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Impression of off season vegetable varietal adoption demonstration on the yield and economics of Early Cauliflower (*Brassica oleracea* var. *botrytis*) cv. Sabour Agrim in Bhagalpur District of Bihar

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Abstract
Early Cauliflower (*Brassica oleracea* var. *botrytis*) is one of the important cole crops grown for fresh and processing purpose all over the India due to its wider adaptability under various agro-climatic conditions, which plays a major role in supplementing the income of small and marginal farmer of the Bhagalpur district of Bihar state. The present study was carried out at Bhagalpur district during *kharif* 2017-18 and 2018-19. Off season vegetable varietal replacement through Farmer FIRST Project were conducted on early cauliflower by the active participation of the farmers with the objective of improved technologies of early cauliflower production potential. The improved technologies consist improved variety (Sabour Agrim), balanced fertilizers (Soil test based) application and integrated pest and disease management, etc. The development of the agriculture is primarily depends on the application of the scientific technologies by making the best use of available resources. One of the major constraints of traditional early cauliflower farming is low productivity because of non-adoption of advanced technologies like improved varieties. To increase the production, productivity and quality of agricultural produce, off season vegetable varietal replacement are being conducted at various farmer's field. All the recommended practices were provided to the selected farmers. The data related to the cost of cultivation, production, productivity, gross return and net return were collected as per schedule and analysed. Result of the present study revealed the higher average yield in the off season vegetable varietal replacement demonstration was recorded (185.26 q/ha) as compared to farmers practice (287.50 q/ha) traditional adopted by the farmers. The percentage increase in the yield over farmer's -35.70 was recorded. The technology gap and extension gap were computed 5.84 and -102.28 q/ha respectively, along with 3.07 percent of technology index. The off season vegetable varietal replacement demonstration field gave higher average net return Rs. 809986.00 and B:C ratio is 1: 6.96. The result of the study indicated the gap existed in the potential yield and demonstration yield is due to soil fertility and weather conditions. Present result clearly show that the yield and economics of early cauliflower can be boost up by adopting recommended technologies.

Keywords: *Brassica oleracea*, vegetable varietal, Bihar

Introduction
Early Cauliflower (*Brassica oleracea* var. *botrytis*) is a conventional crop with a long history of cultivation in cauliflower is thought to have been domesticated in the Mediterranean region since the greatest range of variability in the wild types of B. oleracea is found there. It originated in the island of Cyprus from where it moved to other areas like Syria, Turkey, Egypt, Italy, Spain and north western Europe. It ranks second after china in terms of total production, area and consumption (Poonia and Pithia 2011) [7]. Early cauliflower also known as Phulgobhi is a temperate vegetable crop belong to the family "Brassicaseae" of the order "Arales" whose members are known as "aroids" (Henry, 2001) [12] and Van Wyk, 2005). Early cauliflower is believed to have originated in Mediterranean region, perhaps in Cyprus or Syria (Sturlevant, 1919) [13]. All parts of the plant including curd and leaves are edible and contain abundant starch (Bose *et al*., 2012). Early cauliflower is a rich source of major components of the diet viz. proteins, minerals and vitamins. The nutritional value of a food depends upon its nutritional contents, digestibility and the presence or absence of anti-nutrients or toxic factors. Several authors have evaluated the chemical composition of whole curd and leaves of early cauliflower (Surjit and Tarafdar, 2015) [15]. It has been observed that in spite of the fact that early cauliflower are major crops, their nutritional value is high.

Apart from the low fat content, the crop is nutritionally superior to other vegetable and root crops in protein, mineral and vitamin contents (Onwueme, 1978) [14]. Investigation have shown that early cauliflower contains digestible starch, protein of good quality, vitamin C, thiamine, riboflavin, niacin and high scores of proteins and essential amino acids. The crop is also very rich in dietary fibre, thus, it could be employed in the treatment of diseases such as obesity, diabetes, cancer and gastrointestinal disorders (Mukherjee *et al*., 2016) [16]. Cauliflower is cultivated in an area of around 453 thousand ha with an annual production of 8668 thousand tonnes (NHB Database, 2018) [1] and the major Cauliflower growing states are Bihar, Orissa, Maharashtra, Kerala, Andhra Pradesh, Himachal Pradesh, Punjab, Haryana, Delhi, West Bengal, Uttar Pradesh, Gujarat and Jammu & Kashmir. In Bihar state total area under Cauliflower is 66.36 thousand ha with a production of 1013.94 thousand tonnes (NHB Database, 2016) [2]. Cauliflower is mainly grown as a major vegetable crop in Bihar areas like Nalanda, Patna, Lakhisarai, Munger, Bhagalpur, Muzaffarpur, Samastipur, Vaishali, East Chaparan, Madhubani, Shitamarhi, and Begusarai districts in Bihar. Despite of the importance of this crop, its cultivation anywhere in India is generally a subsistent to commercial crop due to low productivity because of non-adoption of off season vegetable advanced technologies like improved varieties. To increase the production, productivity and quality of agricultural produce, off season vegetable varietal replacement demonstrations are being conducted at project area various farmers' field.

