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Yield gap and constraints analysis of cotton in India

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ABSTRACT : A survey was conducted during 2010-2011 and 2011-2012 in 9 cotton growing districts to analyze the yield gap and constraints in cotton production in India. Major constraints in cotton production was identified and prioritized based on economic loss caused by each of the constraints. Results revealed that the yield gap ranging from 6.66 to 18.4 q/ha is present in cotton production. Highest yield gap was found in Gujarat followed by Madhya Pradesh and Maharashtra. Yield gap was comparatively low in Punjab, Haryana, Karnataka and Tamil Nadu. Major constraints in north zone includes higher degree of used of inferior quality seed, sucking pests, dry spells and cotton leaf curl virus. In central zone sucking pests, weed infestation, leaf readdening, non availability of good seed and other inputs and delayed sowing are limiting the cotton production. In south zone non availability of human labour, weed infestation, sucking pests, untimely interculture and delayed sowing are some of the constraints which need to be addressed. Concrete efforts need to be made to identify and implement interventions and strategies to counter these constraints to improve the cotton yields.

Key words : Constraint analysis, cotton production, yield gap, yield loss

The realization of the production potential at the farm level with the given technology is determined by the constraints associated with the biophysical as well as socio economic environment under which the production system is functioning. Gradual use of technology in agriculture has resulted in increased crop productivity. The actual yields obtained are considerably lower than those recorded in the demonstration plots and research stations/farms though the technology was tested for its feasibility and suitability before it is released. Several studies show the existence of considerable untapped yield potential in various crops and attribute this gap to difference in the cultural practices and differences in input use levels between the farmers' fields and demonstration plots. Like other crops, in cotton also there exist yield gaps which vary from place to place and time to time. These yield gaps exist due to various constrains faced by the crop as well as farmer at different stages of crop growth. Some of these constraints as identified by the earlier studies include leaf reddening, high see cost, low yield, non availability of quality seed, pests and diseases, large price spread, lack of proper marketing facilities, inadequate crop stand, high temperatures at the time of germination, rains at flowering stage and sucking pests (Monga, 2008, Kiresur and Manjunath, 2011, Hosmath *et al.,* 2012, Pavithra and Kunnal, 2013). Impact of these constraints vary from place to place and time to time. New constraints will also arise due to the changed production scenario. This study was conducted during 2010-2011 in 9 major cotton growing states. Hence it is necessary to analyze the constraints in cotton production at field level to find ways to reduce the yield gap. This study is an attempt in this direction.

MATERIALS AND METHODS

Sample and data : All 9 important cotton growing states *viz.,* Punjab, Haryana and Rajasthan of North Zone, Gujarat, Maharashtra and Madhya Pradesh of Central Zone, Andhra Pradesh, Karnataka and Tamil Nadu of South Zone were selected for the present study. In each State, 2 important cotton growing districts were

selected from each district, data were collected from 30 cotton farmers selected randomly. Thus the data has been collected from 180 cotton farmers in each zone. Data regarding yield loss caused by each constraint, average area affected by each constraints and frequency of occurrence of that constraint during last 10 years were collected from the selected farmers. Collected data were analyzed by using suitable statistical methods.

Identification of constraints : In each selected district, constraints which have potential effect on the yield were listed based on the discussion with the field functionaries, experts and from the literature. Among the list, 10 most important constraints in each district were selected for further study.

Yield gap : Several researchers defined yield gap in many ways depending on the objectives of the study. It is actually the difference between an achievable yield (defined separately by different authors) and actual yield achieved by the farmers. The actual yield achieved depends on a wide range of factors that vary from farm to farm. In this study, achievable yield is defined as the highest yield achieved in that locality during the recent past (past 10 years). Yield gap was defined as the difference between this achievable yield and the actual yield achieved by the farmer during period of reference.

