CONTEMPORARY RESEARCH IN INDIA
ISSN 2231 - 2137

IMPACT OF IMPROVED TECHNOLOGY ADOPTION FOR WHEAT IN MAHARASHTRA

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Received: 30/08/2017	Edited: 08/09/2017	Accepted: 14/09/2017

Abstract: *Indian population increased to 121 crore with a decadal growth of 17.64 per cent. Maharashtra is the second most populous (9.28 per cent) state in India. Total foodgrains production during 2015-16, estimated at 252.23 million tonnes, has been higher by 0.21 million tonnes over the production of 252.02 million tonnes during 2014-15. Production of wheat estimated at 94.04 million tonnes is higher by 7.51 million tonnes than the production of 86.53 million tonnes of wheat during 2014-15. Wheat is the major staple food crop grown as a commercial crop in Maharashtra. In order to achieve, the required production level of wheat through higher productivity, in depth analysis of wheat production methods and adoption pattern of technology is necessary. In view, the present study had been undertaken in Western Maharashtra continuously for three years i.e. 2012-13, 2013-14 and 2014-15 with objectives viz.; to asses the extent of adoption of improved technology for wheat crops, to ascertain the constraints in adoption of improved wheat production technology, to study the effects of improved wheat production technology on resource use productivities, costs and returns and to study the resource use productivity of major inputs of wheat crops.*

This study had been carried out in 16 tahsils from 10 districts. From each selected tahsil one village having the highest area under wheat was considered for the study. On the basis of operational holding, 30 wheat growers were selected randomly i.e. 10 from each of the category of small, medium and large size farms. Thus in all, 480 sample wheat growers were selected for the study. To assess the extent of adoption of improved crop production technology, the concept of technology adoption index was used. The resource use pattern, costs and returns was analyzed by using tabular method separately for up to 50 per cent and above 51 per cent technology adoption. It observed that area under wheat crop increased by 18.41 per cent within thirteen years. Production increased by 31.80 per cent and productivity also increased by 11.33 per cent. Uttar Pradesh has highest share in wheat production of India followed by Punjab and Madhya Pradesh. Hundred percent farmers adopt medium to heavy drained soil, harrowing and 4-5 irrigations after 21 days.

In case of small, medium and large group 97.92, 98.08 and 96.92 per cent farmers were total N users followed recommended seed use (87.50, 90.38 and 96.15 per cent, respectively), Total P users was 95.38 per cent in case of large group. Interculturing was 94.23 per cent in large group and total K users were 70.83, 80.77 and 84.62 per cent in case of small, medium and large group, respectively. About 90 per cent growers expressed that bio-fertilizers was not available for seed treatment. In case of chemical fertilizers 45 per cent of wheat growers indicated that it was costly and 21 per cent growers were facing the problems of finance at the overall level. The per hectare human labour was increased by about 20 man days with higher technology adoption. The use of seed, manures and fertilizer (except nitrogen) were higher for above 51 percent technology adoption level than upto 50 per cent. The per ha. Cost 'C' of wheat were Rs. 16111 and Rs 18398, the productivity were 23.72 qt. and 29.40 qt. and net farm income was Rs. 5913 and Rs.9748 among the farmers up to 50 per cent level of adoption and above 51 per cent level of adoption, respectively. The technology adoption index, other working capital, human labour, machine hours, N and P fertilizer nutrients together explained 85 per cent yield variation of wheat for above 51 per cent technology adoption, whereas 80 per cent variation shown by these variables in case of upto 50 per cent technology adoption. Thus, there is ample scope for expanding yield through crucial management in inputs and technology for wheat production. Immediate efforts are needed for evolving a breakthrough in the production technology of wheat for optimizing the use of different inputs to increase the productivity.