Material and Methods

The off season vegetable varietal replacement demonstration is an applied approach to accelerate the dissemination of proven technologies at project area farmer's fields in a full package and practice mode with an objective to explore the maximum available resources of crop production and also to bridge the productivity gaps by enhancing the production in national basket (Choudhary *et al*., 2018) [4]. To overcome the problems faced by the farmers in cultivation of early cauliflower, integrated crop management in early cauliflower was conducted by Farmers FIRST Project, Bihar Agricultural University, Sabour, Bhagalpur during *Kharif* 2017-18 and 2018-19 in five farmers of Bhagalpur district. In the off season vegetable demonstration, improved variety "Sabour Agrim" was grown in 0.5 ha area each farmer with integrated crop management practices and the farmers practice traditionally in 0.5 ha area for comparison. The integrated crop management practices consisting the conjoint use 25 t/ha FYM with a balanced fertilization of 120:60:80 NPK kg/ha.

Improved variety of early cauliflower i.e. Sabour Agrim introduced under demonstration was released from a mass selection from Vaishali area of Bihar is able to yield 175-190 q/ ha. The curd is non-acrid, well-shaped and generally devoid of compact maturity is synchronised. Treated with fungicide namely, Bavistin and integrated pest management strategies were demonstration as per need.

Selection from mass collections of Vaishali district, Average yield of 190.00 q/ha, potential yield Bihar, released from Department of Horticulture (Vegetable & Floriculture), Bihar Agricultural University, Sabour, Bhagalpur of 190.00 q/ha, days to 50% maturity by 95-98 days Sabour, under the aegis of All India Co-Ordinated Research Project (AICRP) on Vegetable Crops. The Sabour Agrim variety was a mass selection. Salient features of technology are growth habit erect to semi spreading, curd maturity duration 11-14 days, curd size 450-480 gm, speciality synchronized curding, equal size curding, summer/heat tolerant up to 36-380C, semi self-blanching type, uniform white colour, suitable for late September to early November harvesting (early kunwari and katiki group) may also be grown under summer season suitable for culinary purpose due softness which make it easy to cook.

Responsive to recommended dose of fertilizer at irrigated condition situation in *Kharif* off season vegetable and field tolerant to pest and leaf blight disease with average yield of 184.06 q/ha early cauliflower (Sabour Agrim) may progressively commercialized in Bihar as well as in Jharkhand and Uttar Pradesh.

The technological interventions followed in farmers practice and demonstration is given in table 1. Before initiating the demonstration, the beneficiary farmers were given with skill training on various technological interventions to be followed in early cauliflower cultivation. The performance of crop was periodically observed by the scientists of Farmers FIRST Project, Bihar Agricultural University, Sabour, Bhagalpur and advisory recommendations were followed. During harvest, yield data was collected from both the demonstration and farmers practice. At the end, cost of cultivation, net income and cost benefit ratio were worked out. An average of cost of cultivation, yield and net returns of different farmers was analysed by the formula.

$$\text{Average} = (F_1+F_2+F_3\text{…….}+ Fn)/N$$

Where,

F= Farmer (s)

N= No. of farmers

In the present study, technology index was operationally defined as the technical feasibility obtained due to implementation of varietal replacement demonstrations in elephant foot yam. To estimate the technology gap, extension gap and technology index following formula used as given by Samui *et al*., 2000 [9].

Technology Gap = P_1 (Potential yield) – D_1 (Demonstration yield)

Extension Gap = D_1 (Demonstration yield) – F_1 (Farmers yield)

Technology index = Potential yield – Demonstration yield/Potential yield X 100

B: C ratio = Net income (Rs/ha)/Cost of cultivation (Rs/ha)

$$\text{Percent increase over farmer's practices} = \frac{\text{Improved practices} - \text{Farmers practices}}{\text{Farmers Practices}} \text{ X } 100$$

Results and Discussion

The economic indices depicted in table 2 showed that the average yield of early cauliflower variety (Sabour Agrim) were 184.16 q/ah and 187.78 q/ha during *kharif* 2017-18 and 2018-19 respectively under demonstrated technology however, under farmer's practices the average yield were found to be 286.44 q/ha and 288.82 q/ha during respective years. The average percent increases over main season yield were -35.70. The results clearly indicated the negative effect of off season vegetable varietal replacement demonstration over the existing practices toward enhancing the yield of early cauliflower in the study area due to use of high yielding variety, high price off season time, early sowing, balance dose of fertilizers, proper and timely irrigation, need based plant protection etc.

