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Challenges faced by farmers in maize cultivation: A review

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Abstract

Maize or corn (*Zea mays L.*) is an important cereal crop of the world. Maize, a globally significant crop, supplies around 30% of the food calories for over 4.5 billion people across 94 developing countries. The conventional paddy-wheat cropping pattern, symbolic of Punjab's agricultural legacy, has perpetuated the overuse of water resources, posing a severe threat to the sustainability of agriculture in the state. With worldwide demand for maize projected to double by 2050, it stands as the third most crucial cereal crop in India, contributing approximately 9% to the national food supply. India's annual maize production is about 21.7 million tons. However, maize farmers face numerous challenges, including labour shortages, increased incidence of pests and diseases, susceptibility to drought and heat, climate change impacts, degraded soil quality, and insufficient communication between farmers and agricultural extension workers. This review presents a detailed view on the Challenges Faced by Farmers in Maize Cultivation. Due to increasing attention being drawn towards the diversification in agriculture sector, maize crop have recently drawn more attention of studies. Thus, this review aims to discuss the major challenges and hurdles being faced by the cultivators, in order to better understand the aim and consequently improve its area under cultivation.

Keywords: Maize, adoption, challenges, corn, extension

1. Introduction

Background

Punjab, a historically significant region in India, is currently grappling with a critical water crisis. The situation is further aggravated by traditional paddy cultivation practices that have led to the depletion of groundwater levels. Paddy, an integral part of Punjab's agricultural landscape, has long been associated with high water demands, contributing significantly to the state's water woes. Punjab has been split into 150 water blocks, 132 of which have previously been designated as dark zones (Anonymous 2024) [1]. The conventional paddy-wheat cropping pattern, symbolic of Punjab's agricultural legacy, has perpetuated the overuse of water resources, posing a severe threat to the sustainability of agriculture in the state. The study is to identify the challenges associated with its production and utilization.

The Green Revolution introduced high-yielding maize varieties, which significantly boosted production. However, ecological challenges such as land degradation, water scarcity, and climate change continue to impact maize production (Grote *et al* 2021) [7].

Kumar *et al* (2020) [10] reported that by implementing different spring maize-based cropping systems, such as Paddy-Potato-Spring Maize and Paddy-Toria-Spring Maize, farmers can cultivate more than two crops in a single agricultural year and achieve higher returns from their farms. Additionally, there is significant potential to enhance the productivity of spring maize through the adoption of improved and innovative technologies. While most farmers in Punjab have traditionally followed the rice-wheat cropping system, those who grow potatoes have embraced the rice-potato-spring maize cropping system. Introducing suitable intercrops, such as summer squash, fodder maize, spring groundnut, and spinach, alongside spring maize can make this cropping system more productive and economically viable. The ideal sowing window for spring maize spans from January-end to mid-February, with some farmers extending it until early March. This temporal alignment, however, coincides with elevated temperatures from March to June, coupled with prolonged sunshine hours, presenting formidable challenges to depleting groundwater in the state. The harsh reality of Punjab's climatic conditions during these months is stark, with temperatures ranging between 35 to 45 degrees Celsius and daily sunshine hours extending from 9 to 9.5. These factors lead to rapid water evaporation from the soil, necessitating frequent irrigation for crops like maize, adding to the existing water crisis.

2. Materials and Methods

The objective of this study is to assess the potential challenges faced by the farmers in maize cultivation with a specific focus on ensuring food security and improving environmental quality. The present study employed the systematic literature review methodology as suggested by Tawfik *et al* (2019) [21]. The systematic literature review framework is considered to be a dependable approach. A preliminary review of the literature was conducted to identify pertinent articles, validate the proposed idea, avoid redundancy with previously covered issues, and ensure the availability of sufficient articles for conducting a comprehensive analysis of the subject matter. Moreover, the focal point of the themes should revolve around the inquiries on the significance of maize cultivation in ensuring food security and improving environmental quality. The present study examined various strategies aimed at focusing the real obstacles faced by cultivators in maize crop cultivation.

