



Economic Viability of Crop Diversification in Punjab

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ABSTRACT

Crop diversification is essential for an agricultural based economy like Punjab. With only 1.53 per cent of the total geographical area of the country, Punjab state produces about three per cent of rice, two per cent of wheat and one per cent of cotton of the world. During 2017-18, Punjab's share in central pool was about 32.5 for rice and about 36 per cent for wheat. However, its contribution has been declining over years because of the increased contribution of rice to the Central Pool from other states. The area under rice has increased by six times in the state *i.e.*, from 6.9 per cent (1970-71) to about 39 per cent of total cropped area in 2016-17. With increased irrigation facilities R-W monoculture has replaced others crops from Punjab's cropping pattern. To meet increased irrigation requirement of paddy, the rising dependence on groundwater resources has led to widespread decline in water table, increased operation and maintenance cost, more power consumption, and deterioration of groundwater quality affecting the socio-economic conditions of the farmers. Also, fertiliser consumption has increased from 37.5 kg/ha (1970-71) to about 245 kg/ha in 2016-17. The excess use of fertilizers above the recommended dose in wheat, paddy and cotton led to an additional expenditure of about Rs 250 crore. Assured purchase of wheat and rice at MSP by the public agencies along with lack of marketing infrastructure for other crops explains the concentration on wheat paddy monoculture. Area under paddy may be replaced either by raising the MSP or by raising the productivity of competing crops. Therefore, investment in Research and development, marketing infrastructure for alternate crops to paddy-wheat and strengthening of food processing and value addition industry is need of the hour.

Key Words: Cropping pattern, Diversification, Minimum support price, Returns, Variable costs

INTRODUCTION

Diversification oriented from the word diverge which means to move or extend in a different direction from common phenomena. In the agricultural context, diversification is defined as shift from the regional dominance of one crop (like rice) to another crops (like oilseeds), or from one enterprise (like crop based) to another enterprise (like livestock) or to engage in other complimentary activities. It is a paradigm shift from one crop to another, bringing out a desirable change in the existing cropping pattern towards more balanced cropping system to meet increasing demand.

Crop diversification is essential for an agricultural based economy like Punjab. With only 1.53 per cent of the total geographical area of the

country, Punjab state produces about three per cent of rice, two per cent of wheat and one per cent of cotton of the world. The state led the country's Green Revolution during 1960s and earned for itself the distinction of becoming Granary of India or India's breadbasket. During 2017-18, Punjab's share in central pool was about 31 for rice and about 36 per cent for wheat. However, its contribution has been declining over years because of the increased contribution of rice and wheat to the Central Pool from other states. Punjab, known for its prosperity largely due to the Green Revolution, is under scrutiny since the 1990s because of concerns for the sustainability of current cropping system. Wheat and rice, which have low production risks and negligible marketing risks due to procurement

at minimum support price are now occupying more than 80 per cent of the total cropped area. Cotton is another important crop which was grown at about 3.6 per cent of the cropped area during 2016-17. However some disturbing trends have emerged in the agriculture sector of the state during past two decades.

The over dependence on wheat and rice and intensive use of farm land with nearly 190 per cent cropping intensity have led to a crisis in terms of over exploitation of natural resources *viz.*, soil and ground water. Cultivation of paddy which covered only about seven per cent of total cropped area of the state in 1970-71, has increased to nearly 39 per cent of the total cropped area in 2016-17 and resulted into over-exploitation of water resources, increased electricity consumption and also putting serious strain on state exchequer to meet cost of free power supply to farm sector. The productivity level of wheat and rice has almost reached a plateau. This poses serious threat to long term sustainability of agriculture in the state. Keeping in view serious repercussions in terms of overuse of natural resources, ecological problems and growing farm income risk due to declining crop diversity in terms of paddy-wheat monoculture, the present

study was carried out to explore the possibilities for crop diversification in Punjab.

