A Review on Yield Gap Analysis on Millets in India

Abstract

Millet is a healthy grain that is high in vitamins, minerals, and fibre. It is also gluten-free and has a low glycemic index, making it a suitable diet for persons with gluten intolerance or diabetes. Millet is an important crop for small farmers, in addition to its nutritional importance. Unlike rice or wheat, millet is drought-resistant and requires relatively little water to thrive. This makes it an attractive crop for farmers in dry locations where water scarcity is a big concern. Furthermore, millet has a short growth season and is easy to cultivate, making it an appealing alternative for small farmers with low resources. Efforts have been made in recent years to boost millet productivity and promote its consumption. The Millet Mission, initiated by the Indian government in 2016, is one such project. Another endeavour to increase millet intake is the "Millets for Health" programme, which aims to raise knowledge of millet's nutritional benefits. The initiative includes the creation of millet-based recipes as well as the installation of millet-based food processing plants, which can aid in the creation of a market for millet-based products.

Introduction

Millets is the collective name for small-grained cereal grasses. These are among the first foods that mankind have ever farmed (Tomar and Singh, 2017). They are said to have been domesticated by humans before wheat and rice. As compared to rice and wheat, millet has a much higher amount of protein, fibre, and minerals, which are recognized to provide nutritional benefits (Anbukkani*et al.*, 2017; Ganapathy *et al.*, 2021). Millets are classified as nutri-cereals due to their great nutritional content. Because to their drought resistance, millets may be cultivated in challenging conditions. These crops are often grown in mountainous and semi-arid areas and are the traditional source of food for the rural poor in the country's dry land regions (Padulosi*et al.*, 2009; Mal et al., 2010). (Rao *et al.*, 2021). According to Gowri and Shivakumar 2020, India is the world's greatest millet grower, contributing to over 41% of global millet output. It is a staple food in several regions of India (Mishra *et al*., 2019). Millets are divided into two groups: large millet, which includes sorghum and pearl millet, and small millet, which includes finger, barnyard, tiny, kodo, foxtail, and proso-millet.

Table 1 : Sorghum production scenario of top 10 countries in 2021

Country	Yield(Kg/ha)	Area(ha)	Production(tonnes)
United States of America	433090.00	2626440.00	11374900.00
Nigeria	117980.00	5700000.00	6725000.00
India	113440.00	4240000.00	4810000.00

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Ethiopia	269700.00	1650000.00	4450000.00
Mexico	336800.00	1297538.00	4370063.85
Sudan	51010.00	6920000.00	3530000.00
Argentina	443430.00	748566.00	3319341.00
China	475090.00	631910.00	3002146.00
China, mainland	476190.00	630000.00	3000000.00
Brazil	282120.00	888534.00	2506772.00

Source: FAOSTAT

During the period of the Green Revolution, there has been a decline in the area and output of millets in India, while the area of key cereal crops like wheat and rice has expanded, as has the cultivation of commercial crops including oilseed, cotton, spices, fruits, and vegetables (Malathi, *et al.*, 2016). Between the Indo-Gangetic Plain to the north and the Vindhya Mountains to the south, the UP state's Bundelkhand area is hot and semi-humid. In Uttar Pradesh, it is made up of the following 7 districts: Banda, Chitrakoot, Hamirpur, Jalaun, Jhansi, Lalitpur, and Mahoba. Rain-fed, diversified, hazardous, and susceptible, Bundelkhand's agriculture has a long history of droughts (Gupta *et al.*, 2014). Traditional crops of the Bundelkhand region of UP state, such as pearl millet, sorghum, as well as minor millets like kodo millet, little millet, and barnyard millet, continue to occupy a sizable area. An attempt was made to examine the trend of area coverage, production, and productivity of millets over the previous two decades (2000-20) in the region in light of the significance of millets in the region as well as the rising relevance of millets as nutritious food in the country.

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Materials and method

Front Line Demonstrations (FLDs) are an important aspect of agricultural development that helps to increase the yield potential of various crops. In the case of millet crops, FLDs can play a critical role in increasing the production of these crops, which are an essential source of food and livelihood for millions of people in many parts of the world. This essay explores the importance of FLDs in increasing the yield potential of millet crops.