Key words: *wheat area, production, productory, production constants.*

Introduction

According to the reports released on 31 March 2011, the Indian population increased to 121 crore with a decadal growth of 17.64 per cent. Maharashtra is the second most populous (9.28 per cent) state in India. Total foodgrains production during 2015-16, estimated at 252.23 million tonnes, has been higher by 0.21 million tonnes over the production of 252.02 million tonnes during 2014-15. Production of wheat estimated at 94.04 million tonnes is higher by 7.51 million tonnes than the production of 86.53 million tonnes of wheat during 2014-15. Wheat is the major staple food crop grown as commercial crop in the state. It occupies 0.59 million ha. area with the production of 0.88 million tones which gives productivity of 11492 kg/ha for the year 2012-13. In order to achieve, the required production level of wheat through higher productivity, in depth analysis of wheat production methods and adoption pattern of technology is necessary. Therefore, the present study has been undertaken in Western Maharashtra continuously for three years *i. e.* 2012-13, 2013-14 and 2014-15 with objectives *viz.*; to asses the extent of adoption of improved technology for wheat crops, to ascertain the constraints in adoption of improved wheat production technology, to study the effects of improved wheat production technology on resource use productivities, costs and returns and to study the resource use productivity of major inputs of wheat crops.

Material and Methods

The three stage stratified random sampling design was adopted with tahsil as a primary unit, villages as the secondary unit and the wheat grower as the ultimate sampling unit. This study has been carried out in 16 tahsils from 10 districts. From each selected tahsil one village having the highest area under wheat was considered for the study. On the basis of operational holding, 30 wheat growers were selected randomly i.e. 10 from each of the category of small (up 0.01 to 2.00 ha.), medium (2.01 to 4.00 ha.) and large size farms (above 4.01 ha.). Thus in all, 480 sample wheat growers from 16 clusters (160 from each size group) were selected for the study. The data for the year 2014-15 were collected by the cost accounting method with the help of specially designed schedules for the purpose. The analysis was carried out by using tabular method as well as functional approach.

Technology Adoption Index (T.A.I.)

The important components of cultivation technology were assigned score (zero for non adoption of improved practice and one to three for proportion of adoption of recommendation, i.e. one for partial adoption, two for recommendation level of adoption and 3 for excess level of adoption) and points obtained for all inputs/technologies considering together were equated to 100 and the technology adoption index in terms of percentages was worked out. The score obtained for production of wheat crops, the wheat growers were grouped into two categories *i. e.* (i) up to 50 per cent level of adoption of improved technology and (ii) above 51 per cent level of adoption of improved technology. The resource use pattern, costs and returns was analyzed by using tabular method separately for up to 50 per cent and above 51 per cent technology adoption. The cost of cultivation of wheat was worked out by the using standard cost concepts and accordingly returns at different cost levels were estimated.

Functional Analysis-Resource Productivity

In order to know the factors influencing resource use productivity of wheat crops, the functional analysis was carried out by using following Cobb-Douglas type of production function,

$$Y = a X_1^{b1} X2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} X_8^{b8} X_9^{b9} e^{u}$$

Where,

Y= Output (qtl. Ha^{-1})

X_1 = Human labour (man days ha^{-1})

X2 = Bullock (pair days ha^{-1}.)

X_3 = Machine (hour ha^{-1}.)

X_4 = Nitrogenous fertilizer (kg ha^{-1}.)

X_5 = Phosphatic fertilizer (kg ha^{-1})

X_6 = Potassic Fertilizers (kg ha^{-1}.)
X_7 = Other working capital (Rs ha^{-1})
X_8 = Technology adoption index
X_9 = Irrigation expenditure (Rs ha^{-1})

a = Constant
u = error term.
Bi's = regression coefficients

Results and Discussion

A) Area, Production and Productivity of Wheat in India

Table 1: Area, Production and Productivity of Wheat in India (2001-02 to 2013-14)

Year	Area (Million ha.)	Production (Million tonn)	Productivity
2001-02	26.34	72.77	2762
2002-03	25.20	65.76	2610
2003-04	26.59	72.16	2713
2004-05	26.38	68.64	2602
2005-06	26.48	69.35	2619
2006-07	27.99	75.81	2708
2007-08	28.04	78.57	28.02
2008-09	27.75	80.68	2907
2009-10	28.46	80.80	2839
2010-11	29.07	86.87	2988
2011-12	29.86	94.88	3177
2012-13	30.00	93.51	3117
2013-14	31.19	95.91	3075

The area, production and productivity of Wheat in India from 2001-02 to 2013-14 is depicted in table 1. It observed that area under Wheat crop increased by 18.41 per cent within thirteen years. Production increased by 31.80 per cent and productivity also increased by 11.33 per cent.

