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PRODUCTION POTENTIALS, YIELD GAPS AND RESEARCH PRIORITIZATION OF PRODUCTION CONSTRAINTS IN MAJOR OILSEED CROPS OF SAURASHTRA REGION

M.G. Dhandhalya and R.L. Shiyani

Department of Agricultural Economics,
Junagadh Agricultural University, Junagadh-362 001, India.

ABSTRACT

Groundnut and sesame are the leading oilseed crops of Saurashtra region of Gujarat state. The yield gap and constraints in production were studied to set priority for major research problem areas, for better understanding of resources allocation. The multi-stage sampling procedure was followed to collect primary data from 120 farmers during 2003-04. The methodologies developed by International Rice Research Institute have been adopted to estimate the magnitude of yield gaps and identification of constraints. The investigation revealed a wide yield gap in major oilseed crops of Saurashtra region. The average yield gap II was about 710 kg/ha and 424 kg/ha in groundnut and sesame, respectively. Yield gap I was also large in both the crops. A large production potential is still unexploited in both the crops. Among abiotic constraints water stress is the single most limiting factor in Saurashtra, which caused about 3.6 lakh tones and 0.33 lakh tonnes production loss amounting to Rs.507.37 crores and Rs. 48.97 crores in case of groundnut and sesame, respectively. Among biotic constraints, tikka in groundnut and brown angular spot in sesame topped the list causing maximum value loss of Rs. 92.93 crores and Rs. 10.97 crores, respectively. More attention towards watershed development and drip irrigation system, soil fertility management, regular power supply and strengthening extension services are the major suggestions emerged from the study.

Key words : Groundnut, Sesmal, Production constraints, Oilseds.

INTRODUCTION

Groundnut and sesame are the principal oilseed crops of Saurashtra region of Gujarat state. These crops have achieved impressive growth in agricultural production of this region during last three decades. Concerns are now being raised that the existing high level of productivity is under threat due to symptoms of soil degradation, outbreak of new pests and diseases, strain on water resources and natural calamities. Identification of important production constraints and problem areas would provide a base for research priority setting, which helps (i) reviewing existing resources allocations, (ii) update research agenda, (iii) make resource allocation more transparent and unambiguous, and (iv) strengthen credibility of the institution in soliciting support for research.

Currently agricultural research system faces growing scarcity of resources. In recent years, the Consultative Group on International Agricultural Research (CGIAR) has started cutting the magnitude of resources provided earlier. Very recently, the Word Bank, while funding State Agricultural Universities (SAUs) in India has insisted to prepare prioritized research agenda to be included in the project appraisal. Prioritizing production constrains in India is primarily confined to rainfed rice system. (Ramasamy *et al.*, 1996; Widawsky and O' Toole, 1996). One diagnostic survey has been conducted (Roy and Shiyani,

2000) for *kharif* groundnut highlighted some facts, regarding important causes of yield loss. The limited and scarce research resources need to be allocated judiciously and rationally to enhance the research efficiency Joshi *et al.*, (2003). Thus, there is a growing need for evaluation of agricultural research investment and setting priorities for research investment.

The present investigation was therefore undertaken to analyze the yield gap and constraints in groundnut and sesame production and to set priority for major research problem areas, for better understanding of resources allocation. There is consensus that homogenous Agro-ecological-Zone as a basic unit of agricultural planning is a better and more logical domain for research target.

MATERIAL AND METHODS

The study covers the Saurashtra region of Gujarat state consisting of seven districts viz., Amreli, Bhavnagar, Jamnagar, Junagadh, Rajkot, Surendranagar and recently formed Porbandar from Junagadh district. Saurashtra is an important agro-climatic region of Gujarat state where *Kharif* groundnut (17.94 lakh ha) and sesame (2.64 lakh ha) occupy dominant cropping pattern; and are considered to be the most suitable and profitable one (Annexure I).

Sampling design : After selection of research domain, the farm household survey was carried out for *kharif* season of 2003-04 adopting the multi-stage sampling technique. In the first stage, Bhavnagar, Junagadh and Rajkot districts were purposively chosen which properly represent the soils and agro-climatic conditions of whole Saurashtra. In second stage, two talukas were randomly selected from the each chosen district. In next stage, two villages were randomly selected from each of the six selected talukas. From the each selected village, 10 farmers representing small, medium and large holding were randomly selected. Thus, the total number of selected farmers stood at 120 for the study. The secondary data on experimental station yields, demonstration trial yields, etc. were collected from various publications.