Yield loss and prioritization : The yield gap between maximum achievable yield and the actual yield achieved is the result of a variety of constraints which are imposed by the biophysical as well as socio economic environment in which the production system function. The importance of individual constraint depends on the loss as well as the affected area and the frequency of occurrence associated with that constraint. Hence constraints identified should be prioritized based on these parameters in order to prepare an action plan to tackle them. Questionnaire was prepared based on the constraints to collect information regarding average yield loss, area affected, frequency of occurrence etc. Total yield loss/year in each district was worked out by using the following formula and constraints were ranked accordingly;

Yield loss = average yield loss/ha x average area affected by the constraint x frequency of the occurrence of the constraint

RESULTS AND DISCUSSION

Yield gap : Yield gap was found to be higher in central zone when compared with North and South zones (Table I). Yield gap ranged from 6.66 q/ha in Tamil Nadu to 18.40 q/ha in Gujarat. Highest yield gap was found in Gujarat (18.40 q/ha) followed by Madhya Pradesh and Maharashtra. In north zone, the yield gap was comparatively high in Rajasthan. In Punjab and Haryana the yield gap was about7.5 q/ha while it was 9.86 q/ha in Rajasthan. In south zone, highest yield gap was seen in Andhra Pradesh (11.0 q/ha) followed by Karnataka (9.72 q/ha) and Tamil Nadu (6.66 q/ha). Highest achievable yield was also found in Gujarat (53.13 q/ha) followed by Madhya Pradesh (46.60 q/ha). Hence there is much scope to increase average yield by

Table 1. Yield gap (%) in 9 cotton growing zones in India

States	Highest achieved yield (q/ha)	Actual average yield (q/ha)	Yield gap (q/ha)	Yield gap (%)
Punjab	29.38	22.13	7.35	24.68
Haryana	28.90	21.31	7.61	26.33
Rajasthan	29.29	19.43	9.86	33.66
Maharashtra	30.13	18.52	11.61	38.53
Madhya Pradesh	46.66	30.83	15.83	33.93
Gujarat	53.13	35.73	18.40	34.63
Andhra Pradesh	34.42	23.42	11.00	31.96
Karnataka	32.56	22.84	9.72	29.85
Tamil Nadu	29.98	23.32	6.66	22.20

addressing the constraints which are limiting the yield in these two States. Aggarwal *et al.,* (2008) while modeling the cotton yields found that the yield gap in cotton was highest in the States of Gujarat and Maharashtra, modest in Andhra Pradesh and relatively low in Karnataka and Madhya Pradesh.

Constraints and their priority : Identified constraints were prioritized based on the yield loss worked out as per the formula given above. Important constraints as per the priority are presented in Tables 2 to 4.

North zone : There are about 7 constraints found to make considerable loss in north zone (Table 2). In Punjab (Bathinda, Mansa), higher degree of use of inferior quality seed ranked first in both the districts. This constraint is causing a loss of 1.17 to 1.42 q/ha. Second important constraint in Punjab was the incidence of sucking pests that caused a loss of about 1.0 q/ha. Other important constraints include incidence of leaf curl virus which ranked third in both the districts. This constraint was also causing about 1.00 q/ha yield loss. Dry spell during flowering and boll development stage and lack of knowledge about recommended practices occupied fourth and fifth ranks, respectively.

In Haryana also, higher degree of use of inferior quality seed and incidence of sucking pests occupied first and second ranks. Lack of knowledge about recommended practices occupied third while dry spell during flowering and boll development stage and lack of availability of genuine plant protection chemicals ranked fourth and fifth ranks in the order of priority. Use of inferior quality seed is causing a loss of 1.82 to 2.15 q/ha while the incidence of sucking pests is causing a yield loss of 1.34 to 1.61 q/ha.

In case of Rajasthan, the priority of the constraints is quite different from Punjab and Haryana. Here, incidence of sucking pests ranked first followed by delayed sowing due non availability of canal water. Higher degree of use of non certified seed occupied third rank followed by dry spells during flowering and boll development stage. The yield loss caused due to the incidence of sucking pests ranged from 1.11 to 2.05 q/ha. Similarly delayed sowing is causing a yield loss of 0.7 to 1.73 q/ha.

