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Impact assessment on frontline demonstration for popularization of biofertilizer application (*Azotobacter* and PSB) @ 250 g/10 kgs in maize under Jhum condition of Kiphire District Nagaland, India

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Abstract

Krishi Vigyan Kendra Kiphire, ICAR for NEH Region, Nagaland Centre, conducted a study on impact of Frontline Demonstration biofertilizer application in maize which was demonstrated during two consecutive years, 2021 and 2022, where 120 farmers were involved for demonstrating the technology in an area of 10 hectares covering 2 villages. The crop was sown in the first fortnight of April and harvested in the month of August during both the years. The average data on yield was recorded for both demonstrated and farmers practice for analyzing the different parameters. The highest average maize yield was recorded with the application of biofertilizer (24.50 q/ha and 25.95 q/ha) by following recommended package of practices as against the farmers' practice (20.22 q/ha and 19.20 q/ha) during the year 2021 and 2022, which recorded an increase in yield percentage of 21.17 and 35.16 percent respectively over the farmers' practice. It was observed that there is a considerable extension gap which stand at 4.28 q/ha and 6.75 q/ha during the year 2021 and 2022 respectively. It was also observed that the there is a wide technology gap during both the years. A higher technology gap during 2021 was recorded at 5.50 q/ha as compared to 2022, which was recorded at 4.05 q/ha. The technology index during 2022 was lower (13.50) than during 2021(18.34). The gap analysis reveals the need for more effort to be initiated through different means by different agencies so as to educate and encourage the farmers about the new technologies so as to reduce these gaps.

Keywords: Front line demonstration, technology gap, extension gap, technology index

Introduction

Maize (*Zea mays* L.) is an important cereal crop belonging to family Poaceae and has its centre of origin in Mexico. Maize is mainly a kharif season crop but also cultivated in rabi season in some places. It is grown throughout the temperate, tropical and sub-tropical zones of the world. In Nagaland, maize is cultivated in an area of 39784 hectare with a production of 62010 metric tons (Anonymous 2022) [1]. Ideal soils are rarely found in nature. Hence, soils have to be improved to suit the crop not only by adding nutrients but also by other soil amendments, like organic matter for maintaining the activity of soil organisms. As heavy feeder of nutrients, maize productivity is largely dependent on nutrient management because of which it needs fertile soil to express its yield potential. It is an exhaustive crop and requires all types of macro and micro nutrients for better growth and yield potential. Fertilizer application is one major farming operation needed to correct deficiencies in the soil in order to ensure proper growth and functioning of crops with the aim of increasing yield. However, for effective soil fertility management, the right quantity of fertilizer needs to be applied. Hybrids and composite varieties of maize exhibit their full yield potential only when supplied with adequate quantities of nutrients at proper time (Singh *et al.*, 2017, Singh *et al.*, 2018) [10, 11]. Bio-fertilizers play a very significant role in maintaining soil fertility by fixing atmospheric nitrogen, both in association with plant roots and without it, solubilizing insoluble phosphates and producing plant growth substance in soil. Proper application of bio-fertilizers increases the crop yield to 15-20% under field conditions.

Maize is the major crop taken up by the farmers of the district on a large scale which is commercially grown and covers majority of the land under cultivation, which accounts for 5539 ha with a production of 7320 MT (Nagaland Statistical Handbook, 2022). The cultivation of the maize is mostly of local variety which, besides longer in crop duration, gives very less productivity (13.21 q/ha). Maize is an exhaustive crop and its continuous cultivation may lead to severe nutrient depletion particularly N, P and K. At the same time, the farmers of the district do not adopt to any nutrient management practices and rely only on the natural soil replenishment. Therefore, there is a wide gap between the production potential and actual production realized by the farmers. This may be due to non-adoption of recommended package of practice including non- adoption of soil fertility management by the farmers of the district.

In the line of the above points, On Farm Trial was conducted and as a follow up program where a large-scale demonstration on application of biofertilizer in maize was conducted covering 10 ha in two different villages by involving 120 farmers.

Keeping the above points in view and steps taken up to popularize the technology, the present study was undertaken to find out the potential of the technology on bridging the yield gap in terms of technology gap, extension gap `and technology index.

Materials and Methods

Kiphire district lies in the eastern part of Nagaland and is the ninth district of Nagaland which was carved out of Tuensang on January 24, 2004. Kiphire district is surrounded by Myanmar in the east, Tuensang in the north, Phek in the south and Zunheboto district in the west. The district had a total area of 1526.36 sq. km with an altitude of 896.42 MSL. The climate is humid and hot during summer and cold during winter with winter temperature touching a low of 2.7 ^{0}C and a high of 37 ^{0}C during summer. Monsoon period extends from June to September and sometimes up to October where sufficient amount of rainfall was received over the years. It has 104 recognized villages and a total household of 11015 with a population of 74,033 (2011 census).

The frontline demonstration on bio-fertilizer in maize crop was conducted at Longmatra block in two different villages during the year 2021 and 2022 with an aim to provide organic nutrient to the crop at the same time to aid in soil sustainability. The seed were treated with *Azotobacter* and *PSB* @ 250 g/10 kg of maize seeds by dipping into the slurry for half an hour and then shed dried before sowing in the field. All recommended package of practices were followed in the demonstrated field whereas in the non-demonstrated field, the existing practices were followed. A total of 10 demonstration was conducted covering and area of 10 ha involving 120 farmer participants. To further understand the impact of the technology demonstrated, the study was conducted to identify the gap and suggest effort to put in by different agencies to bridge the gap.

