advisories for economic advancement, increasing their productivity and reducing asset losses by using tailored weather-based advisories, an early warning system, and a disaster management tool, fostering inclusive growth and prosperity. The study also aims to encourage female farmers to participate in their farming practices and to adopt sustainable agriculture practices, such as crop rotation, organic farming, and integrated pest management, to reduce the environmental impact of food production and implement strategies to reduce food loss and waste at all stages of the supply chain, from production to consumption. BKK and MARI have worked together to strengthen the means of implementation and revitalize the partnership for sustainable development.

Materials & Methods:

Research Area:

The area selected for the research is Daharki, a city in Ghotki District in the Sindh Province. The reason behind selecting the Daharki is that it falls in the social and operational responsibility zone of Mari Energies Limited, which operates Pakistan's biggest gas reservoir in this region. The Daharki region also faces food insecurity and unstable livelihoods due to chronic poverty, limited agricultural productivity, and inadequate access to modern agricultural techniques, soil salinity, and fragmented land holdings.

Target Population and Sampling:

The study focuses on female households in the Daharki region who are cultivating the rice crop. The purposive sampling was made with a particular background of the targeted population. The sample size of 100 selected females who encouraged their families, especially male members, to utilize the interventions of the Mari Kissan Dost Program.

Program Interventions:

The MKDP underwent with multiple interventions. One of the core interventions is Crop monitoring through GIS. The farms of female owned farmers were marked; crop classification and farm digitization was done. Remote crop monitoring allows field officer to identify stressed or problematic fields in advance and conduct targeted visits, ensuring timely and precise recommendations to farmers. The female field officer in this regard plays an important role. She visits the farms of these female farmers and provide them with on-ground advisory services related to rice production. This intervention has equipped farmers with data-driven decision-making and localized advisory in their native language for better adoption.

The second intervention of this program was Remote advisory services that include weather, crop & livestock advisory SMS and VMS. Farmers can get the required information through dynamic Integrated voice response IVR and call center services.

Another intervention utilized in this program was the creation of transparent digital financial inclusion (Agri-pay wallet), through which female farmers availed 7% subsidy against the rice crop. Subsidy cards with unique QR code embedded are given to female farmers to avail the subsidy manually if they don't have the smart phone and cannot access the digital wallet. This intervention has reduced the cost of input, leading to an increase in revenue and reducing poverty.

The Agri-Center provides subsidized and quality agricultural inputs, ensuring timely access to essential farm supplies. It also includes a dedicated display and sales area for female farmers, enabling them to showcase and market their produce. In addition, the warehouse component offers secure storage space for farmers to safely store their harvested produce, reducing post-harvest losses and improving income stability.

Data Collection:

All of the data used in the study came from the primary data collection sources. Structured and semi-structured questionnaires were developed to collect data. The questions were translated into the local language for the understanding of respondents.

Data Analysis:

The data obtained has been analyzed through the statistical software SPSS 16.0 version and Microsoft Excel.

Results:

The data was statistically analyzed, classified, and tabulated on SPSS software. Furthermore, descriptive statistics have been used to analyze the data. Interpretation and discussion are also made based on the results obtained.

Table 1: Socio-demographic information of respondents

Gender	Sample size (n)
Female	100

Table 1 describes the gender of respondents i.e. all respondents were females, who were contacted for the purpose of data collection. These females helped families in utilizing the interventions used during the program for increasing crop productivity.

Table 2: Distribution of respondents according to landholding size

Landholding	Frequency	Percent
0-1 acre	52	52.0
1-2 acres	17	17.0
2-3 acres	16	16.0
3-4 acres	12	12.0
4 and above acres	3	3.0
Total	100	100.0

Table 2 shows the distribution of respondents according to landholding size. The results show that 56 percent of respondents owned 0-1 acre land, 16.7 percent owned 1-2 acres land, 14.7 percent owned 2-3 acres land, 9.3 percent owned 3-4 acres land, and 3.3 percent owned 4 acres above land. This indicated that the majority of the respondents were small landholding farmers, and the mobile advisory service was mainly used by farmers with relatively small landholdings.

