



Terms of Trade for Selected Crops in Rajasthan: Insights on Farmers' Complex Crop Choice Behaviour

Dinesh Kumar¹, Madhu Sharma², B. L. Manjunatha^{3*} and Dipika Hajong⁴

^{1,2}Department of Agricultural Economics, College of Agriculture, SKRAU, Bikaner, Rajasthan, India

^{3,4}Scientist, Agricultural Extension, ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan, India

*Corresponding author email id: manju4645@gmail.com

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ABSTRACT

This study estimated the Terms of Trade (TOT) between the input and output prices for pearl millet, wheat, paddy and gram crops cultivated in Jaipur, Sri Ganganagar, Hanumangarh and Ajmer districts respectively in Rajasthan state for the period 1996-97 to 2018-19. It was found that the Compounded Annual Growth Rate (CAGR) of Procurement Price Index (PPI) and Farm Harvest Price Index (FHPI) have increased consistently for all crops with a CAGR ranging from 5-8 per cent p.a. The CAGR of Composite Input Price Index (CIPI) was always higher (ranging from 6-8% p.a.) than the PPI and FHPI indicating that the input prices have increased at a much higher rate than the output prices during the study period. Analysis revealed that TOT (ratio of PPI to CIPI and ratio of FHPI to CIPI) for all crops for most of the years was unfavourable (<100) as evident from negative CAGR (ranging from -0.15 to -2.40% p.a.). The selection of the base year in which output prices are around 150% (i.e. 1.5 times the cost of cultivation) of the composite input prices for estimating TOT is recommended. The study further explored as to why farmers cultivated these crops despite declining and negative TOT.

INTRODUCTION

Agriculture not only supported livelihoods but also influenced the culture and traditions in rural India. However, lot of changes have occurred in Indian agriculture since independence on account of governments' regulation and policies and adoption of improved technologies. The important change has been the shift from farming system centric agriculture to crop/ commodity centric agriculture. The subsistence nature of farming has gradually transformed into commercial agriculture with the consequence of shift in decision making power from farmers/ regional factors to market forces. Commoditisation of agriculture has forced farmers to depend on external inputs and markets. Now the agricultural production in the country has become market oriented and marketable gluts of some agricultural commodities are very common in the country, and agriculture in Rajasthan is also not an exception to this change

(Sharma & Singh, 2013). The shift towards monocropping/ few crops has made farmers vulnerable to volatile market prices.

The farmers' decision to grow crop in a season is influenced by a number of complex group of factors such as family consumption needs, weather conditions, level of technology and resources requirement of crop to be grown. Changes in relative prices of different commodities influence the farmers' decision to allocate area under a particular crop which in turn would affect the level of production of different crop enterprises. There has been an uncertain trend in prices of agricultural commodities in India (Koshta et al., 1990). In the distorted and unregulated market conditions prevailing for agricultural commodities in India, support prices are very crucial for farmers to get assured income from their crop cultivation. Agricultural price policy is aimed at intervening in agricultural produce markets to influence the level of fluctuations in prices which spread from farm gate to the retail level. The price

support scheme linked to procurement has served the country well in the past decades (Kalamkar et al., 2013). Among the major policies for farm sector, agriculture price policy is one of the instruments that has helped farmers and brought a noticeable change in production and productivity of agriculture sector. The state price support schemes have tremendous effects on the allocation of resources and distribution of income in agriculture and non-agriculture sectors (Niti Aayog, 2016). In this context, the present study was aimed at estimating the changes in terms of trade between input and output prices for selected crops in Rajasthan and the factors affecting the choice of these crops for cultivation by farmers.

METHODOLOGY

Rajasthan state was selected purposively for this study. Four major food crops such as pearl millet, wheat, paddy and gram cultivated in Jaipur, Sri Ganganagar, Hanumangarh and Ajmer districts respectively were selected purposively. These districts were selected based on the highest production of these crops in Rajasthan. These crops are covered under the Minimum Support Price (MSP) scheme and floor prices are announced regularly by the Government of India before sowing of crops. One tehsil each from Sri Ganganagar, Hanumangarh, Jaipur and Ajmer districts were selected purposively in which wheat, paddy, pearl millet and gram are cultivated as the principal crop. Two villages from each tehsil were chosen randomly, using chit method. Fifteen farmers from each village were selected randomly, making a total of thirty farmers from each selected tehsil of a district. The total sample size was 120 farm households. The study employed both primary and secondary data which were compiled from the different sources (DoE&S, 2022a; DoE&S, 2022b; DoE&S, 2022c; CACP, 2021; CACP, 2022) for the period 1996-97 to 2018-19.

