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Farm level yield gap analysis in soybean crop in Ahilyanagar district of Maharashtra State

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Abstract

Amid decreasing yield of soybean (*Glycine max* L.) this study analyzed yield gaps using data collected through a survey of 192 farmers across different farm size groups in Shrirampur and Rahuri tehsils in Ahilyanagar district in Maharashtra, India. The data were collected with the help of pretested interview schedule. The data was analyzed using standard statistical tools. The Findings revealed that the 30.73 per cent of growers reported a low level of yield gap followed by 23.96 percent reported medium level of yield gap. The mean YGI was 10.04 per cent, YGII was 16.11 per cent whereas the mean YG III was 29.06 per cent indicating the possibility of increasing yield in farmers field. The results suggested that land holding, annual income, management practices sand water stress had significantly contributed to the yield gap indicating that managing magnitude of these variables will decrease the yield gap in soybean crop.

Keywords: Farm level yield gap, soybean crop, progressive farmers, average farmers

Introduction

Soybean [*Glycine max* (L.)] originated in the eastern region of Northern China, where it was domesticated by farmers and valued as an oilseed crop rich in essential nutrients such as protein, carbohydrates, vitamins, and minerals. As a legume, it is adaptable to tropical, subtropical, and temperate climates. India is the fifth-largest producer of soybeans in the world (ICAR-IISR, 2023). In India, soybean is a significant commercial oilseed crop, particularly in Madhya Pradesh, where it is a major rainy-season crop in the central part of the country. It holds the top position among oilseed crops in terms of both cultivated area and production (Kuchlan). According to the first advance estimates by the Government of India, soybean production for the 2022-23 *kharif* season is projected to reach 13.60 million tons, cultivated over an area of 120.90 lakh hectares. More than two-thirds of the total area and production come from six key states: Madhya Pradesh (50.18 lakh hectares), Maharashtra (49.10 lakh hectares), Rajasthan (11.51 lakh hectares), Karnataka (4.43 lakh hectares), Gujarat (2.22 lakh hectares), and Telangana (1.75 lakh hectares). India is the fifth-largest producer of soybeans in the world (ICAR-IISR, 2023). Despite its importance, there remains a significant gap between potential yield (Yp) and actual yield (Y_a) in many soybean-producing regions. Globally, the average soybean yield is approximately 2.8 tons per hectare, while the potential yield under optimal management and environmental conditions can exceed 4.5 tons per hectare in many areas, depending on agroecological conditions (Van Ittersum *et al*., 2013) [15].

Even though India's soybean productivity increased from 426 kg/ha in 1970-1971 to 1158 kg/ha in 2022-23, it is still far less than the crop's potential. Thus, the main source of concern in India has been the low crop productivity and significant fluctuations in it. In contrast to the national average of 1158 kg/ha, simulation studies conducted throughout India have shown that the crop's climatic potential is 3000 to 3500 kg/ha, while its rainfed potential is 2000 to 2500 kg/ha. (DA&FW 2023-24).

Combination of different environmental, management and socio-economic variables and their interactions determines crop yield and its variability (Tittonell and Giller 2013) [13]. Despite the fact that inherent properties of soil and rainfall play significant role in determining crop yield, management also plays important role (Yengoh, 2012) [17]. The analysis of yield gap, which is obtained from the analysis of difference between potential and actual yield, arises due to various factors, including suboptimal agronomic practices, pest and disease pressures, soil fertility limitations, and socio-economic constraints. The extent of gap between the actual and potential yields indicates farmers resource base and technical ability in a given environment and is important for agricultural policy development and resource planning in crop production. (Angulo *et al.* 2012) [2]. However, though yield gaps between experimental stations and farmers' fields are well understood (Pala *et al*. 2011) [11]. However, yield gaps among farmers' fields cannot be generalized based on studies conducted in specific locations due to differences in biophysical and socioeconomic conditions. Lobell *et al*. (2009) [7] suggested that addressing any location-specific yield can help to build specific responses to local circumstances. To address location-specific yield gaps, it is important to identify factors that contribute to the difference between farmers fields and experimental stations, as well as within farmers fields themselves.