3. Review of Literature

The adoption of maize production technology among farmers has been studied extensively, revealing varying levels of uptake. Studies, such as those by Singh *et al* (2010) indicate that knowledge and education play critical roles in adoption rates. Farmers with higher education levels, larger land holdings, and greater access to credit and extension services are more likely to adopt recommended practices. Conversely, factors like low education levels, limited knowledge, and poor economic status are barriers to adoption. The correlation and regression analyses further highlight the significant impact of socioeconomic variables on the extent of technology adoption among maize growers.

The study was conducted by Singh *et al* (2012) in the Kanker district of Chhattisgarh to evaluate the knowledge and adoption levels of maize farmers, indicated that the majority (62.50%) of respondents had a medium level of knowledge about the recommended maize production technology, and 61.66% had a medium level of adoption of these practices.

According to study of Pati B B (2013) [16], perception survey results revealed that yield and profit were the two most determining factors for farmers. High-yielding seed varieties and line sowing emerged as the two most influential practices.

Sharma *et al* (2014) [18] and Manan *et al* (2016) [13] noticed that it is now apparent that crop growth cannot be sustained and net profitability is declining. Farmers in the region were planting maize hybrids created by several private companies and making large net profits.

Yadav *et al* (2014) [23] reported that 74.17 per cent respondents their adoption level had to medium whereas, 10 per cent of respondents fall under the category of high level and 15.83 per cent of respondents were found having low level of adoption in Tomato production technology.

Manan *et al* (2016) [13] revealed that 36.4 per cent farmers were applying higher doses of urea. However, excessive urea application leads to economic losses as well as soil/water pollution through ammonia or nitrate leaching.

Manan *et al* (2017) [11] observed a significant reduction in maize yield levels and prices due to heavy rainfall in January and February, resulting in a 9.9 per cent decrease in gross returns. Despite this, farmers continued to utilize inputs such as DAP and irrigation at higher levels than recommended, leading to diminished net returns and the depletion of natural resources. Regarding urea application, farmers adhered to the recommended quantity but applied it at inappropriate growth stages for spring maize. The adoption of insecticide and herbicide was minimal, with only 12 per cent of farmers not using either and merely 2 per cent using herbicide while applying insecticide more than once. Overall, farmers were deviating from recommendations based on their assumptions, highlighting the need for education on precise input utilization. By implementing precise input management practices, there exists the potential to further increase yield levels and gross returns.

Singh G (2017) [19] revealed that most farmers are middle-aged, have completed matriculation, and possess medium-sized landholdings. The majority have limited exposure to mass media. It was observed that over half of the farmers used the recommended seed rate for kharif maize. Most farmers planted the kharif maize crop at the recommended time. However, more than 80% of the farmers did not follow the recommended timings and methods for other agricultural practices.

Netam *et al* (2018) [14] illustrated that a significant majority of respondents (73.70%) demonstrate a medium level of adoption of recommended maize cultivation practices, with low adoption rates (22.60%) being notable. High adoption rates are minimal (3.70%). Key practices such as selecting suitable land and using improved varieties show varying levels of partial and complete adoption, while technologies like seed treatment and micronutrient application exhibit very poor adoption rates. Factors influencing adoption levels include lack of awareness, availability of resources, and the specific challenges of rainfed agriculture.

Traditional maize agriculture faces numerous challenges that hinder its potential to ensure food security (Chinthiya *et al* 2019**)** [3]**.** In Sub-Saharan Africa, malnutrition persists despite high maize consumption, partly due to nutrient loss during processing and consumer preferences that do not always align with nutritional needs (Ekpa *et al* 2019) [5]. Furthermore, the adoption of innovative agricultural practices is often constrained by limited access to seeds, finance, and education/training (Grote *et al* 2021) [7]. The environmental impacts of traditional maize farming, such as nutrient mining and water resource depletion, also pose significant challenges (Karnatam *et al* 2023) [9]. Precision agriculture and digital management tools are transforming maize farming by optimizing resource use and improving crop management (Hua *et al* 2019) [8]. These technologies include the use of GPS, remote sensing, and data analytics to monitor and manage field variability, ensuring efficient use of inputs such as water, fertilizers, and pesticides. By providing real-time data and predictive insights, precision agriculture helps farmers make informed decisions, ultimately enhancing productivity and sustainability (Grote *et al* 2021) [7]. The adoption of these innovations, however, faces constraints such as access to seeds, finance, and education/training, which need to be addressed to fully realize their potential. In summary, modern advancements in maize production, encompassing agricultural technologies, genetic improvement, and precision agriculture, are crucial for enhancing global food security. These innovations not only improve the productivity and nutritional quality of maize but also ensure its sustainability and resilience in the face of environmental challenges (Ulrike *et al* 2021) [22].

