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Yield gap analysis 'Infarmers' participatory seed production plot of lentil (*Lens culinaris* Medic.) at old alluvial zone of West Bengal, India

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Abstract
A field study was carried out during *rabi*2016-17, 2017-18 through the demonstrations to analyse the yield gap of lentil in Dakshin Dinajpur district of old alluvial zone, West Bengal, India in real farm situation. Seed inoculation with *rhizobium* along with foliar spraying of supplemental nutrient NPK (19-19-19) and micronutrient Boron as solubor (20.5%B) at 25-30 DAS and 45-50 DAS in basal application of 20:40:20N: P_2O_5: K_2O kg ha^{-1}showed better seed yield (1092.18 kg ha^{-1} and 1115.24 kg ha^{-1} during 2016-17 and 2017-18 respectively) in comparison to the traditional farmers' practice (783.94 kg ha^{-1} and 798.16kg ha^{-1} during 2016-17 and 2017-18 respectively) with decreasing technology gap as well as technology index. On an average of two years, demonstration package also fetched a good return per rupee of investment (2.19) in comparison to farmers' practice (1.82).

Keywords: Demonstration, lentil, extension gap, technology gap, technology index

Introduction
Pulses play a vital role in food and nutritional security of millions of down trodden people of the world. Being rich in protein, poor people mostly depends on pulses to meet their daily requirements of essential nutrient. 2.5-3. 5million tonnes of pulses are imported by our country every year for meeting the demand of the growing population and this led to decline in the availability of pulses in the country from 69 g capita $^{-1}day^{-1}$ in 1961 to 33 g $capita^{-1}day^{-1}$ in 2009-10 (Ali and Gupta, 2012) [3]. Amongst the sixty cultivated species of grain legume, the lentil (*Lens culinaris* Medic.) is widely adopted annual legume pulse crop in winter and is traditionally also grown as rain fed crop in *rabi* season. Lentil is a common pulse crop in rice intensive cropping system of West Bengal. Dakshin Dinajpur district of West Bengal is not in the exception of this agricultural scenario. This Dakshin Dinajpur district of old alluvial zone is characterised by clay-loam soil having pH between 4.5 and 5.5 with annual rainfall of 1500-1700 mm. Though lentil is the common pulse crop in this district, the productivity is declining in comparison to the state average productivity. The poor productivity of lentil might be due to imbalance application of inorganic fertilizers round the year in a same piece of land and non-availability of macro and micro nutrients especially boron to the plants due to acidity in soil. Foliar spray of supplemental nutrients may provide immediate nutrition to the crop and boost the yield (Begum *et al.* 2018) [4]. Furthermore, the resource poor farmers are reluctant towards to take the pulse crop as serious one and to manage the crop scientifically. Therefore, it always matters for the researcher and the extension workers that real potential of lentil crops are harvested at the farmers' field. In the real farm situation a gap is observed between potential yield of certain variety of a crop during its evaluation in yield on organized farm demonstration and yield harvested by the farmers themselves. But utilizing the available resources and applying low cost technologies it is possible to achieve higher seed yield by minimizing the yield gap and increasing the existing productivity level up to a certain extent.
Keeping this in mind a field study was undertaken to assess the yield gap between the technological interventions with foliar spray of NPK (19:19:19) along with boron (20.5%)and the conventional farmers' practice in the lentil at the old alluvial zone of West Bengal.

Materials and Methods
The study was carried out during 2016-17 and 2017-18 in the farmers' field at the Gangarampur block of the Dakshin Dinajpur district of West Bengal. The Regional Research Station, Old Alluvial zone under Uttar Banga Krishi Viswavidyalaya took an initiative to produce lentil seeds through the participation of the farmers and the technology to be