The present study was undertaken to study yield gaps between an experimental stations yield and farm yield and also gap within farmers fields. This is followed by analyses of determinants explaining the yield gaps. Findings of this study may make important contributions to interventions for improving soybean yield in study area as well as in other areas with similar environmental conditions.

Conceptual Framework

Yield gap is the difference between the potential and actual yields. The productivity of the crop primarily depends on the extent of the levels of resources used and total management of crop. Crop production is influenced by a combination of biophysical, agronomic, socio- economic and policy factors (FAO, 2010). Farmers with very limited income are risk averse and show lower tendency to experiment and utilize new technologies compared to farmers with better asset possession. For practical purposes it is important to study the yield gap between maximum attainable yield and the farmers actual yields, whereby maximum attainable yield is the yield achieved at any agricultural research station within the same agro-ecological zone (Singh *et al*. 2009) [12]. But most of the farmers cannot afford the inputs and financial resources or the technical expertise to achieve yield compared to experimental stations. Their yields are therefore likely to be below maximum attainable levels and are termed as actual yields or average farmer yields. Lobell *et al.* (2009) [7] Gave a conceptual framework for depicting yield gap indicated in the figure are as follows:

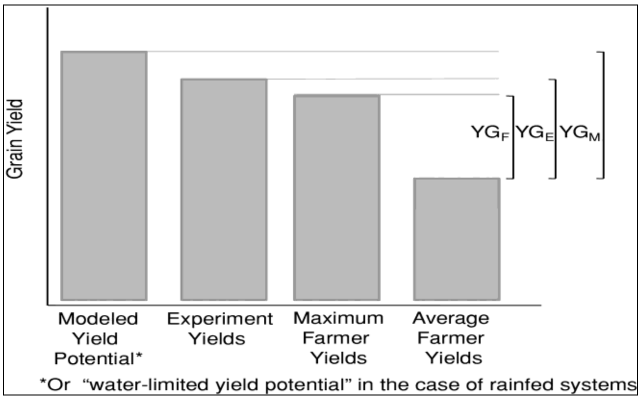
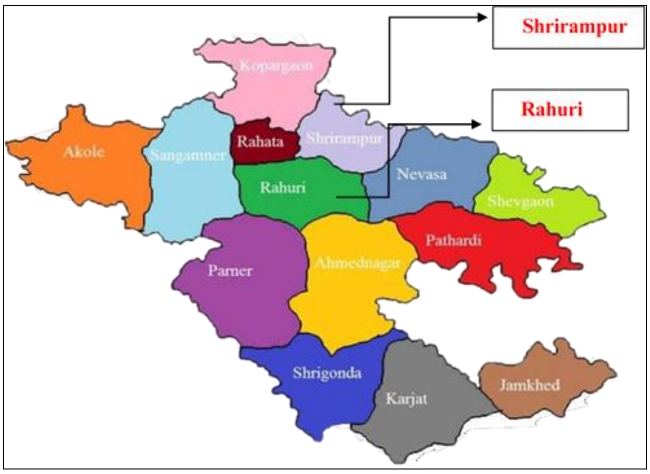


Fig 1: A conceptual framework depicting the relative rankings of average farmer yields and three measures of yield potential. Different measures of the yield gap (YG) are indicated at the right side of the figure and are as follows: YGM, model- based yield gap (yield potential is simulated with a model); YGE, experiment-based yield gap (yield potential is estimated with a field experiment); and YGF, farmer- based yield gap (yield potential is estimated with maximum of farmers' yields).

Materials and Methods

Study area



Study was undertaken in Ahilyanagar district of Maharashtra (Table 1). Soybean, groundnut, bajra, maize etc. are the major crops grown in these districts in kharif season, while sorghum, wheat, chickpea etc. are grown in rabi season. Cultivation of Soybean in Ahilyanagar district is on area of 1500.56 hectares and a production of 2578.20 tonnes, followed by Nashik and Solapur in Western Maharashtra (Department of Agriculture, Government of Maharashtra).