To study the TOT between the input and output prices of the selected crops for the selected districts of Rajasthan, the Composite Input Price Index was constructed by giving the weights to the individual selected inputs in the total cost structure calculated under the cost of cultivation scheme and the Index of Farm Harvest Prices / Procurement Prices received by the farmers for the period 1996-97 to 2018-19 by taking agricultural year 1996-97 as base year.

To work out the indices of input prices, actual prices paid by the farmers for all important agricultural inputs viz., preparatory tillage, sowing, seed, fertilizer, irrigation, weeding, harvesting, threshing, interest on working capital, transportation charges, management charges, risk factor and rental value of land as used in the production of selected crops were considered. The input price indices were estimated by using weighted average of price relatives as given below (Laspeyres, 1871):

$$I_{tj} = \frac{\sum_{i=1}^n \frac{P_{ti}}{P_{oi}} \times w_i}{\sum_{i=1}^n w_i}$$

$$I_{tj} = \frac{\frac{P_{t1}}{P_{o1}} \times W_1 + \frac{P_{t2}}{P_{o2}} \times W_2 + \dots + \frac{P_{tn}}{P_{on}} \times W_n}{W_1 + W_2 + \dots + W_n}$$

Where, I_{tj} = Input Price index of j^{th} crop in year 't'; P_{ti} = Price of i^{th} item of input in year 't'; P_{oi} = Price of i^{th} item of input in the

base year; n = Number of inputs used; and W_i = Weight of i^{th} item of output in the base year.

Weights were used as the percentage contribution of individual input to the total cost of that crop in the base year. Output price index of j^{th} crop in period 't' is the ratio of the Price of j^{th} crop in the year 't' to the Price of j^{th} crop in the base year. Finally, to study the terms of trade between input and output prices, the indices of output prices received by farmers were divided by the indices of input prices paid by them. The Compound Annual Growth Rate (CAGR) and the Cuddy-Della Valle Instability Index (Cuddy and Della Valle, 1978) methods were used respectively to measure the growth rate and the instability (or variation) of various price indices and TOT.

The exhaustive list of factors affecting choice of crop for cultivation by farmers was prepared and categorized into five broad themes/ factors (Table 5) based on extensive review of literature and discussion with key farmers, experts and stakeholders during a pilot study conducted in 2017. The primary data was collected from 120 households between January 2018 and December 2019 by personal interview method using a pre-tested semi-structured interview schedule. A survey research design was adopted for the study. Farmers were asked to rank these factors affecting the choice of crop for cultivation using Garrett ranking technique.

RESULTS AND DISCUSSION

Terms of trade (TOT) between input costs and output prices

Pearl millet and paddy are the kharif crops whereas wheat and gram are cultivated in rabi season. Pearl millet is grown under partially irrigated conditions (rainfed crop with 2-3 life saving irrigations) whereas paddy is a completely irrigated crop (canal irrigation). Wheat is a completely irrigated crop (canal irrigation) whereas gram is cultivated under the residual moisture of kharif season with limited irrigation. The TOT for pearl millet, wheat, paddy and gram in Jaipur, Sri Ganganagar, Hanumangarh and Ajmer districts respectively are presented in Tables 1 to 4.

The Procurement Price Index (PPI) and Farm Harvest Price Index (FHPI) increased constantly from 1996-97 to 2018-19 with a CAGR of 7.49 and 6.51 per cent p.a. respectively in case of Pearl millet (*Pennisetum glaucum*). The CAGR of PPI was higher than the FHPI indicating that MSP was higher than the market prices for higher number of years. The CAGR of Composite Input Price Index (CIPI) was 7.65 per cent p.a. which was higher than the PPI and FHPI. The TOT for pearl millet has shown mixed trend of ups and downs. The CAGR of TOT for the entire period was negative: -0.15 per cent p.a. (ratio of PPI to CIPI) and -1.06 per cent p.a. (ratio of FHPI to CIPI) indicating that the composite input price has increased at a much faster rate than output prices during the study period.