Maize production faces several agronomic challenges that impact its yield and sustainability. One significant issue is the adverse effects of climate change, which threaten agricultural productivity through unpredictable weather patterns and increased incidences of pests and diseases (Ekpa *et al* 2019) [5]. Additionally, land degradation and water scarcity are critical ecological drivers that impair maize production. Soil fertility decline and the presence of the striga weed further exacerbate these challenges, particularly in regions like Sub-Saharan Africa. Innovations in maize breeding, such as biofortification and the development of drought-resistant varieties, are essential to address these agronomic issues and improve overall productivity (Palacios-Rojas *et al* 2020) [15].

Manan *et al* (2019) [12] noticed that, farmers in Punjab are cultivating spring maize (Zea mays) from February through June despite its high-water needs, particularly during April and May's extreme temperatures. The state's provision of free power for tubewells leads farmers to overlook irrigation costs. Spring maize requires 19.7 irrigations and 9850 m^3/ha of water, causing significant subsurface water depletion, with the water table dropping 60-70 cm annually in Punjab's central plain zone. If this trend continues, the district may be designated a dark zone. The cost of irrigation water for spring maize is estimated at Rs 9,850/ha, assuming a rate of 1 paisa per 10 liters. Thus, it is crucial to discourage spring maize cultivation to prevent further water resource depletion.

Insects and pests are another severe problem for maize production. The activities of insect pests may damage 100% yield in maize. The major insects are borers, aphids, caterpillars, grasshoppers, weevils and armyworms, which affecting severely on maize production (Azad *et al* 2020) [2]. There are some (root rot of seedling, leaf blight, maize streak, downy mildew, purple leaf sheath, different kinds of spots in leaves) deadly pathogens in maize production, which severely damage maize (Azad *et al* 2020) [2]. Therefore, the management of the insect-diseases is very essential for maize production in Bangladesh.

Chowhan *et al* (2021) [4] concluded, small and large farm maize growers show high adoption rates for basic practices like land preparation and thinning. However, adoption rates drop significantly for advanced technologies such as mechanization, hybrid seed use, and pest management. Reasons cited include lack of knowledge, availability of subsidized inputs, and risk aversion under rainfed conditions. These findings highlight the gap between recommended agricultural practices and actual adoption levels, influenced by socio-economic factors and awareness among farmers.

Garcia *et al* (2021) [6] resulted that Research on the adoption of technologies in spring maize has shown various factors influencing the uptake of innovations and their impacts on productivity and sustainability. A systematic review of sustainable intensification technologies (SIT) in maize systems of the Global South highlights the socioeconomic benefits and the challenges faced, such as environmental sustainability and socio-economic inequalities. The review indicates that adoption patterns are highly context-specific, influenced by factors such as climate variability, socioeconomic conditions, and policy frameworks.

Economic and market challenges also play a significant role in maize production and consumption. Small holder farmers, who are the primary producers of maize in many regions, often face financial constraints that limit their access to quality seeds, fertilizers, and other essential inputs (Grote *et al* 2021) [7]. This economic barrier is compounded by the lack of access to education and training, which hinders the adoption of innovative farming practices. Furthermore, the market dynamics for maize are influenced by its dual role as a staple food and a key component in animal feed and biofuel production, leading to fluctuating demand and prices (Tanumihardjo *et al* 2020) [20]. The negative perception of yellow maize as a "poor man's crop" and its association with food aid also affect its marketability and consumption, despite its superior nutritional value compared to white maize.

The reviewed studies indicate that maize farmers face significant challenges in adopting recommended agricultural practices due to factors such as inappropriate input utilization, unsustainable water use, and socio-economic barriers. While hybrid varieties have led to high yields, sustainability and profitability are concerns. Adoption rates for advanced technologies remain low due to lack of knowledge and resources. Enhanced education and resource provision are essential to improve productivity and sustainability in maize farming.

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