Table 1: Production of Soybean in Kharif 2022-23

District	Area ("00"ha)	Production ("00"tonnes)
Beed	3452.32	5254.17
Jalna	2023.28	3500.66
Ahmednagar	1500.56	2578.20
Nashik	1182.08	2066.15
Solapur	966.05	984.97

Sampling framework

Using simple random sampling technique, two blocks were selected from a district namely Shrirampur and Rahuri while four villages were selected from each block, comprising a total of 8 villages for complete study. From each village, twenty-four farmers were selected randomly as respondents making total sample of 192 soybean cultivating farmers.

Data collection and analysis

The data were collected using focused group discussion with the villagers and in depth interview of selected respondents using standardized interview schedule. Response was elicited from the farmers on whether or not they face particular listed constraint while cultivation of the soybean. Collected data was categorized under major heads and analyzed using descriptive statistics such as frequency and percentage.

Table 2: Variables and their measurement in the study

S. No.	Variables	Definition	Measurement
1.	Age	Farmers chronological age in completed years at the time of data collection.	Young (up to 29), Middle (30 to 60), Old (61 and above) (National Youth Policy, 2014.)
2.	Education	Number of years of formal education completed by the farmer.	Illiterate (no education), Primary (Up to 4th std.), Secondary (5th to10th std), Higher secondary (11 to 12th std), Graduation and above
3.	Land holding	Actual land owned by the soybean farmers in hectares at the time of interview.	Marginal (Up to 1ha), Small (1.01 to 2 ha), Semi-medium (2.01 to 4 ha), Medium (4.01 to 10 ha) (Agriculture Census 2015-16)
4.	Area under Soybean	Per cent area under soybean crop during kharif season	Area under soybean = area under soybean cultivation ×100 Net Cultivated Area During kharif season
5.	Cropping Intensity	Raising of number of crops from same field during one agricultural year.	Cropping intensity = Total Cropped Area in a year × 100 Net Cultivated Area in a year
6.	Experience in	Number of years engaged in	Measured in absolute number of
	Soybean cultivation	soybean cultivation	years.
7.	Annual income	Income of soybean farmers and his family from agriculture and other allied sources.	Measured in lakhs (Rs)
8.	Credit Supply	Farmers having access to credit facility	Dummy variable (Access=1, No Access = 0)
9.	Soil fertility	Farmers perceived level of his/ her farm soil fertility	Farmers response on 3 point continium: Low soil fertility =1, Medium soil fertility =2, High soil fertility =3
10.	Variety	Population of plants of a given species selected and cultivated	Variety of soybean which was used by farmers for sowing
11.	Adoption of soybean production technology	adoption of production technology recommended by Mahatma Phule Krushi Vidyapeeth, Rahuri	Dummy variable (Adoption =1, Non Adoption = 0)
12.	Water Stress	Farmer reported farm level water stresses in soybean crop during different critical growth stages.	Dummy variable (Water stress observed =1, No water stress observed = 0)
13.	Risk Aversion	Minimizing or avoiding risk, even if the uncertain outcome has a higher expected value.	Farmers response on 3 point continium: Low=1, medium-2, and high=3
14.	Yield gap	Yield gap is calculated by substracting achieved average yield from the yield potential.	Yield gap at 3 level worked out. Yield Gap I: Potential Yield - Farm Level Yield Yield Gap II: Potential Yield - Average Farmers Yield Yield Gap III: Progressive Farmers Yield - Average Farmers Yield

Computation of yield gap in soybean

Yield Gap I: Difference between the Potential Yield and Farm Level Yield

Yield Gap II: Difference between the Potential Yield and Average Farmers Yield

Yield Gap III: Difference between Progressive Farmers **Yield and Average Farmers Yield**

In the present study the yield of soybean recommended by Agricultural University MPKV, Rahuri was considered as potential yield (PY). Potential yield was treated as best yield which can be obtained with proper management practices and input use (Lobell *et al*., 2009) [7] Farm level yield (FY) Farm-level yield refers to the actual crop yield obtained from individual farms, which can vary significantly due to numerous factors such as environmental conditions, management practices, and resource availability. Farm level yield (FY) is the average yield achieved by farmers in a particular farm. (Fischer *et al*., 2014). In the present study, average farmers yield(AFY) refers to the average yield achieved by the average farmers (n=160) on their farms. Similarly, progressive farmers yield refers to average yieldson the Progressive farmers field (n=32). Thus the three yield gaps were calculated across each category of farm size.