In case of wheat (*Triticum* sp.), the PPI and FHPI increased constantly from 1996-97 to 2018-19 with a CAGR of 5.65 and 5.63 per cent p.a. respectively. Further, it is to be noted that there was no significant difference between PPI and FHPI indicating that Minimum Support Price (MSP) was hovering around the market prices for most of the years. The CAGR of CIPI was 6.65 per cent p.a. which was higher than the PPI and FHPI. The TOT for

wheat was unfavourable (<100) throughout the period except during 2007-08 to 2012-13. The CAGR of TOT was negative: -0.85 per cent p.a. (ratio of PPI to CIPI) and -0.87 per cent p.a. (ratio of FHPI to CIPI).

The PPI and FHPI increased constantly from 1996-97 to 2018-19 with a CAGR of 6.63 and 5.32 per cent p.a. respectively in case of Paddy (*Oryza sativa*). The CAGR of PPI was higher than the FHPI indicating that MSP was higher than the market prices for higher number of years. The CAGR of CIPI was 5.84 per cent p.a. which was higher than the FHPI and lower than the PPI. The TOT for paddy was favourable (>100) from 2005-06 to 2007-08 and 2015-16 to 2018-19. In the remaining period, the TOT was unfavourable (<100). The CAGR of TOT was positive with PPI (0.74% p.a.) and negative with FHPI (-0.50% p.a.). It indicated that farmers who sold their produce at MSP to government procurement agencies were benefitted with positive TOT whereas farmers who sold in open market were at negative TOT. However, the question is how many farmers got benefitted from MSP since enforcement of MSP is successful in few crops in few selected states.

In some rice producing States like Punjab, Haryana, and Telangana, more than 80 percent of marketed surplus of rice was procured by Government agencies, which is primarily triggered by open-ended procurement policy (CACP, 2021). The Commission recommended the Central Government to review open-ended procurement policy for rice and wheat and take a policy decision to procure from small and marginal farmers, who constitute 86 per

cent of total operational holdings, and a fixed quantity from farmers having more than two hectare farm size. Efforts should also be made to strengthen procurement operations in other major rice producing States like West Bengal, Uttar Pradesh, Assam, Bihar, etc. to meet at least the State requirements under NFSA and other welfare Schemes (CACP, 2021). The cost of production is an important factor that goes as an input in determination of MSP, but it is certainly not the only factor that determines MSP (CACP, 2022). The production of paddy in Rajasthan is confined to canal command area and farmers grow mainly basmati varieties for sale which fetch higher price than that of normal paddy.

For Gram (*Cicer arietinum*), the PPI and FHPI have increased constantly from 1996-97 to 2018-19 with a CAGR of 7.56 and 5.70 per cent p.a. respectively. The CAGR of PPI was much higher than the FHPI indicating that MSP was higher than the market prices for higher number of years. The CAGR of CIPI was 8.30 per cent p.a. which was higher than the PPI and FHPI. The TOT for gram was unfavourable (<100) throughout the period. The CAGR of TOT was negative: -0.68 per cent p.a. (ratio of PPI to CIPI) and -2.40 per cent p.a. (ratio of FHPI to CIPI).

The TOT for all the four crops was declining and mostly unfavourable throughout the period from 1996-97 to 2018-19 (compared to base year 1996-197) except for paddy when sold at MSP prices. Similar trends were observed for major oilseed crops in Rajasthan (Kumar et al., 2021). The trend in indices of TOT in Gujarat was in favour of farmers in case of castor, groundnut, and maize whereas in case of Tobacco (Bidi), Tobacco (Calcutti) and