Annexure - I

Cropping pattern of the Saurashtra region (area in '00' ha)

Crop	2003-04		
	Area	%	Rank
Groundnut	18214	48.73	1
Sesame	2740	7.33	4
Castor	321	0.86	8
Other oil seeds	46	0.12	10
Wheat	2453	6.56	5
Bajra	2893	7.74	3
Jowar	370	0.99	7
Other cereals	33	0.09	11
Total puses	1242	3.32	6
Cotton	9016	24.42	2
Other crops	51	0.14	9
Total cropped area (Saurashtra)	37379	100.00	–
Total cropped area (Gujarat state)	91508	–	–

Source : Director of Agriculture, Gujarat state, Gandhinagar.

The constraints *viz.*, pests, diseases, adverse soils, water scarcity/drought, agronomical and others; and socio-economic which have economic significance, were short-listed separately for both the crops on which information was gathered.

Quantification of yield losses and value losses : The severity of each constraint was assessed through estimation of yield loss. For each crop, the average absolute quantity of yield loss attributed to each constraint was estimated from the response given by the farmers. The farmers were also asked to estimate the proportion of area affected by each constraint to total area under particular crop in his fields/village and to estimate the long term (about 5 years) probability of occurrence of a particular constraint in that village on the basis of their past experiences. This information was then cross-checked with the scientists of concerned discipline and extension personnels. Estimates of each sample household about area affected (in percent), yield loss (kg/ha) and probability of occurrence of each constraint were then averaged (taking the weighted average with total land area surveyed for each crop).

The total yield loss was calculated from these averages. The average yield loss multiplied by total area affected of the region and then by the price of particular crop (recommended by the Commission for Agricultural Cost and Prices) provided the value of production foregone. The procedure for calculating production loss and value loss is given as:

$$Q = a \cdot p \cdot l$$

Where, Q = Average yield loss attributed to each constraint (kg/ha)
a = Proportion of area affected (%)
p = Probability of occurrence of a particular constraint/event (%)
l = Absolute yield loss attributed to each constraint (kg/ha)

$$T = Q \cdot N$$

Where, T = Total production loss ('00' tonnes)
Q = As explained above
N = Total area under individual crop in target region (lakh ha)

$$V = T \cdot Z$$

Where, V = Value of production loss (Rs. crore)
T = As explained above
Z = Price of output (Rs/kg)

Prioritizing socio-economic constraints is more difficult as the same set of constraints affect the entire region irrespective of crops or season. Hence, the study assumed yield gap II as the culminating effect of both technical and socio-economic constraints. Therefore, cardinal measurement of their impact on yield gap could not be tried, but the farmers were asked to rank the constraints as per the severity.

Estimation of yield gaps : The methodology developed by International Rice Research Institute (IRRI) have been followed to estimate the magnitudes of yield gaps, wherein potential yield, potential farm yield and farmers' yield are defined as yield obtained on research stations, demonstration plots and farmers' fields, respectively (Gaddi *et al.*, 2002). Yield gap is the difference between potential yield and actual yield. The difference is explained by a number of constraints - biological, physical and socio-economic. All these constraints together account for the total yield gaps. It can be decomposed into two parts *viz.*, yield gap I and yield gap II. Yield gap I is the difference between experiment stations average attainable maximum potential yield (atleast two different locations and varieties under cultivation) and on farm experiments average maximum yield. This yield gap arises from differences in environment that cannot be managed in the farmers' fields. Yield gap II, which is primary concern of the present study is the difference between yield attained in on-farm experiments and the average actual farm yield. This gap reflects the effects of biological, soil and water, physiological, genetic and socio-economic constraints.

RESULTS AND DISCUSSION

Yield gap analysis : In Gujarat state, groundnut production is mainly concentrated in Saurashtra region, which is known as the "Peanut Bowl" of India. In Saurashtra region, groundnut and sesame production are mainly practised under rainfed conditions in *kharif* season. The estimates of yield gaps in groundnut and sesame (under rainfed conditions including experiment stations) are presented in Table 1.