demonstrated at the seed production plots under real farm situation. Two numbers of group meeting were conducted to motivate the farmers about the seed production as well as demonstration package in two parts of the block with the active cooperation of a local Farmers' Club and accordingly identified the interested farmers and the farmers list was prepared. Total area of 10.00 hectare was covered under demonstration package in lentil seed production plots with active participation of 45 farmers during two years of the study. Specific skilled training of the farmers in the seed production technology as well as the demonstration package was organized to make the farmers aware on the modalities and to convince about the potentialities of the technologies. The package demonstration comprised seed inoculation of lentil with *rhizobium* culture along with two combined foliar sprays of NPK (19:19:19) and solubor (20.5% B) in addition to the basal application of recommended dose of fertilizer (N: P_2O_5: K_2O @ 20:40:20 kg ha^{-1}). Timely irrigation were emphasized in the demonstration. The traditional cultivation practices were maintained in the adjacent plots which were considered as farmers' practice or the local control. WBL-77 (Moitree) was the test variety in this demonstration as well as in the seed production as this is the popular variety of lentil in the West Bengal context. This variety was released from The Pulses and Oilseeds Research Station, Berhampore, West Bengal in the year 2008. This variety was taken for demonstration package and the same variety is also in practice by the farmers. The differences between the technological interventions in the demonstration package and the existing farmers' practice are specified in the table1. The soil under the study were slightly acidic; ranged between 5.0 and 5.5, the status of the available N and P_2O_5 was low and K_2O was medium. The technology index is an effective tool to test the feasibility of a technology. The technology index can measure the applicability of the technology evolved by the farmers. The data output received from both the plots from package demonstration plots and the farmers plot or the control plots were finally used to determine the extension gap, technology gap and technological index as described by Samui *et al*, (2000) [9] is given here.

Technology gap = Potential yield – Demonstration yield
Extension gap = Demonstration yield- Farmers' practice yield

$$\text{Technology index} = \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}} \times 100$$

The return per rupee of investment was also calculated considering the market price prevailed. Though the plots were under seed production, the sell rate of lentil was not considered as the rate of quality seed, it was considered only as a non-seed lentil to keep the parity in the return with the farmers. The productivity of lentil was more emphasized here.

Table 1: Interventions in demonstration package and Farmers' conventional practice on lentil

Sl. No	Particulars	Lentil (*Lens culinaris* Medic.)	
		Demonstration package	**Farmers' practice (Control)**
01.	Farming situation	Medium land	Medium land
02.	Cultivar	WBL-77 (Moitree)	WBL-77 (Moitree)
03. a.	Fertilizer	N: P_2O_5: K_2O @ 20:40:20 kg ha^{-1}	Indiscriminate application; mainly DAP @ 75 kg ha^{-1}
b.	Seed inoculation	*Rhizobium* @ 5g kg^{-1} of seed	No inoculation
c.	Foliar sprays of nutrients and micro nutrients	NPK(19:19:19) @ 5 g lit^{-1} of water along with Solubor (20.5% Boron) @ 2g lit^{-1} of water at 25-30 and 45-50 DAS	No spray
04.	Water management	One light irrigation just before flowering	One light irrigation just before flowering
05.	Weeding	No such measure was taken	No such measure was taken
06.	Plant Protection	No such measure was taken	No such measure was taken

Results and discussion

From the table 2 it is revealed that the demonstration package has the positive effect over the farmers' practice on yield attributing characters of lentil. The number of pod per plant (115.6), number of seed per pod (1.82), number of root nodule per plant at 45 DAS (13.68) and number of root nodule per plantat 65 DAS (17.85) were recorded higher than the farmers' practice which ultimately reflected in the seed yield (table 3) of lentil successively in the Dakshin Dinajpur district of the old alluvial zone during 2016-17 and 2017-18.

Table 2: Yield attributing characters of lentil under demonstration package and existing farmers' practice (Mean of two years)

Parameters	Demonstration package	Farmers' practice
No. of pods $plant^{-1}$	115.6	88.7
No. of seed pod^{-1}	1.82	1.14
No. of root nodule $plant^{-1}$ at 45 DAS	13.68	9.03
No. of root nodule $plant^{-1}$ at 65 DAS	17.85	10.12