Table 1. Terms of Trade for pearl millet crop in Jaipur district of Rajasthan

Year	Procurement price index (PPI)	Farm harvest price index (FHPI)	Composite input price index (CIPI)	Index of the ratio of PPI to the CIPI	Index of the ratio of FHPI to the CIPI	Acreage (ha)
1996-97	100.00	100.00	100.00	100.00	100.00	NA
1997-98	102.70	102.86	95.05	108.06	108.22	219100
1998-99	105.41	102.86	114.58	91.99	89.77	204151
1999-00	112.16	178.00	142.61	78.65	124.82	205164
2000-01	120.27	115.71	163.86	73.40	70.62	229018
2001-02	131.08	94.00	92.30	142.02	101.84	269972
2002-03	131.08	155.43	176.88	74.11	87.87	237581
2003-04	136.49	107.71	89.11	153.17	120.88	330319
2004-05	139.19	134.86	126.16	110.32	106.89	268113
2005-06	141.89	165.14	179.15	79.20	92.18	278884
2006-07	145.95	180.29	154.34	94.56	116.81	282245
2007-08	162.16	176.29	138.46	117.12	127.32	298431
2008-09	227.03	190.86	187.53	121.06	101.77	295678
2009-10	227.03	252.00	234.69	96.73	107.37	318687
2010-11	237.84	230.86	180.26	131.94	128.07	330657
2011-12	264.86	229.14	269.27	98.37	85.10	317293
2012-13	317.57	312.57	379.82	83.61	82.29	301504
2013-14	337.84	321.43	344.90	97.95	93.20	302960
2014-15	337.84	322.86	391.51	86.29	82.47	297162
2015-16	344.59	374.29	541.26	63.67	69.15	300104
2016-17	351.35	398.00	431.21	81.48	92.30	303965
2017-18	385.14	359.43	551.63	69.82	65.16	298579
2018-19	527.03	426.57	545.10	96.68	78.26	298195
CAGR	7.49	6.51	7.65	-0.15	-1.06	1.41
Instability Index	18.96	17.08	29.67	23.51	17.84	9.52

Note: (i) The Procurement price, Farm harvest price and Composite input price were Rs. 370, 350 and 420.45/qt respectively in 1996-97 (base year). Procurement price and Farm harvest price were 88 per cent and 83.24 per cent of the Composite input price in 1996-97. (ii) NA = Not available.

Table 2. Terms of Trade for wheat crop in Sri Ganganagar district of Rajasthan

Year	Procurement price index (PPI)	Farm harvest price index (FHPI)	Composite input price index (CIPI)	Index of the ratio of PPI to the CIPI	Index of the ratio of FHPI to the CIPI	Acreage (ha)
1996-97	100.00	100.00	100.00	100.00	100.00	NA
1997-98	103.85	101.89	102.63	101.18	99.27	254000
1998-99	105.77	103.77	112.29	94.19	92.41	265752
1999-00	111.54	122.64	122.82	90.81	99.85	267339
2000-01	117.31	116.04	138.93	84.44	83.52	218401
2001-02	119.23	120.75	123.03	96.91	98.15	213808
2002-03	119.23	125.09	144.69	82.40	86.46	154930
2003-04	121.15	121.51	134.03	90.39	90.66	173534
2004-05	123.08	132.64	130.10	94.60	101.95	149237
2005-06	125.00	148.11	136.66	91.47	108.38	191727
2006-07	144.23	163.77	149.07	96.76	109.87	192667
2007-08	192.31	199.25	161.61	118.99	123.29	202387
2008-09	207.69	200.00	162.36	127.92	123.18	213503
2009-10	211.54	212.08	187.24	112.98	113.26	202210
2010-11	215.38	218.87	159.73	134.85	137.03	236076
2011-12	247.12	241.32	213.92	115.52	112.81	252690
2012-13	259.62	271.89	235.86	110.07	115.28	243122
2013-14	269.23	287.92	271.71	99.09	105.97	262808
2014-15	278.85	295.66	340.50	81.89	86.83	256659
2015-16	293.27	303.40	337.57	86.88	89.88	274584
2016-17	307.69	308.87	325.91	94.41	94.77	248342
2017-18	333.65	317.92	381.98	87.35	83.23	262110
2018-19	353.85	352.45	431.04	82.09	81.77	261633
CAGR	5.65	5.63	6.56	-0.85	-0.87	0.13
Instability Index	11.26	9.28	21.17	15.18	14.70	15.84

Note: (i) The Procurement price, Farm harvest price and Composite input price were Rs. 520, 530 and 298.40/qt respectively in 1996-97 (base year). Procurement price and Farm harvest price were 174.26 per cent and 177.61 per cent of the Composite input price in 1996-97.