Results and Discussion

Table 3: Description of socio- economic and farm characteristics of the respondents

Sr. No.	Variable	Progressive Farmers (N= 32)	Average Farmers (N=160)	Overall (N=192)
1	**Age group (years)**			
a	Young (Below 30)	4 (12.50)	17 (10.62)	21 (10.94)
b	Middle (30 to 60)	24 (75.00)	114 (71.25)	138 (71.87)
c	Old (Above 60)	4 (12.50)	29 (18.12)	33 (17.19)
2	**Level of education (Standard)**			
a	Illiterate (no education)	0 (00.00)	4 (2.50)	4 (2.08)
c	Secondary (5th to10th std)	18 (56.25)	75 (46.87)	93 (48.44)
d	Higher secondary (11 to 12th std)	7 (21.88)	38 (23.75)	45 (23.44)
e	Graduation and above	4 (12.50)	25 (15.63)	29 (15.10)
3	**Experience in Soybean cultivation**			
	Mean	19.06	21.48	21.08
	Standard Deviation	11.71	11.27	11.33
4	**Annual Income**			
a	Mean	309109.4	270062.5	299600
b	Standard Deviation	166203.1	192671.02	200086
5	**Risk Aversion**			
	Low risk aversion	00 (00.00)	36 (22.50)	36 (18.75)
	Medium Risk Aversion	32 (100.00)	86 (53.75)	118 (61.46)
	High risk aversion	00 (00.00)	38 (23.75)	38 (19.79)
6	**Cropping Intensity**			
a	Below State Average i.e. 142%	5 (15.63)	38 (23.75)	43 (22.40)
b	Above State (142%)	27 (84.37)	122 (76.25)	149 (77.60)
7	**Soil Fertility**			
a	High Fertility	4 (12.50)	7 (04.38)	11 (5.73)
b	Medium Fertility	28 (87.50)	141 (88.12)	169 (88.02)
c	Low Fertility	00 (00.00)	12 (07.50)	12 (06.25)
8	**Per cent area under soybean**			
a	Low (Below 26%)	1 (3.13)	9 (05.63)	10 (17.19)
b	Medium (26% to 50%)	11 (34.38)	70 (43.75)	81 (42.18)
c	High (51% to 75%)	13 (40.63)	49 (30.62)	62 (32.29)
d	Very high (above 75%)	7 (21.88)	32 (20.00)	39 (20.31)
9	**Variety used for sowing**			
a	Phule Sangam	10 (31.25)	52 (32.5)	62 (32.29)
b	Phule Kimaya	1 (03.12)	27 (16.88)	28 (14.58)
c	Phule Durva	12 (37.51)	36 (22.5)	48 (25.00)
d	J S 9305	2 (06.25)	18 (11.25)	20 (10.42)
e	GG 3344	4 (12.50)	11 (6.88)	15 (7.81)
f	Eagle 335	1 (03.12)	7 (4.38)	8 (4.17)
g	GG 441	2 (06.25)	9 (5.63)	11 (5.73)
10	Water stress observed	00 (00.00)	81 (50.62)	81 (42.18)
	Early Drought	00 (00.00)	24 (15.00)	24 (12.50)
	During Early Growth Stage	00 (00.00)	26 (16.25)	26 (13.54)
	Flowering and pod filling	00 (00.00)	30 (18.75)	30 (15.62)