During the year 2016-17 the average demonstration yield was recorded as 1092.18 kg ha^{-1} which was 39.32% increase over the farmers' practice and in the next year the average yield of lentil was recorded as 1115.24 kg ha^{-1} which was 39.73% higher than the farmers' practice. Biological nitrogen fixation by the *Rhizobium* sp. in root nodule is a way in which atmospheric nitrogen enters in to the biosphere. The living organisms exist in natural state in the biosphere. Seed inoculation with *Rhizobium* was supposed to increase the population of the active nitrogen fixing bacteria in the rhizosphere of the lentil crop which encouraged the sufficiency and availability of adequate plant nutrients for better nodule formation. Ahmed *et al*. (2008) [1] reported that the root nodulation, nitrogen content of shoot and root of lentil, yield components as well as yield components are significantly affected by *Rhizobium* inoculation. Thus *Rhizobium* inoculation might have played an important role in higher seed yield of lentil in demonstration plots. Among the application methods of fertilizers, the most important methods of application is foliar nutrition because foliar nutrients

facilitate easy and quick consumption of nutrients by penetrating the stomata or leaf cuticle and enters in to the cells. It is determined that during crop growth supplementary foliar fertilization increases plants mineral status and improve crop yields (Rahman, 2014) [8]. Foliar application of NPK (19:19:19) and Solubor (20.5%B) was supposed to have a better nutrient consumption by the lentil crop with the efficient use of the applied nutrients in the demonstration blocks of the old alluvial zone. Anonymous (2009) [2] reported that balanced application of N, P, K and B significantly increases the yield of lentil. Mudalagiriyappa *et al.* (2016) [6] also found higher plant height, number of secondary branches, total dry matter accumulation, yield attributes such as number of pods per plant, pod weight per plant and seed yield in chick pea with the foliar spray of NPK (19:19:19) at the time of flowering and pod development stage as compared to no foliar spray.

Table 3: Seed yield, Technology gap, Extension gap, Technology index and return per rupee of investment of lentil

Year	Seed yield of lentil (var.WBL-77) in kg ha^{-1}			% of increase over the control	Techno-logy gap (kg ha^{-1})	Extension gap (kg ha^{-1})	Technology index (%)	Return rupee^{-1} invested	
	Potential	Demonstration	Farmers practice					Demonstration	Farmers Practice
2016-17	1500	1092.18	783.94	39.32	407.82	308.24	27.19	2.17	1.81
2017-18	1500	1115.24	798.16	39.73	384.76	317.08	25.65	2.21	1.83
Mean of two years	1500	1103.71	791.05	39.53				2.19	1.82

The decreasing trend in technology gap (Table 3) clearly focused in the farmers' cooperation in conduction and adoption of this technological demonstration. It is also reflected in the increasing yield scenario in the subsequent year. Decreasing trend in technology index also observed in subsequent years in this study. It is also indicates the feasibility of the technology applied in the farmers' field. The technology index in the year 2016-17 was 27.19% and in the next year decreased to 25.65% exhibited the justification of the demonstrated technology in the Gangarampur block of the Dakshin Dinajpur district under oil alluvial agro-climatic zone. The similar decreasing trend in technology index on demonstrated technology has also been found by Katare *et al.* (2011) [5] in rapeseed mustard and Pandit *et al.* (2016) [7] in large cardamom. Widening of the extension gap clearly indicated the lack of knowledge of the farming community in the improved practices and those are still in traditional practices. The extension gap in the year 2016-17 was 308.24 kg ha^{-1} but in the year 2017-18 it was increased up to 317.08 kg ha^{-1}. The perusal of the data indicated the need of more training programmes for making farmers aware through various means for the adoption of new and improved technology for the betterment of the lentil crop production and it may drive the extension gap in to reverse direction. The extension functionaries may play a vital role in sensitizing the farming community engaged in lentil cultivation.

Conclusion

After a close view of the data it can clearly be concluded that the use of scientific management techniques of lentil can reduce the technology gap to an extent leading to the productivity of lentil crop in old alluvial zone of West Bengal. The extension gap in this field study revealed the need of education for the farmers. The farmers' education can be done through various means of like organising training programme, method demonstration, front line demonstration etc. In this context, Extension agencies of this district need to provide the proper technical support to the lentil farmers. Researchers may also concentrate in any other zone specific components which needto be addressed in achieving the potential productivity of the lentil.

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