FLDs are a method of on-farm testing and demonstration of new technologies, practices, and inputs that can help increase crop yields and improve the overall performance of a farming system. FLDs are conducted in collaboration with farmers, and they aim to test and demonstrate the effectiveness of new agricultural technologies, such as improved seed varieties, crop management practices, and post-harvest handling techniques. FLDs provide an opportunity to demonstrate the potential of new technologies to farmers, extension workers, and other stakeholders, and to assess their adoption and impact on farm productivity and profitability.

In the case of millet crops, FLDs can help increase the yield potential by testing and demonstrating the effectiveness of improved seed varieties, crop management practices, and post-harvest handling techniques. For instance, FLDs can test the performance of new millet varieties that have higher yield potential, improved resistance to pests and diseases, and better adaptation to local conditions. FLDs can also test and demonstrate the effectiveness of improved crop management practices, such as integrated pest management, soil fertility management, and water management. Finally, FLDs can test and demonstrate the effectiveness of post-harvest handling techniques, such as improved storage and processing methods that can help reduce losses and improve the quality of millet crops.

FLDs can be effective in increasing the yield potential of millet crops for several reasons. First, FLDs involve farmers in the testing and demonstration of new technologies, which can increase their interest and motivation to adopt these technologies on their farms. Second, FLDs provide an opportunity to assess the potential of new technologies under local conditions, which can help identify the most suitable technologies for local farmers. Third, FLDs can provide scientific evidence on the effectiveness of new technologies, which can help convince policymakers and other stakeholders to support their adoption and scaling up.

There are yield gaps in India's various crops, despite the technologies developed by various National Agricultural Research System (NARS) institutes and made available to end users by extension agencies. Since yield gaps in crops are a real issue, they must be resolved in the interest of increased and sustainable crop production. This review article's goal is to discuss yield gaps in millet crops, offer techniques to close those gaps and increase yield, identify the factors that contribute to yield gaps, and then offer advice, primarily to the government and policymakers, on how to come up with rules or solutions to the issue.

Result and discussion

Extension gap

The gap between demonstration yield and farmer practice production is known as the extension gap. Greater extension gaps show how widely used modern technologies are. The yield gap for Kharif Jowar was 10.90, 9.15, and 4.93 q/ha, respectively, in the North Eastern Plain Zone, Eastern Plain Zone, and Vindhyan Zone of Uttar Pradesh, according to Verma *et al.* (2019).According to Rawat *et al.* (2019), the average extension grain yield gap for finger millet varied from 4.82 to 5.29 q/ha over five years, whereas the extension grain yield gap for barnyard millet ranged from 5.60 to 8.25 q/ha. Fodder yield, on the other hand, revealed a greater extended yield gap in both crops, ranging from 12.27 to 17.61 q/ha in the case of finger millet and 10.98 to 13.25 q/ha in the case of barnyard millet.Sorghum yield was shown to be much greater than that of farmer's practices, according to Ashoka*et al*. (2020). In compared to the local check, higher grain yields of 20.64, 15.19, and 25.29 q/ha were noted over the research period. In three years, the extension gap between farmers' practices and the technology that had been exhibited ranged from 3.6 to 1.31 q/ha, with 2.45 q/ha being the average.The average extension gap in the improved methods was 8.76 q ha-1 for finger millet, 8.28 q ha-1 for Kodo millet, and 3.11 q ha-1 for tiny millet, according to Thakur *et al*. (2017). The yield gap founded by various

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researchers shows farmers fails to adopt the recommended package of practices which is the major cause of extension gap and there is a scope to increase yield in the regional farmers.

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Technological gap

The result of discrepancies between prospective yield and demonstrated yield is the technological gap. According to Rawat*et al*. (2019), the average technological gap for grain yield in finger millet ranged from 5.63 to 7.81 q/ha over the five years, and 6.63 to 8.81 qtl/ha in barnyard millet, whereas fodder yield varied from 32.65 to 35.21 q/ha in barnyard millet and 27.65 to 30.21 qtl/ha in barnyard millet. According to Thakur *et al*., the average technology gap for finger millet is 9.91 qtl/ha.The technology gap was measured over several years, and according to Ashoka *et al.* (2020), it was lowest (1.81 q/ha) in 2017–18 and largest (2.73 q/ha) in 2018–19. The technological gap was 2.45 q/ha on average.The average technological gap in the improved technology was observed at 9.91 q ha-1, 5.43 q ha-1, and 4.15 q ha-1 in finger, kodo, and tiny millet, respectively, according to Thakur *et. al*. (2017).