The results of these estimates illustrate considerable yield gaps in both bunch and spreading groundnut genotypes. The yield gap II was realized about 710 kg/ha on an average basis, which ranged from 672 kg/ha in case of spreading variety to 845 kg/ha in bunch groundnut. It accounted for 39 per cent of the actual farm yield of groundnut, which ranged from 35 per cent in spreading to 55 per cent in case of bunch groundnut. The bunch groundnut revealed relatively higher yield gap than spreading one, because the bunch groundnut is mainly grown in the areas having an inadequate and uneven distribution of rainfall whereas, the cultivation of spreading varieties are confined mostly in Junagadh district and its surrounding areas where rainfall condition is relatively better.

Like yield gap II, yield gap I is also very large in both genotypes. The average total yield gap ranged from 75 per cent in spreading varieties to 119 per cent in case of bunch cultivars with the overall average of 85 per cent.

Table 1. Estimated yields and yield gaps in groundnut and sesame in Saurashtra (kg/ha)

Particulars of yields	Groundnut (*kharif*)			Sesame
	Bunch	Spreading	Overall	
Experiment station yield	3358	3390	3377	1205
On-farm experiment yield	2375	2613	2533	991
Actual farm yield	1530	1941	1823	567
Yield gaps				
a Yield Gap I	983	777	844	214
b Yield Gap II	845	672	710	424
c Total Yield Gap (I + II)	1828	1449	1554	638
d Total Yield Gap (per cent*)	119	75	85	113
e Yield Gap II (percent*)	55	35	39	75

* based on actual yield

The magnitude of total yield gap found to be 638 kg/ha in sesame was more than the actual average yield obtained on farmers' fields. This was due to the combined effect of yield gap II (424 kg/ha) and yield gap I (214 kg/ha). Yield gap II accounts for 75 per cent of the actual yield obtained by sesame growers. This might be due to the fact that sesame crop is generally grown in the soil having poor nutrient and highly influenced by water stagnation or stress in initial growth stage.

The sample farmers realized nearly 72 and 57 per cent (based on index of realized on-farm experiment yield equals to cent percent) of farm potentials of groundnut and sesame, respectively in the study area. This suggests that concerted extension efforts need to be made to abridge the yield gap. This will not only improve the farmers' income but will change the macro-scenario as well. Further, an estimate of additional production at different realization rates of 25, 50, 75 and 100 per cent of exploitable yield gaps reveals that the tapping of the yield potential to the extent of 50 per cent could augment ground and sesame production in Saurashtra region to the extent of 12.09 and 0.57 tonnes respectively (Table 2). This is in commensurate with the findings of Singh and Dhaliwal (1993) in case of oilseeds production potentials in India.

Estimates of yield losses and value of production losses : The analysis of yield gap further inquires to identify the composition of the gap in terms of technical and socio-economic constraints and measures the contribution of these constraints that the farmers are facing in this region. The opinion of sample farmers on the difficulties in realizing potential farm yield was collected and it is presented in Table 3 and 4. It does not mean that all these enlisted constraints are major one and occur simultaneously. These may occur in the most severe form in any one of the seasons/years and in any one of the sub-regions. The yield loss indicated by the farmers is when the constraints is occurring beyond which the damage becomes considerable and has economic significance and in moderate severity condition.

In groundnut crop, total yield loss from technical constraints was 626 kg/ha. Water stress at anthesis topped the list among all constraints by causing a maximum average yield loss of 107 kg/ha, closely followed by dry spell at vegetative phase (95 kg/ha). Among diseases, tikka tops the list of damage by causing average yield loss of 37 kg/ha every year and in case of pests, thrips was the major problem reducing the yield by about 25 kg/ha. Adverse soils are also a prime constraint and poor organic matter is the serous problems causing average yield loss of about 58 kg/ha. The socio-economic constraints like inadequate power supply, high cost of irrigation and shortage of water, and price risk etc. also caused about 84 kg/ha yield loss in groundnut crop.