B) Three largest producing states of Wheat crop

Table 2: Three largest producing states of Wheat crop during 2013-14

Sr. No.	State	Production (Million tonn)	Per cent Share
1	Uttar Pradesh	30.25	31.53
2	Punjab	17.04	17.76
3	Madhya Pradesh	13.93	14.52
4	Total (All India)	95.91	100

Three largest producing states of Wheat crop during 2013-14 indicated in table 2. It observed that Uttar Pradesh has highest share (31.53 per cent) in Wheat production of India followed by Punjab (17.76 per cent) and Madhya Pradesh (14.52 per cent).

C) Adoption of improved wheat production technology on sample farms.

Table 3: Adoption of improved wheat production technology on sample farms

Sr. No	Components of Technology	Small		Medium		Large		Overall	
		N-48	%	N-52	%	N-65	%	N-165	%
1.	**Soil**								
	Medium to heavy well drained	48	100.00	52	100.00	65	100.00	165	100.00
2.	**Preparatory Tillage**								
	Deep ploughing	32	66.66	42	80.77	49	75.39	123	74.55
	Harrowing-	48	100.00	52	100.00	65	100.00	165	100.00

3.	**Manuring**	1	2.08	8	15.38	8	12.31	17	10.30
	Recommend	---	---	3	5.77	1	1.54	4	2.42
4	**Sowing**								
	1) Timely 1tst to 15th Nov	35	72.92	38	73.08	52	80.00	125	75.76
	2) Late 15th to 15th Dec	13	27.08	14	26.92	13	20.00	40	24.24
	3) Rainfed 15th to 30th Oct	-	-	-	--	-	--	-	--
5.	**Sowing Method**								
	1 Seed Drill Method	30	62.50	37	71.15	52	80.00	119	72.12
	2 Hand Sowing /broadcasting	18	37.50	15	28.85	13	20.00	46	27.88
6.	**Variety**								
	HD -2189, MACS-2496 Others (Lokwan-1, Eagle, Narmada, Nirmal,Western,496)	37 1 10	77.08 2.08 20.83	38 - 14	73.08 -- 26.92	39 - 26	60.00 -- 40.00	114 1 50	69.09 0.60 30.31
	2 Irrigated Late sowing NIW-34	-							
7.	**Recommended Seed use**	42	87.50	47	90.38	56	86.15	145	87.88
	Excess seed use	2	4.17	1	1.92	1	1.54	4	2.42
	Seed Treatment- Azotobactor, Azosperilium/ Packet 10 kg seeds	--	--	--	--	--	--	--	--
8.	**Fertilizer**								
	Total N users	47	97.92	51	98.08	63	96.92	163	98.79
	Recommend N users	6	12.50	12	20.07	15	23.07	33	20.00
	Total P users	36	75.00	39	75.00	62	95.38	137	83.03
	Recommend P users	7	14.58	17	32.69	18	27.69	42	25.45
	Total K users	34	70.83	42	80.77	55	84.62	131	79.39
	Recommend K users	---	---	---	---	---	---	---	---
9.	**Irrigation** 4 to 5 after 21 days	48	100.00	52	100.00	65	100.00	165	100.0
10	**Plant protection**								
	a)Aphid Dimethoet 30 Ec 500 ML / Endosulphan 35 Ec 700 Ml /ha 500 Lit water	3	62.50	1	1.92	-	--	4	2.42
	c) Blight Coperoxychoride 0.2% 1 litrer water, Dithen M-45 (0.2%)	-	--	2	3.85	6	9.23	8	4.85
11	**Weed control** 2-4 D	-		3	5.77	3	4.62	6	3.63
12	**Interculturing**	38	79.17	49	94.23	49	75.38	136	82.42

The results presented in Table 3 indicate that hundred percent farmers adopt medium to heavy drained soil, harrowing and 4-5 irrigations after 21 days. In case of small, medium and large group 97.92, 98.08 and 96.92 per cent farmers were total N users followed recommended seed use (87.50, 90.38 and 96.15 per cent, respectively), Total P users was 95.38 per cent in case of large group. Interculturing was 94.23 per cent in large group and total K users were 70.83, 80.77 and 84.62 per cent in case of small, medium and large group, respectively.