Technology index

The technology index shows the degree of viability of commercially available technologies. According to Rawat *et al*. (2019), the technology index estimated for finger millet ranged from 24.92 to 28.83% for grain yield whereas barnyard millet exhibited a higher value that ranged from 30.14 to 40.05% for grain. According to Thakur*et al*. (2017), the indices for finger, kodo, and tiny millet were 39.63, 27.17, and 70.97% respectively. According to Jat and Gupta (2014), the average technology index for pearl millet fodder output was determined to be 69.30%. The technology index was greatest in village Singwara in 2008, at 110.82 percent, and lowest in villages Aluda and Reta in 2011.

Economic return/analysis

According to Rawat *et al.* (2019), highest gross returns of 46,731.30 Rs. /ha, net returns of 25,390.22 Rs./ha, and B:C ratio of 1.48 were calculated under improved practices, while highest gross returns of 44651.30 Rs./ha, net returns of 24,300.22 Rs./ha, and B:C ratio of 1.30 were observed across the years for barnyard millet under farmers' practices. According to Ashoka*etal*. (2020), the average net returns from the suggested practice were greater (Rs. 39, 085/-) than those from the farmers' practice/control plot (Rs. 30,008/-). The benefit: cost ratios of demonstration plots (3.50) were substantially greater than the control plots, according to an economic study of the yield (2.78). According to Thakur (2017), better practices resulted in a greater net return and B: C ratio of Rs. 14153.00 and 1.67 for finger millet, 20449 and 3.15 for kodo millet, and 3766 and 0.67 for tiny millet. This might be attributed to increased yields achieved from improved technology *vs* farmer practices. According to Jatand Gupta (2014), the average fodder output of the front line demonstration was 5290 kg/ha in hamlet Bhojpura, Peechupada. Moreover, among the greatest B: C ratio was recorded in hamlet Bhojpura, Peechupada, with a ratio of 4.34.

Constraints

Farmers encounter a variety of issues while growing crops. The bulk of the time, these issues prevent farmers from adopting improved agricultural methods recommended by research institutes or organizations; some of these issues are addressed in this section and have also been noted by many researchers throughout India in their studies like Lack of credit availability, lack of irrigation facilities, labour management, low availability of improved varieties, high cost of fertilizers, irregular power supply, inadequacy of labour at required time, unavailability of biofertilizers. According to Rawat*et al.* (2019), the major problems faced by farmers are wild animal damage (86.67%), which causes massive crop losses, followed by a lack of high yielding varieties (81.17%), timely availability of quality seeds (78.33%), marketing (76.33%), a lack of technical knowledge (74.78%), and the use of higher seed rates (71.50%) Diseases such as grain smut in barnyard millet and Cercospora leaf spot in finger millet were also identified as a key grain production restriction by farmers (41.67%), followed by insects (21.17%).

Conclusion

Millet has been an important part of Indian culture and cuisine for thousands of years. However, its cultivation and consumption have been declining in recent years due to various factors. Efforts are being made to increase the yield of millet and promote its consumption, particularly in regions where it has traditionally been grown. By doing so, we can ensure that millet continues to play an important role in the lives of millions of Indians, both as a nutritious food crop and as a source of livelihood for small farmers. India has a huge potential to increase crop yields at farm level. In many countries of the world, yield gaps in crops between potential and farmers' yields are still substantially high due to the combination of constraints, such as poor management and socio economic conditions of farmers and lack of resources, especially credit and knowledge and commitment of the government. The major constraints observed in many studies were socio-economic constraint lack of knowledge about improved technologies, At the same time, development of infrastructure and rural institutions are essential to further accelerate and sustain the productivity growth in the region. It is also essential to promote collaboration among research, extension, NGOs, and private sector to develop appropriate technologies with a view to narrowing yield gaps. It has been observed in majority of the studies that training and FLD had acquired latest knowledge on the improved sorghum production technologies, value-added food products, sweet sorghum and topics covered in the training/FLD. The training had a positive impact on them by increasing their understanding and practical aspects of the course content. It is stated that FLD is much needed to improve competencies of extension functionaries of state development departments in the context of changing agricultural scenario. It has been observed from various studies that Front Line Demonstration is being helpful tool in increasing the knowledge, yield of the farmers and in minimizing the technological and extension gap.

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