It can be seen from table 3 that The study of 192 farmers, including 32 progressive and 160 average farmers, revealed key demographic and agricultural insights. The majority of farmers (71.87%) fell within the middle age group (30-60 years), with 10.94% being young (below 30) and 17.19% old (above 60). Education levels showed that 48.44% had secondary education (5th to 10th standard), while 23.44% had higher secondary education (11th to 12th standard), and 15.10% held graduation or higher degrees. Progressive farmers had slightly less experience in soybean cultivation (mean = 19.06 years) compared to average farmers (mean = 21.48 years). Annual income was higher among progressive farmers (₹309,109.4) than average farmers (₹270,062.5). Risk aversion was predominantly medium (61.46%), with no progressive farmers exhibiting low or high risk aversion. Cropping intensity was above the state average (142%) for 77.60% of farmers. Soil fertility was mostly medium (88.02%), and soybean cultivation area was medium (42.18%) or high (32.29%) for most farmers. Popular soybean varieties included Phule Sangam (32.29%) and Phule Durva (25.00%). Water stress was observed in 42.18% of farmers, primarily during early growth stages (13.54%) and flowering/pod filling (15.62%).

Table 4: Description of Adoption of soybean production technology by respondents

Sr. No.	Adoption of soybean production technology	Progressive Farmers (N= 32)	Average Farmers (N=160)	Overall (N=192)
1	**Land preparation**			
a.	Deep Summer Ploughing	32 (100.00)	160 (100.00)	192 (100.00)
b.	Harrowing	30 (93.75)	132 (82.50)	162 (84.38)
2	**Sowing Method**			
a.	Drilling	23 (71.88)	145 (90.62)	168 (87.50)
b.	Dibbing	00 (00,00)	15 (93.75)	15 (07.81)
c.	Broad Bed Furrow	09 (28.12)	00 (00.00)	09 (04.69)
3	Seed treatment	32 (100.00)	112 (70.00)	144 (75.00)
a.	Rhizobium+ Trichoderma (250 g/10kg seed0	14 (43.75)	48 (42.85)	62 (43.06)
b.	Carboxin+ Thiram (30 g / 10 kg seeds)	10 (31.25)	34 (30.36)	44 (30.56)
c.	Carbendazim+ Mancozeb (25 g/ 10 kg seeds)	08 (25.00)	30 (26.87)	38 (26.38)
4	**Sowing time**			
a.	Before 1st June	00 (00.00)	10 (06.25)	10 (05.21)
b.	1st June- 15th July (*Recommended*)	32 (100.00)	133 (83.12)	165 (85.94)
c.	After15 th July	00 (00.00)	17 (10.63)	17 (08.85)
5	**Seed rate**			
a.	55-75 Kg (*Recommended*)	32 (100.00)	151 (94.38)	183 (95.31)
b.	Less than 55 kg	00 (00.00)	09 (05.62)	09 (04.68)
6	**Spacing (cm)**			
a.	30×5	03 (9.37)	43 (26.87)	40 (20.83)
b.	45×5 (*Recommended*)	29 (90.63	102 (63.75)	125 (65.11)
c.	45×10	00 (00.00)	15 (09.38)	27 (14.06)
7	**Sowing depth**			
a.	Up to 4 cm (*Recommended*)	32 (100.00)	140 (67.50)	172 (89.58)
b.	More than 4 cm	00 (00.00)	20 (12.50)	20 (10.42)
8	**Fertilizer Application**			
a.	Application of macronutrient	32 (100.00)	136 (85.00)	168 (87.50)
b.	Application of micronutrient	12 (37.50)	00 (00.00)	12 (06.25)
9	Irrigation Availability	32 (100.00)	106 (66.25)	145 (71.87)
9 a	**Method of irrigation**			
a.	Flow Irrigation	12 (37.50)	75 (70.75)	87 (45.31)
b.	Sprinkler Irrigation	20 (62.50)	31 (29.25)	51 (26.56)
10	Weed Management	32 (100.00	150 (93.75)	182 (94.79)
10 a	**Method of Weed Management**			
a.	Hand Weeding	00 (00.00)	48 (32.00)	48 (25.00)
b.	Chemical Weeding	00 (00.00)	04 (02.67)	04 (02.08)
c.	Chemical + Hand weeding	32 (100.00)	98 (65.33)	130 (67.18)
10 b	**Herbicides used**			
a.	Pendimethalin (30-40 ml/ 10 lit water)	18 (56.25)	58 (56.86)	76 (56.72)
b.	Imazethapyr (20 ml/ 10 lit water)	12 (37.50)	35 (34.31)	47 (35.07)
c.	Clodinafop (15ml/10 lit water)	02 (06.25)	09 (08.82)	11 (08.20)
11	Pest Management	32 (100.00)	150 (95.00)	182 (94.79)
11 a	**Pesticides used**			
a.	Imidacloprid (2.5 ml/ 10 lit water) for White fly	12 (37.50)	46 (30.67)	58 (31.86)
b.	Chloropyriphos (10 ml /10 li water) for pod borer	10 (31.25)	40 (26.67)	50 (27.48)
c.	Emamectin (15 ml/10 lit) for pod borer	08 (25.00)	36 (24.00)	44 (24.18)
d.	Flubendamide (15 ml/10 lit) for leaf eating caterpillar	02 (06.25)	28 (18.66)	30 (16.48)
12	Disease Management	32 (100.00)	140 (87.50)	172 (89.58)
12 a	**Fungicides used**			
a.	Propiconazole 25% EC (10ml/10lit) for yellow when mosaic	21 (65.63)	72 (51.43)	93 (54.07)
b.	Tebuconazole 10% (15ml/ 10 lit water) for yellow when mosaic	11 (34.37)	68 (48.57)	79 (45.93)
13	**Harvesting Time**			
a.	100-110 days (Recommended)	32 (100.00)	138 (86.25)	170 (88.54)
b.	More than 110 Days	00 (00.00)	22 (13.75)	22 (11.46)