D) Constraints in adoption of improved production technology of wheat

The constraints in adoption of improved production technology are presented in Table 4.

Table 4: Constraints in adoption of improved production technology of wheat

Sr. No.	Constraint	Small N-48		Medium N-52		Large N-65		Total N-165	
		No	%	No	%	No	%	No	%
1.	**Preparatory tillage**								
i.	To avoid loss of moisture	4	8.33	4	7.69	4	6.15	12	7.27
Ii	Non availability of bullocks	2	4.17	2	3.85	4	6.15	8	4.85
Iii	Ploughing for Kh. Crop/ Once in 3 years	12	25.00	6	11.54	12	18.46	30	18.18
2.	**Time of sowing**								
i.	Late due to previous crop	8	16.67	4	7.69	4	6.15	16	9.70

ii.	Delayed for proper field condition	4	8.33	6	11.54	7	10.77	17	10.30
iii.	Late due to non availability of bullocks	1	2.08	4	7.69	2	3.08	7	4.24
3.	**Method of sowing**								
i.	North- South method of sowing	10	20.83	7	13.46	6	9.23	23	13.94
ii.	Broadcasting method of sowing	4	8.33	6	11.54	5	7.69	9	5.45
4	**Improved variety**								
i.	Improved variety seed not available	3	6.25	2	3.85	2	3.08	7	4.24
ii.	Improved variety seed costly	12	25.00	8	15.38	5	7.69	25	15.15
5.	**Seed treatment**								
I	Non availability of Biofertilizer	38	79.17	48	92.31	62	95.38	148	89.70
ii.	Seed treatment practice not useful	9	18.75	5	9.62	11	16.92	25	15.15
6.	**Chemical Fertilizer**								
i.	Chemical fertilizer costly	22	45.83	31	59.62	21	32.31	74	44.85
ii.	Lack of finance	12	25.00	13	25.00	10	15.38	35	21.21
iii.	Not availability in time	9	18.75	9	17.31	4	6.15	22	13.33
7.	**Water Management**								
I	Used as available	8	16.67	6	11.54	6	9.23	20	12.12
8.	**Plant Protection**								
i.	No occurrence of pests/diseases	4	8.33	2	3.85	10	15.38	16	9.70
ii.	Less affected by pests/ diseases	5	10.42	5	9.62	9	13.85	19	11.52
iii.	Less infected by rat	1	2.08	6	11.54	10	15.38	17	10.30
iv.	Plant Protection costly	1	2.08	1	1.92	1	1.54	3	1.82
v.	Weedicides are costly	3	6.25	1	1.92	--	--	4	2.42

The intensity of the constraints in adoption of improved production technology was less only than 10 per cent sample farms indicated constraints in preparatory tillage, time of sowing, method of sowing and improved seed. About 90 per cent growers expressed that bio-fertilizers was not available for seed treatment. In case of chemical fertilizers 45 per cent of wheat growers indicated that it was costly and 21 per cent growers were facing the problems of finance at the overall level.

E) Resource use in wheat production by technology adoption.

The per hectare resources use by technology adoption level (upto 50 per cent and above 51 per cent) for wheat are presented in Table 5.

Table 5 Resource use structure on wheat sample farms (ha^{-1})

Sr. No.	Particulars	Irrigated	
		Up to 5 0% adoption (N-91)	Above 51% adoption (N-86)
1	Human labour (man days)	52.88	72.83
2	Bullock power (pair days)	6.89	4.82
3	Machine (hrs)	10.54	14.92
4	Seed (kg)	103.47	110.17
5	Manures FYM (qt)	3.95	5.26
6	Fertilizers (kg)		
	N	65.47	54.86
	P	24.73	41.78
	K	14.55	25.54
7	Irrigation cost (Rs)	496.11	792.90

The per hectare human labour and machine power use was increased by about 20 man days and 5 hrs, respectively with higher technology adoption. The bullock power use decreased from 6.89 to 4.92 pair days with the adoption of technology. The use of seed, manures and fertilizer (except nitrogen) were higher for above 51 percent technology adoption level than upto 50 per cent. The fertilizer use for above 51 per cent technology adoption was 55N:42P:25K and for the upto 50 per cent adoption it was 65N:25P:15K which is still below than the recommended. The irrigation cost ranged from Rs. 496 to Rs. 793.