Table 2. Yield potentials of currently available production technologies for major oil seeds in Saurashtra

Particular		Crops	
		Groundnut	Sesame
Regional average (2001-03, kg/ha)		1394	559
Mean realizable yield with improved technology (kg/ha)		2742	992
Yield gap (kg/ha)		1348	433
Current average area (2001-03, lakh ha)		17.94	2.64
Current average production (2001-03, lakh tonnes)		25.00	1.48
Additional production possible (in lakh tonnes)	25%	6.05	0.29
with realization of exploitable yield gaps under	50%	12.09	0.57
real farm situation	75%	18.14	0.86
	100%	24.18	1.14

In sesame crop, among the technical constraints, water scarcity at vegetative stage was found to be the single most cause reducing the average yield by 82 kg/ha. Problem of weeds was also severe causing an average yield loss of about 78 kg/ha, followed by poor organic mater (40 kg/ha). Nearly half of the area under sesame crop suffered due to poor organic matter.

Table 3 and 4 also reveal the total production losses and value losses (calculated at the minimum support prices of 2003-04) due to all identified constraints in groundnut and sesame, respectively in Saurashtra region. The total production losses in groundnut and sesame due to all constraints at their moderate severity were estimated about 12.74 lakh tonnes and 1.12 lakh tonnes, respectively. This amounted to Rs. 1783.34 crores and Rs.166.10 crores, respectively. Among biotic constraints, tikka in groundnut and brown angular spot in sesame are the single most vital constraints causing maximum production losses of about 0.66 lakh tonnes and 0.07 lakh tonnes amounting to Rs. 92.93 crores and Rs. 10.97 crores, respectively.

The production losses due to socio-economic constraints in groundnut and sesame were estimated amounting to Rs. 210.99 crores and Rs. 28.21 crores, respectively. The total losses in value terms by group of constraints in groundnut and sesame are summarized in Table 5 at the minimum support prices and at the current market prices.

At current market prices, total value of production foregone was estimated about Rs. 2465.67 crores for major oilseed crops together, which comprised of Rs. 2155.94 crores due to technical constraints and Rs. 309.73 crores due to socio-economic constraints.

Water stress alone caused the value loss of about Rs. 705.11 crores, followed by adverse soils (Rs. 417.33 crores) and weed menace (Rs. 416 crores)

Priority research problems : The ranking of top 10 research priority areas on the basis of estimated loss of value production (drawn from Table 3 and 4) can be seen from Table 6. When the constraints were ranked in terms of their contribution to value production loss, the traditional problems oilseed viz., water scarcity, poor soil fertility, weeds, etc. appeared as the major constraints in the major crops.

The drought at anthesis in groundnut and drought at vegetative stage in sesame topped the list, indicating thereby the urgency for research investment to control the damage. Drought at vegetative stage in groundnut and other weeds in sesame were the second most important constraints. Among the insect-pests, thrips in groundnut and leaf roller in sesame were major one causing larger damage to the respective crops. Among diseases, tikka in groundnut and brown angular spot in sesame caused considerable production loss to the crop concerned. The problem of nutrient deficiency viz., potash, sulphur

Table 3. Estimated production losses and value losses due to major constraints in groundnut production in Saurashtra

Constraints	Average loss (kg/ha)	Total loss ('00' tonnes)	Value loss (Rs. crores)
(a) Pests	76	1363.52	190.89
1. Jassids	20	358.82	50.23
2. Aphids	18	322.94	45.21
3. Thrips	25	448.53	62.79
4. Prodenia	4	71.76	10.05
5. Heliothis	9	161.47	22.61
(b) Diseases	57	1022.64	143.17
1. Tikka	37	663.82	92.93
2. Rust	2	35.88	5.02
3. Collar rot	8	143.53	20.09
4. Stem rot	10	179.41	25.12
(c) Weeds	118	2117.04	296.39
1. Cynodon	2	35.88	5.02
2. Cyperus	1	17.94	2.51
3. Celosia	5	89.71	12.56
4. Digera	34	609.99	85.40
5. Others	76	1363.52	190.89
(d) Adverse soils	119	2134.98	298.90
(A) Nutrient deficiency			
1. Poor organic matter	58	1040.58	145.68
2. Potash	23	412.64	57.77
3. Sulphur	13	233.23	32.65
4. Iron	12	215.29	30.14
5. Zinc	2	35.88	5.02
6. Manganese	1	17.94	2.51
(B) Problematic soils		0.00	0.00
1. Soil erosion	1	17.94	2.51
2. Salt affected soils	1	17.94	2.51
3. Physical problem	8	143.53	20.09
(e) Water (scarcity/drought)	202	3624.08	507.37
1. Drought at vegetative stage	95	1704.40	238.62
2. Drought at anthesis	107	1919.69	268.76
(f) Others	54	968.81	135.63
1. Poor seed viability	4	71.76	10.05
2. Delayed sowing	47	843.23	118.05
3. Imbalance use of fertilizer	2	35.88	5.02
4. Damage by animals	1	17.94	2.51
Technical	626	11231.07	1572.35
Socio-economic	84	1507.04	210.99
Total	710	12738.11	1783.34