Central zone : In central zone, incidence of sucking pest ranked first in all the three States causing yield loss of 1.9 q/ha to as high as 9.0 q/ha depending on the severity. This

Table 2. Ranking of constraints in north zone

Constraints	Punjab		Haryana		Rajasthan	
	Bhatinda	Mansa	Hisar	Sirsa	Hanumangarh	Sriganganagar
• Higher degree of use of inferior quality seed	1 (1.42)	1 (1.17)	1 (1.82)	1 (2.15)	3 (0.99)	3(0.40)
• Incidence and damage caused due to sucking pests	2 (1.11)	2 (1.01)	2 (1.34)	2 (1.61)	1 (2.05)	1 (1.11)
• Incidence of cotton leaf curl viral disease	3(1.10)	3(1.30)	—	—	5(1.00)	5(0.75)
• Dry spell during flowering/ boll development stage	4 (0.56)	4(0.81)	4(1.10)	4(1.32)	4(1.79)	4(0.89)
• Lack of knowledge about recommended package of practices	5 (0.44)	5(0.45)	3(1.15)	3(1.31)	—	—
• Delayed sowing due to . non availability of canal water	—	—	—	—	2(1.73)	2(0.70)
• Lack of availability of . genuine plant protection chemicals	—	—	5(0.40)	5(0.41)	—	—

Note: Figures in the parentheses indicate yield loss (q/ha)

problem is showing an increasing trend. In Maharashtra, incidence of sucking pests is causing a loss of 1.9 to 3.4 q/ha to the yield. Weed infestation is another important problem in Maharashtra which ranked second in Yavatmal district. Due to continuvas rains during the initial crop growth period farmers are not able to take proper weed control measures. Hence there is a felt need to device mechanism to overcome this problem which is causing about 2.5 q/ha yield loss. Dry spells during flowering and boll development stage ranked second in Jalgoan districe causing a yield loss of 2.2 q/ha. Leaf readdining and para wilt ranked third in both the districts of Maharashtra. Though the yield loss/ ha is more (2.1-3.0q), area affected and intensity is less. Fourth rank was occupied by delayed sowing due to late on set of monsoon in both the districts of Maharashtra. As most of the cotton area in Maharashtra is rainfed, late onset of monsoon affects the cotton yields adversely. Waterlogging is another problem in isolated locations in Yavatmal district. Similarly non availability of labour is another problem in Jalgoan district.

In Madhya Pradesh, damage due to sucking pests is causing loss of about 8 q/ha ranking first among the constraints identified. weed infestation ranked second in both the districts of Madhya Pradesh causing a yield loss of 3.67-4.17 q/ha. Pink bollworm is also one of the constraints in Madhya Pradesh which ranked third in Khandwa and fourth in Kharagone causing an yield loss of 3.5 to 8.0 q/ha. In Madhya Pradesh farmers who have sufficient irrigation water for one or two irrigations prolongs the cotton crop for another two or three months instead of going for wheat crop in *rabi* season. This extended crop is affected by the pink bollworm causing considerable damage and loss of quality of cotton produced. Leaf reddening is another problem which is causing a loss of 4.67 – 6.33 q/ha. Availability of guanine fertilizers and its high cost is also a problem which is hindering farmers to apply recommended doses of fertilizers. Though the yield loss due to lower doses of fertilizer use is more, the area affected by this problem is less when compared with other constraints. Mostly the farmers who do not have sufficient capital for the purchase of fertilizers are affected with this problem.

In Gujarat, sucking pest menace ranked first with a yield loss of 8-9 q/ha. In this state high price and non availability of quality seed ranked second with a yield loss of 8.5 to 12 q/ha. In each area one or two hybrids are highly

Table 3. Ranking of constraints in central zone

Constraints	Maharashtra		Madya Pradesh		Gujarat	
	Yavatmal	Jalgoan	Khandwa	Khargone	Vadoara	Surendranagar
• Incidence and damage caused due to sucking pests	1(3.40)	1(1.90)	1(8.00)	1(8.33)	1(9.00)	1(8.00)
• Weed infestation	2(2.50)		2(3.67)	2(4.17)	4(4.50)	3(6.00)
• Leaf reddening / parawilt	3(3.00)	3(2.10)	4(4.67)	3(6.33)		
• Delayed sowing due to late onset of monsoon	4(2.80)	4(2.30)				
• Pink bollworm			3(3.50)	4(8.00)		
• High prices of seed/ non availability					2(8.50)	2(12.00)
• Dry spell during flowering / boll development stage		2(2.2)				
• Non availability of human labour		5(1.8)			3(6.00)	4(5.00)
• Non availability of genuine fertilizers/ high cost			5(9.00)	5(7.00)		5(8.00)
• Mealybug infestation					5(15.00)	
• Water logging due to poor drainage / soil condition		5(3.90)				