The result is in conformity with the finding of Tiwari and Saxena (2001) [10] and Tiwari *et al*., (2003). Yield of the off season vegetable varietal replacement demonstration and potential yield of the crop was compared to estimate the yield gaps which were further categorized into technology and extension gap. The data of table 3 depicted the technology gap in the demonstration yield against potential yield which is 185.97 q/ah during both the year and reflects the farmer's cooperation in carrying out such demonstrations with encouraging results in subsequent years. The technology gap observed may be attributing to the dissimilarity in soil fertility status, early sowing and weather conditions. Similar finding was recorded by Mitra and Samjdar (2010) [6]. Further, the higher extension gap was observed. The extension gap ranged from -102.28 q/ha during the period of study that emphasizes the need to educate the farmers through various means for adoption of improved production technologies to mitigate the extension gap. The data of table 2 reveals that as far as average economics of early cauliflower is concerned; gross cost, net income and benefit cost ration were Rs. 920800.00/ha, Rs.805535.00/ha and 1: 6.98, respectively during 2017-18 and Rs. 931800.00/ha, Rs.815486.00/ha and 1: 6.94, respectively during 2018-19 under demonstration plot. However, Rs. 572880.00/ha gross cost, Rs. 457615.00/ha net return with 1: 3.97 benefit cost ration during 2017-18 and Rs.577120.00/ha gross cost, Rs.459756.00/ha net return with 1: 3.91 Benefit cost ratio observed during 2018-19 under farmer's practice.

The superiority of recommended package of practices under off season vegetable varietal replacement demonstration over farmer's practice was also reported by Mitra and Samajdar (2010) [6] and Balai *et al*., (2012) [3]. From the finding of present study, it can be concluded that use of above prescribed technologies of early cauliflower cultivation can reduce the technology gap to a considerable extent resulting in to increased productivity as well as quality in Bihar. It requires collaborative extension efforts to enhance adoption level of location and crop specific technologies among of the farmers for bridging these gaps. Therefore, extension agencies in the district need to provide proper technical support to the farmers through various educational and extension methods for better early cauliflower production in Bhagalpur districts of Bihar.

Table 1.

S. N.	Package of practices (Technology intervention)	Varietal replacement demonstration (Recommended package of practices)	Farmers practice (Local/check)	Gap
01.	Selection of variety	Improved early variety (Sabour Agrim)	Age old variety	Partial gap
02.	Soil testing	Have been done in all the location	Not in practice	Full gap
03.	Seed rate	600 g/ha	600 g/ha	Partial gap
04.	Seed treatment	Seed treated with fungicide Thiram	Not done	Full gap
05.	Spacing	45 cm x 45 cm	60 cm x 50 cm	Partial gap
06.	Application of recommended dose of fertilizer	120 kg N + 60 kg P_2O_5 + 80 kg K_2O per ha (50% N+ 100% P K at the time of planting and remaining 50% N applied at 40 days and 80 days after planting)	Imbalance and inadequate	Partial gap
07.	Application of vegetable special (micro-nutritional) Irrigation	Foliar spray of vegetable special (micro-nutrients) 75 g + 15 lit water + lemon + 1 shampoo (Rs. 1).	Not applied any micro-nutrient	Full gap
08.	Irrigation	Drip or furrow method of irrigation at once in a 7-11 days interval depend upon soil condition	Twice in a month	Partial gap
09.	Weed management	Pre-emergence herbicide pendimethalin @ 1.5 kg a.i/ha, followed by hand weeding depend upon weed intensity.	Weeding is not common	Partial gap
10.	Plant protection measures for control of insect pest and diseases	Need based application for control: Aphid and sucking pest-spraying with diamethoate (30 EC) 1.5 ml/L of water. Leaf eating catter piller: spray NPV (250 LE/ha). Blight, pyithium rot & leaf blight – Spraying of (COC) blitox 50 – 3 g/L of water	Plant protection is not common	Partial gap
11.	Harvesting	Manual	Manual	No gap

Table 2: Economics of varietal replacement demonstration of year 2017-18 and 2018-19

Variables	Yield (q/ha)			Cost of cultivation (Rs./ha)			Gross return (Rs./ha)			Net return (Rs./ha)			Benefit: Cost ratio		
Year	2017-18	2018-19	Average	2017-18	2018-19	Average	2017-18	2018-19	Average	2017-18	2018-19	Average	2017-18	2018-19	Average
Farmers practice (Main season)	286.44	288.56	287.50	115265.00	117364.00	116314.00	572880.00	577120.00	575000.00	457615.00	459756.00	458685.00	1: 3.97	1: 3.91	1: 3.94
Recommended practices (Sabour Agrim) Early Season	184.16	186.36	185.26	115265.00	117364.00	116314.00	920800.00	931800.00	926300.00	805535.00	815486.00	809986.00	1: 6.98	1: 6.94	1: 6.96

Sale Rate of early season cauliflower was Rs. 5000/q and main season cauliflower was Rs. 2000/q

Table 3: Yield technology gap and technology index of varietal replacement demonstration

Variables	Yield (q/ha)	Increase (%) over farmers Practice	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
Farmers Practice	287.50	-	-	-	-
Recommended practices (Sabour Agrim)	185.26	-35.70	5.84	-102.28	3.07

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