The study on the adoption of soybean production technology among 192 farmers, including 32 progressive and 160 average farmers, revealed significant trends in farming practices. All farmers practiced deep summer ploughing for land preparation, while harrowing was adopted by 93.75 per cent of progressive and 82.50 per cent of average farmers. Sowing methods varied, with drilling being the most common (87.50%), though progressive farmers also used broad bed furrow (28.12%). Seed treatment was universal among progressive farmers (100%) but only 70% among average farmers, with Rhizobium + Trichoderma being the most preferred treatment (43.06%). Sowing time aligned with recommendations (1st June-15th July) for 85.94% of farmers, and the recommended seed rate

(55-75 kg) was followed by 95.31 per cent. Spacing of 45×5 cm (recommended) was adopted by 65.11 per cent, while 89.58 per cent adhered to the recommended sowing depth of up to 4 cm. Fertilizer application was widespread (87.50%), though micronutrient use was limited to progressive farmers (37.50%). Irrigation availability was higher among progressive farmers (100%) compared to average farmers (66.25%), with sprinkler irrigation being more common among progressive farmers (62.50%). Weed management was nearly universal (94.79%), with chemical + hand weeding being the dominant method (67.18%). Pendimethalin was the most used herbicide (56.72%). Pest and disease management were widely practiced (94.79%) and (89.58%), respectively), with Imidacloprid for whitefly (31.86%) and Propiconazole for yellow mosaic (54.07%) being the most common pesticides and fungicides. Harvesting at the recommended time (100-110 days) was followed by 88.54 per cent of farmers. Overall, progressive farmers demonstrated higher adherence to recommended practices, particularly in seed treatment, irrigation, and micronutrient application, highlighting their role in adopting advanced agricultural technologies.