MATERIALS AND METHODS

In order to study the present situation of agriculture in Punjab state, the secondary data were collected from different published sources like Statistical Abstract of Punjab, Economic Survey, research papers, reports, newspapers, etc. Information pertaining to variable costs for cultivation of different crops in Punjab was obtained from the enterprise budgets of different crops prepared by the Department of Economics and Sociology, Punjab Agricultural University, Ludhiana. The triennium state average productivity of each crop has been taken into account for the analysis. The gross returns from different crops have been computed by using the minimum support prices/ prevailing market prices.

RESULTS AND DISCUSSION

Shift in cropping pattern

The information relating to area under different crops in Punjab indicated that with time, the cropping pattern has shifted towards rice-wheat monoculture (Table 1). Amongst *kharif* crops, the

Table 1. Shift in cropping pattern in Punjab.

(Per cent to gross cropped area)

Crop	1970-71	1990-91	2010-11	2015-16	2016-17
Wheat	40.5	43.6	44.5	44.5	44.3
Maize	9.8	2.5	1.8	1.6	1.5
Cotton	7.0	9.3	6.10	4.3	3.6
Rice	6.9	26.9	35.9	37.7	38.8
Bajra	3.7	0.2	0.04	-	0.04
Sugarcane	2.3	1.3	0.9	1.2	1.1
Total pulses	7.3	1.9	0.3	0.3	0.3
Total oilseeds	5.2	1.3	0.7	0.6	0.5
Total vegetables	0.9	0.7	2.4	2.7	1.7
Total fruits	0.6	0.8	0.9	1.1	1.0
Cropping intensity (%)	140.1	177.9	190	204	204
Gross cropped area (000' ha)	5678	7502	7882	7872	7823
No. of tube wells (lakh)	1.92	8.00	13.82	14.19	14.19

Source: Statistical Abstract of Punjab, various issues

Economic Viability of Crop Diversification in Punjab

per cent share of area under rice in the total cropped area has increased more than five times from 6.9 per cent in 1970-71 to about 39 per cent in 2016-17 while for other crops like sugarcane, maize, cotton, bajra, barley, pulses, sugarcane and oilseeds has declined with time. Also the per cent share of area under wheat increased from 40.5 to 44.5 per cent during the same time period. All this indicates that because of increased irrigation facilities in terms of rising number of tube wells (14.19 lakh in 2016-17) paddy-wheat monoculture has replaced other crops from Punjab's cropping pattern.

Ground water resources

In the past four decades, state has witnessed a boom in groundwater use and numerous important works exist on the problem of depleting water quality and fall in water tables. As far as the water level is concerned, it has gone down to 20 m or even below in 50 per cent areas of the state. In central Punjab, the figure stands at 10 m or more in about 92 per cent of the area. In 1973, there was only 3.7 per cent area with sub-soil water at 10 m (Anonymous, 2013; Krishan *et al*, 2014; Rao *et al*, 2014 and Sharma *et al*, 2014). During 1980-81, about 42 per cent of net area was irrigated using

canal water which declined to about 29 per cent in 2016-17 i.e. 11.86 lakh ha (Table 2).

With the passage of time, almost entire net sown area is irrigated and about 71 per cent area is dependent on tube wells. The share of tube wells in net irrigated area has risen from 57 per cent in 1980-81 to about 71 per cent in 2016-17. Because of increased irrigation requirement for water juggling crop (paddy), the rising dependence on groundwater resources has led to widespread decline in water table resulting into high investment for deepening of tube wells. The situation further led to increased operational and maintenance cost, more power consumption, and deterioration of groundwater quality. This trend of excessive groundwater drafting for agriculture has created such a situation that during the past many years the water table in the state is dropping at an alarming rate. 79 per cent of the groundwater assessment divisions (water blocks) in the state are now considered over exploited and critical with extraction exceeding the supply/recharge. The extensive water use in Punjab is resulting in falling groundwater levels. From 1982-87, the water table in central Punjab was falling on an average of 18 cm per year which