Note: Figures in the parentheses indicate yield loss (q/ha)

Table 4. Ranking of constraints in south zone

Constraints	Andhra Pradesh	Tamil Nadu		Karnataka	
	Guntur	Coimbatore	Perambalur	Dharwad	Haveri
•Non availability of human labour	1(6.23)	2(3.8)	2(3.7)	1(2.24)	1(3.67)
•Dry spell during flowering /boll development stage	2(5.78)				
•Incidence and damage caused due to sucking pests	3(4.18)	4(3.4)	1(3.6)	5(1.12)	
•Weed infestation / competition		1(3.6)	3(3.4)	2(1.84)	4(1.3)
•Untimely interculture and other operations	5(4.21)	3(2.1)	4(1.19)	2(1.9)	
•Delayed sowing due to late onset of monsoon		4(2.9)		3(1.31)	
•Inadequate irrigation facilities		5(2.8)	5(3.1)		
•Higher degree of use of non certified/inferior seeds				3(2.18)	
•Lack of credit for inputs	4(3.65)				
•Low fertilizers usage/sub optimal use of inputs					5(1.11)

Note: Figures in the parentheses indicate yield loss (q/ha)

preferred by the farmers. Due to short supply these hybrids, they are sold at high prices and other malpractices also took place. As a result farmers were not able to get good quality seed. Scarcity of human labour ranked third in Vadodara district and fourth in Surendranagar district. Similarly weed problem occupies third place in Vadodara and fourth place in Surendranagar. Melybug infestation is a problem in Vadodara district which is causing a yield loss of 15 q/ha. Though the yield loss is more its frequency and area affected is less. Similarly availability of fertilizers and its high cost is a problem causing reduction in yield in Surendranagar district

South zone : In case of south zone, problems and their priorities ranked different amongst States and districts. In Andhra Pradesh, non availability of human labour ranked first among the constraints followed by the dry spells during flowering/boll development stage. The yield loss was to a tune of 6.23 q/ha and 5.78 q/ha, respectively. Similarly, incidence of sucking pests occupied third place with a yield loss of 4.18 q/ha. Lack of credit is another problem faced by the cotton farmers of Andhra Pradesh. Due to the non availability of capital the cotton farmers are not able to apply inputs at optimal doses at right time. Shortage of human labour is also restricting the cotton yields as the farmers are not able to take operations at right time.

In Tamil nadu, infestation of weeds is the major problem which ranked first in Coimbatore and third in Perambalur district causing a yield loss of 3.4 to 3.6 q/ha. Incidence of sucking pests ranked first in perambalur district and fourth in Coimbatore district with similar yield loss. Shortage of human labour is another important in both the districts which ranked second in the priority list. Untimely interculture ranked third in Coimbatore district while delayed monsoon ranked fourth in Perambalur district. In both the districts inadequate irrigation facilities ranked fifth position.

In Karnataka, non availability of human labour ranked top in the priority list in both the districts. In Dharwad weed infestation ranked second followed by use of inferior quality seed and untimely inter culture. The fifth place was occupied by the incidence of sucking pests. In Havari district untimely interculture ranked second followed by delayed sowing and weed infestation. Fifth position was occupied by low fertilizer usage.

CONCLUSIONS

The above study clearly shows that there is scope to improve cotton productivity if the constraints limiting the production are addressed properly. There is need to device policies to supply good quality inputs at right time. Sucking pests

are becoming a major problem in entire cotton growing areas which need to be taken care. Similarly weed management is one of the big issue to be tackled. These problems associated with the shortage of human labour and continuvas rains during initial crop growth periods will still aggravate the problem. The shortage of labour during picking stage is one of the emerging constraints in north zone though it has not figured in the top 5 prioritised constraints which need prior attention. Bringing together multiple stakeholders (including farmers, extension staff, researchers, input suppliers, government policy makers) to discuss issues on management strategies and research needs and test these in participatory on farm research mode and promoting the most promising interventions and strategies is the need of the hour.

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