Table 3. Terms of Trade for paddy crop in Hanumangarh district of Rajasthan

Year	Procurement price index (PPI)	Farm harvest price index (FHPI)	Composite input price index (CIPI)	Index of the ratio of PPI to the CIPI	Index of the ratio of FHPI to the CIPI	Acreage (ha)
1996-97	100.00	100.00	100.00	100.00	100.00	NA
1997-98	103.75	103.66	112.89	91.90	91.82	22600
1998-99	110.00	104.88	130.96	83.99	80.08	31214
1999-00	122.50	118.54	136.04	90.05	87.13	37006
2000-01	127.50	120.98	134.46	94.82	89.97	33537
2001-02	132.50	118.54	140.22	94.50	84.54	28345
2002-03	132.50	106.10	167.46	79.13	63.36	22232
2003-04	137.50	106.10	167.63	82.02	63.29	20869
2004-05	140.00	81.10	168.59	83.04	48.10	17590
2005-06	142.50	81.10	141.51	100.70	57.31	16969
2006-07	145.00	79.27	144.61	100.27	54.81	15550
2007-08	161.25	85.37	147.50	109.32	57.87	18169
2008-09	212.50	113.78	212.92	99.80	53.44	24241
2009-10	250.00	126.34	243.52	102.66	51.88	24635
2010-11	250.00	202.56	285.25	87.64	71.01	22311
2011-12	270.00	152.20	311.42	86.70	48.87	22095
2012-13	312.50	234.15	295.68	105.69	79.19	21401
2013-14	327.50	337.56	303.61	107.87	111.18	23859
2014-15	340.00	281.71	343.71	98.92	81.96	28741
2015-16	352.50	206.34	342.26	102.99	60.29	32986
2016-17	365.00	310.49	341.67	106.83	90.87	34450
2017-18	387.50	334.15	298.43	129.84	111.97	31647
2018-19	437.50	329.39	369.25	118.48	89.21	33485
CAGR	6.63	5.32	5.84	0.74	-0.50	1.80
Instability Index	14.24	32.69	14.48	9.69	26.77	25.16

Note: (i) The Procurement price, Farm harvest price and Composite input price were Rs. 400, 820 and 263.23/qt respectively in 1996-97 (base year). Procurement price and Farm harvest price were 151.96 per cent and 311.51 per cent of the Composite input price in 1996-97.

Table 4. Terms of Trade for gram crop in Ajmer district of Rajasthan

Year	Procurement price index (PPI)	Farm harvest price index (FHPI)	Composite input price index (CIPI)	Index of the ratio of PPI to the CIPI	Index of the ratio of FHPI to the CIPI	Acreage (ha)
1996-97	100.00	100.00	100.00	100.00	100.00	NA
1997-98	101.73	101.79	123.44	82.42	82.46	98800
1998-99	103.47	102.86	140.22	73.79	73.35	123824
1999-00	117.34	114.73	218.36	53.74	52.54	30961
2000-01	127.17	155.80	194.75	65.30	80.00	19597
2001-02	138.73	126.70	270.06	51.37	46.91	21484
2002-03	141.04	147.05	276.52	51.00	53.18	16900
2003-04	161.85	141.96	249.76	64.80	56.84	13841
2004-05	164.74	125.71	188.93	87.19	66.54	20969
2005-06	165.90	180.89	235.66	70.40	76.76	25153
2006-07	167.05	186.25	264.07	63.26	70.53	79660
2007-08	184.97	212.23	292.80	63.17	72.48	36890
2008-09	200.00	206.88	301.91	66.25	68.52	20783
2009-10	203.47	206.52	326.17	62.38	63.32	35800
2010-11	242.77	201.34	254.20	95.51	79.21	111133
2011-12	323.70	296.70	423.69	76.40	70.03	87692
2012-13	346.82	268.84	417.06	83.16	64.46	90065
2013-14	358.38	257.23	388.99	92.13	66.13	167018
2014-15	367.05	298.84	630.64	58.20	47.39	82743
2015-16	395.95	459.82	614.86	64.40	74.79	19690
2016-17	424.86	457.14	523.80	81.11	87.27	149361
2017-18	508.67	337.77	551.36	92.26	61.26	66193
2018-19	534.10	357.95	625.32	85.41	57.24	91332
CAGR	7.56	5.70	8.30	-0.68	-2.40	-0.36
Instability Index	18.72	21.27	19.98	19.88	19.09	69.55