Table 2. Source-wise irrigated area in Punjab

(Area in lakh ha)

Year	Source of irrigation			Net irrigated area	% of net irrigated area to net sown area
	Canals	Tube wells	Other sources		
1980-81	14.30 (42.28)	19.39 (57.33)	13 (0.38)	33.82 (100.0)	81.0
2000-01	9.62 (23.82)	30.74 (76.13)	4 (0.10)	40.38 (100.0)	95.0
2014-15	11.75 (28.53)	29.43 (71.47)	-	41.18 (100.0)	99.9
2015-16	12.01 (29.03)	29.36 (70.97)	-	41.37 (100.0)	99.9
2016-17 (P)	11.86 (28.74)	29.40 (71.26)	-	41.26 (100.0)	99.9

Note: Figures in parentheses indicate percentages to net irrigated area

Source: Statistical Abstract of Punjab, various issues

Kumar and Sangeet

accelerated to 42 cm per year from 1997 to 2002, and to a staggering 75 cm during 2002-06. Water tables are now falling over about 90 per cent of the state, with central Punjab most severely affected. Many districts of Punjab show 100 per cent or even greater levels of exploitation. Irrigation has been a major cause for high water level depletion (Rodell *et al*, 2009). With the continuous rotation of paddy-wheat cropping system, the soil and water of Punjab have been degraded and depleted.

Supply of free/subsidized power to farm sector

In Punjab, power for agriculture was totally free from 1997 to 2002 and from 2005 onwards which is a major reason behind excessive tube well connections in the state that drain the groundwater. The ubiquitous practice of annual rice/wheat cropping system comes with a huge cost, consuming enormous resources, from fertilizers to maintain high yields to enormous amounts of electricity to pump declining groundwater from greater depths.

Table3. Excess use of nitrogen and phosphorous over the recommended doses in wheat, paddy and cotton crops in Punjab, 2014-15.

Nitrogen					Phosphorus				
Excess use (Kg/ha)	% farmers	Area (000 ha)	Qnty ('000 tons)	Value (Rs Crore)	Excess use (Kg/ha)	% farmers	Area (000 ha)	Qnty ('000 tons)	Value (Rs Crore)
Crop: Wheat					Crop: Wheat				
25 (15.4)	19.50	683.48	17.09	21.92	12.5(16.7)	15.07	528.20	6.60	29.70
50 (30.8)	19.50	683.48	34.17	43.84	25 (33.4)	1.14	39.96	1.00	4.49
75(46.2)	1.71	59.94	4.50	5.77	≥37.5(100.2)	3.22	112.86	4.23	19.04
≥100 (123.2)	0.50	17.53	1.75	2.25	Total	19.43	681.02	11.83	53.23
Total	41.21	1444.41	57.51	73.78					
Crop: Non-basmati paddy					Crop: Non-basmati paddy				
25 (15.4)	27.91	567.41	14.19	18.20	12.5 (33.3)	2.78	56.52	0.71	3.18
50 (30.8)	4.42	127.96	6.40	8.21	25 (66.6)	10.23	296.16	7.40	33.30
75 (46.2)	2.21	63.98	4.80	6.16	37.5 (99.9)	0.16	4.63	0.17	0.78
100 (61.6)	2.86	82.80	8.28	10.62	50 (133.2)	0.08	2.32	0.12	0.52
Total	37.40	1082.73	33.66	43.19	Total	13.25	383.59	8.40	37.78
Crop: Basmati paddy					Crop: Basmati paddy				
25 (22.2)	21.89	188.69	4.72	6.05	12.5 (33.3)	1.18	10.17	0.13	0.57
50 (44.4)	8.63	74.39	3.72	4.77	25 (66.6)	3.91	33.70	0.84	3.79
75 (66.6)	2.36	20.34	1.53	1.96	37.5 (99.9)	0.45	3.88	0.15	0.65
100 (88.8)	0.18	1.55	0.16	0.20	50 (133.2)	0.27	2.33	0.12	0.52
Total	33.06	284.98	10.12	12.98	Total	5.81	50.08	1.23	5.53
Crop: Cotton					Crop: Cotton				
37.5 (25.0)	12.53	52.75	1.98	2.54	12.5 (33.3)	9.39	39.53	0.49	2.22
> 37.5 (>25.0)	9.39	39.53	1.98	2.54	≥25 (133.2)	34.23	144.11	3.60	16.20
Total	21.92	92.28	3.95	5.07	Total	43.62	183.64	4.10	18.43