and iron were common in intensive cultivated areas. The ranking of top ten socio-economic problems are listed in Table 7. Since the ranking of these constraints is ordinal, it is difficult to compare them with technical constraints.

Among the socio-economic constrains, inadequate and irregular power supply topped the list, followed by high cost of irrigation and shortage of water, price-risk, poor irrigation facilities, etc. Production of groundnut and sesame in Saurashtra region is very risky as it suffered from a large number of biotic and abiotic stresses. Very low and highly erratic rainfall pattern is common in Saurashtra in which failure of power supply during critical stage of crop growth restricted the application of life saving irrigation and aggravated the situation. All these led to considerable production loss. Increasing production cost is a great hurdle for small and medium farmers.

Conclusion and policy implications : It may be concluded that a tremendous loss in production of both the oilseed crops in Saurashtra region was noticed due to biotic, abiotic and socio-economic constraints. This made possible to identify a partial research agenda for oilseed crops production in Saurashtra region. Water scarcity, the main constraint in crop production in Saurashtra region, requires added attention for watershed development and popularizing drip irrigation system to a greater extent. Looking to the problem of poor organic matter and deteriorating soil fertility, researchers must now address the issue of

Table 4. Estimated production losses and value losses due to major constraints in sesame production in Saurashtra

Constraints	Average loss (Kg/ha)	Total loss ('00' tonnes)	Value loss (Rs. crores)
(a) Pests	12	31.66	4.70
1. Leaf roller	10	26.38	3.92
2. Gall fly	2	5.28	0.78
(b) Diseases	31	81.78	12.14
1. Phytopthora blight	2	5.28	0.78
2. Brown angular spot	28	73.86	10.97
3. Wilt	1	2.64	0.39
(c) Weeds	78	205.76	30.56
1. Cynodon	2	5.28	0.78
2. Cyperus	1	2.64	0.39
3. Celosia	5	13.19	1.96
4. Digera	26	68.59	10.19
5. Others	44	116.07	17.24
(d) Adverse soils	76	200.49	29.77
(A) Nutrient deficiency			
1. Poor organic matter	40	105.52	15.67
2. Potash	10	26.38	3.92
3. Sulphur	8	21.10	3.13
4. Iron	1	2.64	0.39
5. Zinc	1	2.64	0.39
6. Manganese	1	2.64	0.39
(B) Problematic soils			
1. Soil erosion	1	2.64	0.39
2. Salt affected soils	1	2.64	0.39
3. Physical problem	13	34.29	5.09
(e) Water (scarcity/drought)	125	329.75	48.97
1. Drought at vegetative stage	82	216.32	32.12
2. Drought at anthesis	38	100.24	14.89
3. Water stagnation	5	13.19	1.96
(f) Others	30	79.14	11.75
1. Poor seed viability	2	5.28	0.78
2. Delayed sowing	26	68.59	10.19
3. Imbalance use of fertilizer	2	5.28	0.78
Technical	352	928.58	137.89
Socio-economic	72	189.94	28.21
Total	424	1118.51	166.10

integrated soil fertility management on cropping system basis with greater emphasis on crop residues, organic manures, bio-fertilizers, recycling of farm waste and utilization of mineral resources. Considerable loss from delayed sowing, frequent drought and uneven distribution of rainfall demands the acute need for short duration photo-insensitive varieties suitable for various production environments. The pests and diseases problems need to evolve the resistance genotypes addressing biotechnological help to promote sustainable agricultural production. The problem of weed menace particularly of digera, celosia, and cynodon needs some mechanism like selective weedicides to be popularized for these crops to prevent damage in labour scarce areas. The development of deficiencies of potash, sulphur and iron in the soils could be attended through awareness campaign for use of fertilizer with micronutrients.