To estimate the extension gap, technology gap and technology Index, the following formulae as suggested by Samui *et al*., (2000) [9], Kadian, *et al*., (2004) [6] and Sagar and Chandra (2004) [8] were considered. The analytical tool used for assessing the performance of the FLDs are as follows.

$Extension\ Gap$ = Demonstration Yield −Farmers' Practice

$Technology\ Gap$ = Potential Yield− Demonstration Yield

$$\text{Technology Index} = \frac{\text{Potential Yield} - \text{Demonstration Yield}}{\text{Potential Yield}} \times 100$$

$$B.C\ Ratio = \frac{\text{Gross return}}{\text{Gross cost}}$$

Results and Discussion

Yield analysis: Data pertaining to table 1 and Table 3 reveals that the highest average maize yield was recorded with the application of biofertilizer (24.50 q/ha and 25.95 q/ha) by following recommended package of practices as against the farmers' practice (20.22 q/ha and 19.20 q/ha) during the year 2021 and 2022, which recorded an increase in yield percentage of 21.17 and 35.16 percent respectively over the farmers' practice. The higher grain yield associated with *Azotobacter* may also be attributed to more number of cobs per plant, cob length and girth and grains per cob. This effect is also reported by Mala *et al.*, (2010) [7] and Farboodi *et al.*, (2011) [5]. This might be due to the positive effect of organic fertilizer and biofertilizers on better root development which resulted in more nutrient uptake. These microorganisms also produce vitamins and plant growth promoting substances for the betterment of plant growth. Organic manures not only slowly release nutrients slowly but also prevent the losses of leaching (Arshad *et al*. 2004, Anup Das *et al*., 2010) [3, 2].

Gap analysis

It was observed that there is a considerable extension gap which stand at 4.28 q/ha and 6.75 q/ha during the year 2021 and 2022 respectively (Table 2). It was also observed that the there is a wide technology gap during both the years. A higher technology gap during 2021 was recorded at 5.50 q/ha as compared to 2022, which was recorded at 4.05 q/ha. These differences in technology gap during different years may be attributed to differential climatic conditions and a reduction in soil nutrient in the farmers field with application of biofertilizer. The technology index indicates the feasibility of the evolved technology at farmer's field. Lower the technology index, higher is the feasibility of the technology. Higher technology index reflects the inadequacy of the technology or insufficient extension service to transfer the technology. The technology index during 2022 was lower (13.50) than during 2021(18.34). The gap analysis reveals the need for more effort to be initiated through different means by different agencies so as to educate and encourage the farmers about the new technologies so as to reduce these gaps.

Economic analysis of frontline demonstration of biofertilizer in farmer's field

Perusal to data depicted in table 4 reveals the performance of the biofertilizer application which not only results in higher yield but also provided higher benefit cost ratio *i.e.* 2.45 and 2.60 as against 2.03 and 1.96 in the farmers' practice. This may be due to higher yield obtained with the application of the biofertilizer in maize. The table also reveals that the demonstration recorded higher gross return and net return as compared to the farmers' practice.

Table 1: Yield analysis of Frontline Demonstration of biofertilizer in farmers field

Year	No of Demonstration	Technology Demonstrated	Demonstration yield q/ha	Farmers Practice q/ha	Percent increase
2021-22	10	*Azotobacter and PSB*) @ 250 g/10 kgs	24.50	20.22	21.17%
2022-23	10	*Azotobacter and PSB*) @ 250 g/10 kgs	25.95	19.20	35.16%

Table 2: Gap analysis of Frontline Demonstration of biofertilizer in farmer's field

Year	Technology Demonstrated	Potential yield q/ha	Demonstration Yield q/ha	Farmer's Practice q/ha	Extension Gap q/ha	Technology Gap q/ha	Technology Index (%)
2021	10	30	24.50	20.22	4.28	5.50	18.34
2022	10	30	25.95	19.20	6.75	4.05	13.50

Table 3: Average data on the effect of biofertilizer application on growth and yield of maize

Parameters	With Bio-fertilizer	Without Bio-fertilizer
Average no. of cobs/plant	2.40	2.20
Average no. of seeds per cob	611.50	598.36
Average cob length (cm)	28.00	25.44
Test weight (g)	296.24	291.28
Yield (q/ha)	24.50	20.22

Table 4: Economic Analysis

Year	Practice	Gross cost Rs/ha	Gross return Rs/ha	Net return Rs/ha	B.C Ratio
2021-22	Demonstration	20000.00	49000	29000	2.45
2021-22	Farmers' practice	20000.00	40440	20440	2.03
2022-23	Demonstration	20000.00	51900	31900	2.60
2022-23	Farmers' practice	20000.00	38400	18400	1.92

Conclusion

The FLD conducted to study the impact of biofertilizer application as seed treatment in maize and improved package of practice reveals that the farmers' obtained high net return from the adoption of the system of nutrient management. This technology is observed to have a long-term effect on the soil nutrient availability thereby increasing the crop yield in the subsequent years and increases the soil productivity. However, it is observed that there is exist a wide gap in the extension system for which the agencies need to further motivate the farmers for adoption of the new technology and also at the same time ensure the availability of the inputs so as to ensure horizontal spread of the technology ensuring high production and profitability for the farmers.

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