Note: Figures in parentheses denote the excess use of fertilizers in percentage terms.

Source: Field surveys conducted by Department of Economics & Sociology, PAU, Ludhiana

Economic Viability of Crop Diversification in Punjab

The groundwater level is declining at a rapid rate due to increase in the number of tube wells in the recent years. The consumption of electricity per irrigation was estimated at about 88 units in 2001-02 and at about 157 units in 2010-11, which showed that the power requirement for lifting the same quantity of water increased by 78 per cent in 10 years (Singh, 2012). The water table has gone down at a much faster rate in the rice growing areas and the electricity (power) required to draw out the same quantity of water goes on increasing linearly with the depth of water. The power consumption in Punjab agriculture has increased from 5105 million KWH in 2001-02 to 10,780 million KWH in 2012-13 and the subsidy burden (due to free supply of power by Punjab Government) from Rs 385 crore to Rs 6236 crore during this period (Kaur *et al*, 2015).

Excessive use of chemical fertilizers

Punjab state ranks third at national level for fertilizer consumption per hectare (249 kg/ha) with average consumption per hectare being almost double as compared to national of 131 kg/ha during 2015-16. Paddy is being cultivated in more than 30 lakh hectares in the state and controlling the use of urea could result in saving nearly Rs 200 crore. Urea consumption registered for the same is about 10 lakh tonnes which is 3.15 lakh tonnes over and above the recommended quantity (Anonymous, 2018). Excessive and indiscriminate use of fertilizers especially nitrogenous fertilizers not only increases the cost of cultivation, but also causes nutrient imbalance, which adversely affects crop yields. More use of phosphorus may decrease the availability of zinc causing its deficiency in crop. An analysis of data pertaining of the use of nitrogenous and phosphate fertilisers above the doses recommended by PAU in major crops revealed that in wheat crop excess dose of nitrogen (N) on about 14.4 lakh ha of wheat area was leading to an additional cost of about Rs 74 crore to the farmers (Table 3).

In the case of non-basmati paddy, an additional cost of about Rs 43 crore was incurred for excess

doses of N on about 11 lakh ha area under the crop. Majority of the farmers were using an excess dose (by about 15.4%) of 25 kg of N per ha on about 28 per cent area costing about Rs 18 crore. For basmati paddy the figure for overdose of N was worked out to be Rs 12.98 crore being the majority of the farmers were applying 22.2 per cent excess dose on about 1.89 lakh ha area under the crop. In cotton the additional cost of N accounted about Rs 5 crore and farmers were applying the excess dose of about 37.5 kg/ha and above. For use of phosphorus (P), again expenses incurred for excess dose were maximum for wheat (Rs 53.23 crore) as majority of the farmers were found to be applying P in excess of 12.5 kg per ha on about 5.28 lakh ha of wheat area. For non basmati paddy about Rs 38 crore were spent on excess application of P. For basmati paddy, the additional charges were about Rs 5.5 crore as majority of the farmers were applying over dose to the tune of 67 per cent on about 3.4 lakh ha area and for cotton about Rs 18.4 crore were spent and that being for over dose of more than 25 kg per ha on Rs 1.44 lakh ha area. Thus, an over use of fertilizers above the dose recommended by PAU led to an additional expenditure of about Rs 135 crore on nitrogen and Rs 115 crore on phosphorous application in wheat, paddy (including basmati) and cotton crops.