Note: (i) The Procurement price, Farm harvest price and Composite input price were Rs. 865, 1120 and 407.42/qt respectively in 1996-97 (base year). Procurement price and Farm harvest price were 212.31 per cent and 274.90 per cent of the Composite input price in 1996-97.

gram the parity indices were not in favour of farmers (Ganga et al., 2015). A study in major cotton growing states of India reported that the favourable quantity terms failed to offset the negative price terms and net terms became unfavourable. Though the quantity terms are above the base year level, they showed a declining trend during the terminal period (Reddy and Yelekar, 2014). The movement of inter-sectoral terms of trade in India since independence has been characterized by periodical shifts in favour and against agriculture (Rajesh, 2012).

The declining TOT was partly attributed to the methodology used. The TOT for each year was relative to the margin of net returns (output price minus input cost) in the base year. Higher this margin is in the base year, higher the chance of unfavourable TOT for the other years. It is equivalent to comparing the net returns in a given year with the best year. For instance, in wheat, the net returns margin was 74.26 and 77.61 per cent in the base year when sold at procurement price and farm harvest prices respectively. The TOT for a given year will be <100 if the profit margin in that year is less than the base year, even if the profit margin is positive. Such trend was observed in wheat, paddy and gram. In pearl millet, the margin of profit in the base year was negative. Procurement price and farm harvest price respectively covered only 88 per cent and 83.24 per cent of the input price in the base year. This partially explains the favourable TOT for pearl millet for higher number of years. It is equivalent to comparing the net returns in a given year with a year in which farmers incurred losses. Therefore, drawing inferences on profitability of crop cultivation based on indices of

TOT alone may be misleading. Indices of TOT provide the direction of change in TOT when compared with the base year. Critical examination of net returns may provide better insights into profitability of crop cultivation. Therefore, selection of the base year in which output prices are around 150 per cent (i.e. 1.5 times the cost of cultivation) of the composite input prices for estimating TOT is recommended. Despite declining TOT, there was increase in area under pearl millet, wheat and paddy in Jaipur, Sri Ganganagar and Hanumangarh districts respectively whereas there was slight decline in area under gram in Ajmer district (Tables 1-4). This again is partially explained in wheat and paddy by the selection of the base year.

Farmers' crop choice behaviour

All the farmers unanimously agreed that agriculture as a whole was becoming less remunerative over time because of increase in input costs and uncertainties in output prices. Yet, farmers preferred to cultivate these crops indicated that their choice was affected by combination of many factors (Table 5) including suitability of these crops in their farming systems given the agro-ecological and socio-economic resource base, secondary uses of these crops and lack of other remunerative enterprises (opportunity cost). Diverse farming systems were practised by farmers in Rajasthan. For instance, in Jaipur district, farmers cultivate >8 crops in kharif season (pearl millet, pulses, fodder crops and diverse vegetables) under rainfed conditions and >15 crops under irrigated conditions in kharif, rabi (wheat, rapeseed & mustard, fodder crops, vegetable crops) and

Table 5. Factors affecting farmers' crop choice behaviour

S.No.	Factor	Mean score	Rank
1	Farming system approach practised in Rajasthan (crop(s) being one component of diverse farming systems)	91.12	I
2	Lack of alternative remunerative crops and enterprises (Opportunity cost principle)	84.52	II
3	Costs and returns are relative than absolute for farmers (Law of comparative advantage) and peer pressure	70.23	III
4	Policy interventions in favour of selected crops (canal irrigation and MSP)	66.12	IV
5	Farmers' view of costs and returns different from the true economics definition (costs "internal" and "external" to the farm)	64.28	V

occasionally summer season. Further, these crops are one component of farming system consisting of other components such as livestock, horticulture, agro-forestry trees and grasses/ fodder crops. Farmers sell 2-3 crops under rainfed conditions and >10 crops under irrigated conditions and rest of the crops are grown for domestic consumption. The nature and combination of crops and components vary but diverse farming systems exist in all districts in Rajasthan (Manjunatha et al., 2018; Singh et al., 2022). The TOT for crops in Rajasthan has to be looked from this context unlike in Punjab where monocropping (or few crops) is the dominant practice. Further, farmers generally cultivate the crops cultivated by majority of their fellow farmers except few innovative farmers (innovators constitute around 2.5 per cent of population as per most of the adoption studies) who take risk in trying completely new crops.