F) Costs and returns structure of selected food grains: The information on costs and returns structure of the wheat is depicted in Table 6.

Table 6 Costs and returns structure of wheat on sample farms.(Rs/ha)

Sr. No.	Item	Irrigated	
		Up to 50% adoption	Above 51% adoption
1	Cost A	9838.30	11262.01
2	Cost B	14189.94	16359.24
3	Cost C	16111.16	18398.14
4	Productivity (qtl)	23.72	29.40
5	a)Main Produce (value) b)By Produce (value)	21277.55 747.17	27153.51 993.03
	Total	22024.72	28146.54
6	Returns a) Farm business income (cost A) b) Family labour income (cost B) c) Net farm income (cost C)	 12186.42 7834.78 5913.56	 16884.53 11787.30 9748.40
7	Per quintal cost C	647.59	591.93
8	B:C ratio	1.37	1.53

The per ha. Cost 'C' of wheat were Rs. 16111 and Rs 18398, the productivity were 23.72 qt. and 29.40 qt. and net farm income was Rs. 5913 and Rs.9748 among the farmers up to 50 per cent level of adoption and above 51 per cent level of adoption, respectively. B: C ratio showed an improvement from 1.37 to 1.53 with increase in technology adoption.

G) Econometric analysis of selected foodgrains production: The result of Cobb-Douglas type of production function is presented in table 7. The technology adoption index, other working capital, human labour, machine hours, N and P fertilizer nutrients together explained 85 per cent yield variation of wheat for above 51 per cent technology adoption, whereas 80 per cent variation shown by these variables in case of upto 50 per cent technology adoption. The magnitude of yield contribution for additional input use ranged from 0.68 per cent (16 Kg/ ha to 2.02, percent (59/Kg/.ha.)

Table 7 Cobb-Douglas production function for wheat in Western Maharashtra

Sr. No.	Items	Irrigated	
		Up to 50% adoption	Above 51% Adoption
1	Sample Size	91	86
2	Constant (a)	0.1311(0.1388)	1.42098(0.1564)
3	Human labour(man days) X_1	0.2158**(0.0839)	0.2319***(0.0777)
4	Bullock labour (Pair days) X_2	-0.0233 NS(0.0196)	-0.0207 NS(0.0275)
5	Machine hr (Rs) X_3	0.0351 NS(0.0569)	0.1459**(0.0660)
6	Fertilizers (Kgs)N - X_4	0.2032***(0.0488)	0.1483***(0.0496)
	P - X_5	0.0148 NS(0.0106)	0.0844**(0.0352)
	K - X_6	0.0192 NS(0.0145)	0.0183 NS(0.0171)
7	Other working capital X_7	0.3075***(0.0810)	0.3373***(0.0838)
8	Adoption Index X_8	0.6803**(0.2711)	2.0266***(0.3347)
9	Irrigation cost X_9	0.0569 NS(0.0590)	0.1407***(0.0297)
10	R^2	0.80	0.85
11	Σ bi	1.5096	3.1126

(***,** and *Significant at 1,5 and 10 per cent level of significance NS- Non significance)

for components of technology. The premium for technology is 1.35 per cent (43Kg/ha.) for above 51 per cent technology adoption than that of upto 50 per cent technology adoption. In addition to this, expenditure on irrigation, other working capital, N fertilizer and human labour were significant for both

the technology adoption groups. The sum of bi for above 51 per cent adoption (3.11) being more than twice of half way adoption (1.51) indicates higher scale of increasing return for more adoption of technology. Thus there is ample scope for expanding yield through crucial management and adoption of inputs and technology for wheat production.

Conclusions

Hundred percent adoptions of pre-requisite soil, harrowing and irrigation followed by nitrogenous fertilizer were observed. The TAI, other working capital, human labour, machine hours, N and P fertilizer nutrients together explained 85 per cent yield variation of wheat for above 51 per cent technology adoption, whereas 80 per cent variation was shown by these variables in the case of upto 50 per cent technology adoption. Thus, there is ample scope for expanding yield through crucial management in inputs and technology for wheat production.

Implication

Immediate efforts are needed for evolving a breakthrough in the production technology of wheat for optimizing the use of different inputs to increase the productivity.

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