Problem of crop residue management

Punjab has huge potential of biomass resource availability in the form of crop residues. A total of about 50 MT of straw is generated every year. The major contributors to the total crop residue generated are paddy (47.1%) during *khari* season and wheat (47.3%) during the rabi season (Sangeet and Kumar, 2016). About 85 to 90 per cent of the total paddy straw generated in Punjab is burnt every year. Two-third to three-fourth of the rice residue is being burnt mainly due to uneconomical options available to farmers for any alternative use of the same (Kumar *et al*, 2015). Burning crop residue in one year alone results in the loss of 1.43 MT of nutrients from the top soil layer (Mehta *et al*, 2018).

Kumar and Sangeet

Table 4. Comparative economics of major crop rotations in Punjab, 2017-18. (Rs/ha)

Crop rotation	Crop	Average yield* (q/ha)	Gross returns**	Total variable costs	Returns over variable costs (ROVC)
Paddy-Wheat	i. Paddy	62.25	99125.0	47005.0	52120.0
	ii. Wheat	49.00	95755.0	36662.5	59092.5
	Total (i+ii)		194880.0	83667.5	111212.5
Basmati-Wheat-Maize fodder	i. Basmati	45.50	133807.5	45750.0	88057.5
	ii. Wheat	49.00	95672.5	31662.5	64010.0
	iii. Maize fodder	412.50	61875.0	29270.0	32605.0
	Total (i+ii+iii)		291355.0	106682.5	184672.5
Maize-Wheat	i. Maize	37.50	57892.5	40472.5	17420.0
	ii. Wheat	49.00	95672.5	30412.5	65260.0
	Total (i+ii)		153567.5	70885.0	82682.5
Bt-cotton-Wheat	Bt cotton	17.00	77675.0	64880.0	12795.0
	Wheat	49.00	95672.5	30412.5	65260.0
	Total (i+ii)		173347.5	95292.5	78055.0
Paddy- Wheat-Summer moong	i. Paddy	62.25	99125.0	47005.0	52120.0
	ii. Wheat	49.00	95755.0	36662.5	59092.5
	iii. Summer moong	11.25	65122.5	30752.5	34370.0
	Total (i+ii+iii)		260002.5	114420.0	145582.5
Paddy-Wheat-Bajra Fodder	i. Paddy	62.25	99125.0	47005.0	52120.0
	ii. Wheat	49.00	95755.0	36662.5	59092.5
	iii. Bajra Fodder	425.00	53125.0	22897.5	30227.5
	Total (i+ii+iii)		248005.0	106565.0	141440.0
Paddy-Potato-Spring Maize	i. Paddy	62.25	99125.0	47005.0	52120.0
	ii. Potato	259.25	136150.0	134835.0	1315.0
	iii. Spring Maize	75.00	117750.0	56235.0	61515.0
	Total (i+ii+iii)		353025.0	238075.0	114950.0
Sugarcane	Sugarcane	716.00	230837.5	76620.0	154217.5

*State average productivity of Triennium Ending 2016-17

**Includes the value of bi-product

As per the study conducted by Department of Soils, Punjab Agricultural University, Ludhiana in 2010, the soil loses 6-7 kg nitrogen per tonne, 1-1.7 kg phosphorus, 14 to 25 kg potassium and 1.2 to 1.5 kg sulphur due to stubble burning. This leads to an additional expenditure of Rs. 150 crore per year to replenish the soil. The loss of fertility leads to loss

of one quintal extra yield of wheat crop and that could be obtained if the farmer ploughs back the paddy straw into the fields. So, the monetary losses at around Rs. 500 crore per annum in terms of loss of fertility, cost of additional nutrients and loss of yield due to stubble burning are there.