The costs and revenues were always "relative" than "absolute" to the farmers. The costs and returns of cultivation of a particular crop are valued by a farmer against the costs and returns of other crops cultivated in the same season in the same region. Further, the crops have multiple uses. Grains of pearl millet, wheat, paddy and gram are used for domestic consumption and rest is sold in the market. Pearl millet and wheat flour is used for consumption by human beings. Pearl millet grains are also used for preparing feed for lactating cattle/ buffaloes. Stover/ straw of pearl millet, wheat and paddy are used as dry fodder for livestock, which is an integral component of farming systems in Rajasthan. Further, farmers earned extra income from non-agricultural sources such as MNREGA and other enterprises while engaged in cultivation of these crops.

Composite input cost includes the family labour, rental value of land, interest on working capital and management charges. Though these costs are "costs" in true economic sense, farmers do not consider these as "costs" in their cost of cultivation. These costs are "internal to the farm" and farmer need not have to incur extra cost. These costs are perishable in nature in the sense that farmer cannot save these costs even if he doesn't use them. Further, cultivation of these crops is providing employment to the members of the household (making use of these perishable resources). For instance, rental value of land contributed 13 to 27 per cent of the cost of cultivation for major food and oilseed crops cultivated in Rajasthan (Kumar et al., 2018).

Farmers continue to grow these crops in the absence of other remunerative crops/ enterprises. The opportunity cost for cultivation of gram crop was leaving the land fallow. Therefore, farmer has no choice to go for any other crop than gram and tries to get some output with some occasional winter rains or lifesaving 1-2 irrigations. Access to canal irrigation in parts of Sri Ganganagar and Hanumangarh districts and MSP have incentivized farmers in

intensive cultivation of paddy, wheat and other vegetables using very high levels of chemical pesticides (Singh et al., 2022).

The remunerative and profitable agriculture is in the interest of farmers and the Indian economy. This has to be achieved by combination of price and non-price incentives (such as investment in agriculture and promotion of improved technologies) aimed at increasing factor productivity and reducing the cost of cultivation. Water saving technologies can lower water use by 23% in wheat without yield reduction (Kumar et al., 2020). Adoption of stress tolerant varieties and resource conservation technologies like Direct Seeded Rice could enhance farmer capability and improve resilience against climate change (Brar et al., 2020). Drip irrigation has to be promoted through provision of subsidies to overcome high initial costs (Yadav et al., 2019). Adoption of micro-level agro-advisory services helped farmers in their farm planning, better crop management, efficient utilization of existing farm resources while improving the productivity and farm incomes (Dupdal et al., 2021). The farmers sustained crop yields by adopting climate resilient indigenous and modern scientific technologies like manipulating sowing dates, mixed farming, crop diversification, alternate cropping systems and drought tolerant varieties (Dupdal et al., 2022). It is suggested that ways and means of estimating TOT for the whole farm (farming systems approach) have to be developed to measure the profitability of agriculture at farm household level. Further, sustainability of agriculture has to be measured not only from economic perspective, but also from ecological and socio-cultural perspective (Manjunatha et al., 2019; Manjunatha et al., 2021).

CONCLUSION

The terms of trade (TOT) between input and output prices for pearl millet, rice, wheat and gram crops in Rajasthan were found declining and unfavourable for most of the years from 1996-97 to 2018-19 when compared to 1996-1997 (base year for the analysis). Yet, farmers preferred to cultivate these crops owing to comparative advantage and opportunity cost. Cultivation of crop(s) was one component of the diverse farming systems consisting of many other components predominant in Rajasthan. The selection of the base year in which output prices are around 150% (i.e. 1.5 times the cost of cultivation) of the composite input prices for estimating TOT is recommended. It is suggested that robust methodology for estimating TOT for the whole farm (farming systems approach) have to be developed to measure the profitability of agriculture at the farm household level.

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