The socio-economic constraints confronting the groundnut and sesame production also need to be addressed through development and policy intervention. Looking to the energy supply position for agricultural use, the government should take prompt action to ensure regular electric power supply for farm sector to prevent tremendous production loss. The development agencies and private sector should ensure that the critical inputs like quality seeds of recommended varieties, pesticides, fertilizers and credit necessary for productive purpose are timely available at proper prices. The high yield gap in groundnut and sesame necessitates strengthening extension services to

Table 5. Estimated value of production losses by group of constraints in major oilseed crops (Rs. Crores)

Constraints	At minimum support prices			At current market prices		
	Groundnut	Sesame	Total	Groundnut	Sesame	Total
Pests	190.89	4.70	195.59	216.48	9.90	226.38
Diseases	143.17	12.14	155.31	169.86	25.58	195.44
Weeds	296.39	30.56	326.95	351.64	64.36	416.00
Adverse soils	298.90	29.77	328.67	354.62	62.71	417.33
Water stress	507.37	48.97	556.34	601.96	103.15	705.11
Others	135.63	11.75	147.38	160.92	24.75	185.67
Technical	1572.35	137.89	1710.24	1865.48	290.46	2155.94
Socio-economics	210.99	28.21	239.20	250.32	59.41	309.73
Total	1783.34	166.10	1949.44	2115.80	349.87	2465.67

Table 6. Ranking of constraints by crops on the basis of average production loss in Saurashtra region

Rank	Groundnut	Sesame
I	Drought at anthesis	Drought at vegetative stage
II	Drought at vegetative stage	Other weeds
III	Other weeds	Poor organic matter
IV	Poor organic matter	Drought at anthesis
V	Delayed sowing	Brown angular spot
VI	Tikka	Delayed sowing
VII	Digera	Digera
VIII	Thrips	Soil physical problem
IX	Potash deficiency	Leaf roller
X	Jassids	Potash deficiency

Table 7. Important socio-economic constraints in Saurashtra

Constraints	Composite score	Rank
Inadequate and irregular supply of power	1.93	I
High cost of irrigation and shortage of water	2.24	II
Fear of glut in the market/price risk	2.88	III
Poor irrigation facilities	4.87	IV
High cost of inputs	4.95	V
Fear of crop failure	6.44	VI
Poor transfer of technology	8.78	VII
Poor storage facilities	9.03	VIII
Poor marketing facilities	9.87	IX
Lack of awareness about improved technology	10.69	X

provide proper guidance to the farm families. This investigation disclose the facts that there is a vast scope for achieving higher and stable growth of agricultural crops with present level of crop improvement technologies through proper management and reorganizing the research resources allocation for acute problem areas in this region.

REFERENCES

CGIAR, (1992). Review of CGIAR Priorities and Strategies (Part 1). TAC Secretariat, FAO, Rome, Italy.

Gaddi, G.M. *et al.* (2002). *Indian J. Agric. Econ.* **57(4):**723-734.

ICAR, (1987). National Demonstration Projects, Annual Report, 1987-88, New Delhi.

Joshi, P.K. *et al.* (2003) Prioritization of Production Constraints Concept and Methods, NATP, PME Notes 11, NCAP, New Delhi.

Ramasamy, C. *et al.* (1996). In: *Rice Research in Asia: Progress and Priorities.* (Evenson R.E., *et al.* eds.) CAB International, Wallingford, Oxon, U.K., pp. 145-160.

Roy, B.C. and Shiyani, R.L. (2000). *Bangladesh J. Agric. Econ.* **33(1/2):**19-34.

Singh, A.J. and Sarbjit Dhaliwal (1993). *Indian J. Agric. Econ.* **48(3):**357-365.

Widawsky, D.A. and O'Toole, J.C. (1996). In: *Rice Research in Asia: Progress and Priorities.* (Evenson R.E., *et al.* Eds.) CAB International, Wallingford, Oxon, U.K., pp. 109-130.