Economic Viability of Crop Diversification in Punjab

Assured public procurement of paddy and wheat

Assured purchase of wheat and rice at Minimum Support Prices (MSP) by the public agencies for its Public Distribution System (PDS) makes paddy-wheat crop rotation an obvious choice for farmers in Punjab. The wheat paddy crop rotation has been, and remains, the most preferred cropping pattern across Punjab due to its comparative economic advantages, assured marketing and stable productivity levels (Sidhu *et al*, 2010). Because of MSP regime, price instability is lower in wheat and rice which makes it highly stable in terms of gross returns too. On the other hand, the lack of marketing infrastructure for crops other than wheat and rice explains the concentration on wheat paddy monoculture and a reluctance to try new cropping systems. Further increase in rice production with the given technology in Punjab is limited due to almost no scope of area expansion or productivity enhancement in rice.

Comparative economics of major crop rotations in Punjab

Based on Punjab Agricultural University recommendations, the returns over variable costs (ROVC) for major crop rotations followed in Punjab state during 2017-18 were worked out

It was found that ROVC for the most prevalent paddy-wheat crop rotation were about Rs1,11,200/ha which were less than all the observed crop rotations except maize-wheat and Bt cotton-wheat with ROVC of about Rs82682/ha and Rs78055/ha, respectively. This implies that alternate crop rotations can compete with paddy-wheat by either taking third crop as fodder in the crop rotation, or adding legume crop like summer crop which saves nitrogen required for succeeding crop. The solution to reduce area under paddy is to promote its competing crops like maize and cotton by enhancing their economic viability. This can only be done if returns over variable costs become at par as that from the cultivation of paddy crop. The break-even prices at which returns over variable costs of maize and cotton become equal to paddy at their existing

productivity levels are worked out to be about Rs 2400/q for maize and about Rs 6700/q for cotton crop. Another way to achieve this is by raising the productivity level of maize and cotton (at their existing MSPs) to 65 and 27 per q/ha, respectively through intensive research and development efforts.

Present status of crop diversification in Punjab

Though it was planned during Five Year Crop Diversification Plan, 2013 to reduce area under paddy crop by 12 lakh ha over next five years (from 28.5lakh ha during 2012-13 to 16 lakh ha in 2017-18).It had to be replaced by less water demanding crops. Through crop diversification, the government mainly wanted to achieve three goals: check the rapidly falling sub-soil water table, control the mounting power subsidy bill and break the stagnation in terms of yield in the wheat-paddy cycle. Several approaches had been pursued in the past to reduce area under paddy cultivation, but those met with no success as still more than 30 lakh ha area is there under paddy. On the other hand, it was proposed in the action plan to increase the area under cotton and basmati cultivation by 2 lakh ha each; both the crops consume less water as compared to traditional paddy. Besides, the area under maize was proposed to increase by 4 lakh ha, sugarcane by 1.70 lakh ha, pulses 0.70 lakh ha, fruits and vegetables by 0.85 lakh ha, agro forestry by 1.45 lakh ha and green fodder by 0.50 lakh ha.

CONCLUSION

The Punjab state made an outstanding progress in agriculture and contributed extensively to the food security of the country. The state today stands at a critical juncture, with ecological thresholds for soil fertility and water availability nearing their tipping points. The very sustainability of the current cropping system is under threat. In order to change the current trends via use of sustainable practices, better technology and prudent policy, following steps may be taken care of.

The major issues blocking crop diversification have been economic returns from alternative

Kumar and Sangeet

crops; assured marketing and pricing and a reliable and proven technology for alternative crops. A significant investment is required in Research and Development (R&D) as well as marketing infrastructure for alternate crops especially to paddy.

Essential research on crop diversification should be taken up in farmer participatory mode. Farmers have to be taken in to confidence by ensuring the arrangements for marketing of the produce and promotion of agro-industry by educating the farmers' class.

Concept of sustainable productivity for each unit of land and water through crop diversification need to be fostered. Strengthening of public private partnership may lead to enhanced investment in crop research.

Strengthening of food processing and value addition industry in rural areas should be entrusted to increase export avenues of various agricultural commodities produced under diversified farming.

Cattle feed plants should be set up in Punjab for the promotion of fodder crops in the state.

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