Table 5: Farm level yield gaps in soybean crop across the different farm sizes

Sr. No.	Land holding	Yield Gap I (PY-FY) (qtl/ha)	Yield Gap II (PY-AFY) (qtl/ha)	Yield Gap III (PFY-AFY) (qtl/ha)
1.	Marginal farm size (Up to 1ha)	3.95 (14.36)	5.63 (20.47)	10.04 (31.46)
2.	Small farm size (1.01 to 2 ha)	2.6 (9.45)	4.07 (14.80)	9.41 (28.24)
3.	Semi-medium farm farm size (2.01 to 4 ha)	2.47 (8.98)	3.98 (14.47)	9.07 (27.83)
4.	Medium farm size (4.01 to 10 ha)	2.02 (7.35)	3.59 (13.05)	8.81 (27.33)
Total		2.76 (10.04)	4.43 (16.11)	9.45 (29.06)

(Figures in parentheses indicate the percentage to the total)

From the table 4 the analysis of yield gaps across different landholding categories revealed significant variations in soybean production. Marginal farms (up to 1 ha) exhibited the highest yield gaps, with Yield Gap I (Potential Yield - Farmer's Yield) at 3.95 qtl/ha (14.36%), Yield Gap II (Potential Yield - Achievable Farmer's Yield) at 5.63 qtl/ha (20.47%), and Yield Gap III (Potential Farmer's Yield - Achievable Farmer's Yield) at 10.04 qtl/ha (31.46%). Small farms (1.01 to 2 ha) showed slightly lower gaps, with Yield Gap I at 2.60 qtl/ha (9.45%), Yield Gap II at 4.07 qtl/ha (14.80%), and Yield Gap III at 9.41 qtl/ha (28.24%). Semi-medium farms (2.01 to 4 ha) and medium farms (4.01 to 10 ha) demonstrated progressively smaller gaps, with Yield Gap I at 2.47 qtl/ha (8.98%) and 2.02 qtl/ha (7.35%), Yield Gap II at 3.98 qtl/ha (14.47%) and 3.59 qtl/ha (13.05%), and Yield Gap III at 9.07 qtl/ha (27.83%) and 8.81 qtl/ha (27.33%), respectively. Overall, the total yield gaps were 2.76 qtl/ha (10.04%) for Yield Gap I, 4.43 qtl/ha (16.11%) for Yield Gap II, and 9.45 qtl/ha (29.06%) for Yield Gap III, indicating that marginal farms face the most significant challenges in bridging the gap between potential and actual yields, while larger farms perform relatively better in optimizing production.

The table depicts the per cent yield gap across different farm size. In case of yield gap I the average yield gaps were 14.36 per cent, 9.45 per cent, 8.95 per cent, and 7.35 per cent for marginal, small, semi- medium and medium farmers respectively. Across the different farm size groups, marginal group had highest yield gap and decreased with the increasing farm size group of holdings. Similar trend was found in yield gap II and yield gap III. Thus, there is scope to increase the productivity of crop across the farm size groups in the study area. Findings are in line with Muthuprasad (2021) [9].

Conclusion

The research study aimed at analyzing yield gap in soybean in tehsils of Ahilyanagar district of Maharashtra state. The paper also discussed socioeconomic profile, Adoption of soybean production technology and determinants of yield gap in the study area. The findings revealed significant amount of yield gap between potential yield and farm yield. As potential yield was obtained controlled environment with proper management practices and adequate amount of inputs. Because of shortage of resources and improper management practices the farmers in the study area not been able to take potential yield. However, it is possible to narrow this yield gap trough diffusion of technology to the farmers field through extension services, on field demonstrations and timely trainings.

Findings of the study in case of yield gap between progressive and average farmers revealed that despite similar bio physical conditions, there was significant amount of yield gap. The per ha estimates of yield level of soybean production revealed that the yield gap III were highest around 29.06 percent. This implies that with the present level of resource use by the average farmers the yield could be increases up to 29 percent as compare to progressive farmers if proper technologies and management practices used thereof.

The yield gap in soybean showed that the yield of soybean was fluctuated successively in different farms. Implying that there was tendency towards decreasing yield gap with the increasing landholding size. Observed yield gap I, yield gap II, and yield gap III on marginal farms were 14.36 per cent, 20.47 per cent, 31.46 per cent respectively which were highest among other farm size groups. Medium and semi-medium farms, though performing better, still show considerable gaps, indicating room for improvement in resource optimization and technology adoption. This consistently large gap across all farm sizes indicates systemic inefficiencies in achieving the potential farm yield.

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