Table 3: Comparison of maximum yield obtained and mean yield of rice per acre of respondents before (2024) and after (2025) adoption of mobile advisory services.

Yield	Maximum	Mean	Percentage increased in 2025
Yield of rice mounds per acre in 2024	40.00	35.10	14.70 percent
Yield of rice mounds per acre in 2025	41.67	40.24	

Table 3 shows the average yield of respondents before and after the adoption of the mobile

advisory service. The results indicate that the mean yield in **2024 (before adoption)** was 35.10 **mounds per acre**, which increased to 40.24 **mounds per acre in 2025 (after adoption)**. Moreover, the average yield increased by 14.70 percent in 2025 (after the adoption of mobile advisory services) among all respondents, indicating a consistent positive impact of the advisory service on crop productivity. This reflects an overall improvement in crop yield following the use of mobile-based advisory services. This percentage increase has been calculated through the formula mentioned below.

$$\text{Formula: Yield increase percentage} = \frac{\text{Mean Yield in 2025}}{\text{Mean Yield in 2024}} \times 100\%$$

Discussion:

The data of respondents and distribution of land holdings in Daharki reveal that rice cultivation in Daharki is dominated by small and marginal farmers, a group that is particularly vulnerable to the effects of resources, soil salinity, and lack of access to formal agricultural extension. The previous studies reported that there are structural obstacles for small landholders to maintain productivity and stable incomes in Pakistan, especially in ecologically fragile areas such as the province of Sindh (Binswanger & Sillers, 1983). These limitations affected farmers disproportionately as they often have less control over the land, resources, and information, and contribute to the problem of gender-based imbalance in agricultural decision-making and outcomes (Doss, 2001).

The comparison of rice yields before (2024) and after (2025) adoption of mobile advisory services reveals concrete differences in both maximum and mean yield per acre in response to the adoption of digital agricultural advisory services, which indicates the potential critical role of digital agricultural advisory services in farm productivity improvement. This finding is in line with previous evidence showing that ICT-enabled extension services improve access of farmers to timely location-specific information on crop management, weather risks (climate), and optimizing input use to reduce yield gaps (Aker, 2011; Asenso-Okyere & Mekonnen, 2012). Mobile advisory platforms are particularly effective in regions where traditional extension coverage was weak, in offering scalable solutions for improving agronomic practices among smallholders (Mittal & Mehar, 2016).

Besides the increase in productivity, the results of yield improvement also have profound implications for women's empowerment and poverty reduction in the research area. Increased agricultural output leads to increased household income and food security, which are important determinants of childhood nutritional and educational outcomes (World Bank, 2007). Importantly, mobile-based advisory services are a way to reduce information asymmetry by reaching the women farmers to enable them to take a more active role in farm management and economic decision-making (Malapit & Quisumbing, 2015). Thus, the results highlight the potential of integrated digital advisory interventions to support improved rice productivity and, at the same time, address women's inequality and rural poverty in marginalized agricultural communities.

Conclusion & Recommendations:

The mobile-based agricultural advisory services and modern agricultural technologies can play a meaningful role in improving rice productivity among smallholder farmers in the study area, where there are problems like land fragmentation, soil salinity, and poverty, which severely affect the agricultural productivity in that area, ultimately lowering their income, leading to food insecurity. The observed increase in mean and maximum rice yields following the adoption of mobile advisory services shows the value of timely, location-specific information in enhancing farm decision-making and productivity. This progress is about more than just better crops; it's about empowering women. By sharing agricultural knowledge digitally and supporting women, more food can be produced for steady income to their families. These digital programs should be expanded to the communities that need them most, ensuring women are included every step of the way. In future it is a needed to focus

on practical solutions for soil health and keep supporting through leading agric-tech firms like BKK in the long-term impact to make sure the truly difference made in these women's lives.

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Appendix:

