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Returns from pulses in different regions of Rajasthan at alternative price scenarios

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ABSTRACT

Rajasthan is a major producer of pulses along with Madhya Pradesh, Maharashtra, Karnataka and Uttar Pradesh. In 2013-14 Rajasthan had total area of 4197.7 thousand hectares under pulses with production of 2490.9 thousand tones and productivity of 593 kgs/ha. Moong and moth in *kharif* season and gram in *rabi* season are grown extensively in Rajasthan. The study is primarily based on plot-level data collected from the 600 representative households of 60 tehsils for block period (2008-09 to 2010-11) for Rajasthan under CCS scheme of Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India, New Delhi. The study examined the nutrient consumption level, nutrient and irrigation subsidies availed by the pulses per hectare. The net returns of various pulses to the farmer, to the society and to the environment were estimated across zones. Pea, arhar, lentil and black gram were the pulses providing highest net return to the farmer at market price. After deducting the cost of subsidies which is a cost to the society, moong and gram in arid and semiarid zones and pea and arhar in central and south eastern humid zones gave highest net return at economic price. The estimated results for technical, allocative and cost efficiency indicated that the farmers were not operating at optimal scale and there is large scope for increasing output through factors which are under control of farmers. Lentil and arhar were most technical and cost efficient pulse crops while moong is the least technical and cost efficient pulse. In most of the pulses, on an average, the overwhelming cause of inefficiency is technical rather than allocative.

Key words: Green house emission, Natural resource valuation, Net return at economic prices, Net return at market prices, Pulses, Subsidies.

INTRODUCTION

A variety of pulse crops are grown in India. India is the largest importer, producer, processor and consumer of pulses in world. Pulses are a major source of plant protein and carbohydrates for the consumers in general and vegetarians in particular. Other nutrients like phosphorous, minerals, vitamin C, riboflavin and essential amino acids are also major constituents. By product of pulses like leaves, pods, coats and bran are fed to animals in the form of green and dry fodder. Pulses being a member of leguminosae family fix nitrogen into the soil and thus improve soil health and soil fertility. Moong plants are also used as green manure to improve carbon matter in the soil.

Rajasthan is a major producer of pulses along with Madhya Pradesh, Maharashtra, Karnataka and Uttar Pradesh. In 2013-14 Rajasthan had total area of 4197.7 thousand hectares under pulses with production of 2490.9 thousand tones and productivity of 593 kg/ha (IIPR e-pulse databook). Moong and moth in *kharif* season and gram in *rabi* season are grown extensively in Rajasthan. In spite of government thrust, there is no significant improvement in productivity of these pulses over the years. The yield of moong which was 363 kg/ha in 1970-71 increased only to 473 kg/ha in 2014-15(2nd advance estimates). The yield of moth which was 237 kg/ha increased to 1976-77 in 339 kg/ha in 2011-12 (IIPR e-pulse databook). Thus, lot of potential remains untapped in the pulse production of Rajasthan.

The domestic consumption of pulses in India was 186.50 lakh tonnes (TE 2010-11). Against this India produced an average quantity of 158 lakh tonnes. Thus a huge gap is there between demand and supply of pulses. To bridge this gap, All India Coordinated Research Improvement Programme was initiated in 1967. National Food Security Mission started during the 12th Five Year Plan has a component of NFSM-pulses. It includes 16 districts of Rajasthan. It provides financial assistance for improved packages, HYV seeds, resource conservation machines/tools, efficient water application tools etc.

MATERIALS AND METHODS

The study is primarily based on plot-level data collected under "Comprehensive Scheme for Cost of Cultivation of Principal Crops" of Directorate of Economics and Statistics, Ministry of Agriculture, GoI, New Delhi. For Rajasthan, the plot-wise data was collected from the 600

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representative households of 60 tehsils during each year of the block period (2008-09 to 2010-11) by Maharana Pratap University of Agriculture and Technology, Udaipur, which is a nodal agency for this state. From nine agro-climatic zones of the state, farmers were selected using three-stage stratified sampling technique, with tehsil as stage one, a village or cluster of villages as stage two and operational holdings within the cluster as stage three. From each cluster, a sample of 10 operational holdings, two each from the five size-classes, *viz.* marginal (< 1 ha), small (1-2 ha), semi-medium (2-4 ha), medium (4-6 ha) and large (> 6 ha), were selected randomly.

Secondary data sources were also used in the study for few indicators like for subsidy rate on fertilizers and electricity. The data was procured from Department of Fertilizers, Ministry of Chemicals and Fertilizers, GoI and Rajasthan State Electricity Board. The data on district wise ground water depth of observation wells for the three years 2008, 2009 and 2010 has been taken from Central Ground Water Board (CGWB), Ministry of Water Resources, GoI. Statistical Abstract of Rajasthan, (Various issues) has been used to retain data on various cropping and irrigation parameters of Rajasthan agriculture.

Cost-Return Analysis: It's time to assess the performance of different crops by comparing net returns under alternative scenarios, *viz*. (i) Market prices; (ii) Economic prices considering subsidies; and (iii) Income based on natural resource valuation technique (Raju *et.al.* 2015).

Net returns at market prices can be defined as the gross return (value of main product and by product) less variable costs (Cost A1 + imputed value of family labour) at market prices actually paid and received by the farmer or imputed in some cases.

$$NRMP = GR - VC \ldots\ldots \quad (i)$$

Where, NRMP = Net return at market prices;
GR =Gross Return; and VC= Variable Cost.

Net return at economic prices (NREP) can be defined as the difference between net return or income at market prices and subsidies on inputs like fertilizers and irrigation used in crop production.

$$NREP = NRMP - Subsidy \ldots\ldots\ldots \quad (ii)$$

Thus, subsidy component was internalized into the model, by covering two aspects *viz.,* fertilizer subsidy and irrigation subsidy. Fertilizer subsidy consists of subsidy on nitrogen (N) and combination of Phosphorous (P) and Potassium (K). The total irrigation subsidy includes canal, electricity and diesel subsidy and was distributed over selected crops based on area under irrigation of each crop.

Net return based on Natural Resource Valuation (NR NRV) technique has taken care of nitrogen fixation by legume crops and Green House Gas (GHG) emission from crop production. As such NRNRV was computed by adding value of nitrogen fixation by legume crops at economic price of nitrogen (Value of N) and deducting the imputed value of increase in GHG emission cost to the atmosphere.

$$NR\ NRV = NR\ EP + (\text{Value of N} - \text{cost of GHG}) \ldots\ldots \quad (iii)$$

The data on contribution of pulses by biological nitrogen fixation and emission of different crops were collected from various published scientific literature, (Peoples *et al.* 1995,).The value of GHG emissions in terms of CO_2Kg equivalent was taken at the rate of 10 US dollar per tonne. Biological nitrogen fixation for various crops has been calculated by taking the average value of nitrogen fixed by various legumes and then multiplied with the economic price of nitrogen prevailed in the TE 2010-11.

Resource use efficiency under different crop production was estimated on the basis of Data Envelopment Analysis (DEA) at constant returns to scale. Efficiency is defined as a measure of how efficiently inputs are employed to produce a given level of output. Producing same level of output with lower level of inputs or more output with same level of input means higher level of efficiency. The information obtained included the amount of input costs which were used in crop production (such as family labour, causal labour, NPK, insecticides, seeds, etc.) and the yield as an output.

Technical Efficiency (TE): It can be expressed generally as the ratio of sum of the weighted outputs to sum of weighted inputs. The value of technical efficiency varies between zero and one; where a value of one implies that the farmer is the best performer located on the production frontier and has no reduction potential. Any value of TE lower than one indicates that the farmer uses inputs inefficiently (Mousavi-Avval *et. al.*, 2011).

Cost or Economic Efficiency (CE): One can measure both technical and allocative efficiencies to verify the behavioral objectives such as cost minimization or revenue maximization while the Allocative Efficiency (AE) is calculated as the ratio of cost efficiency to technical efficiency i.e. AE = CE / TE

RESULTS AND DISCUSSION

The major pulses of Rajasthan are moth, moong, arhar in *kharif* season and gram in rabi season. Area under total pulses in Rajasthan has declined over the years (Table 1). From TE 1972-73 till TE 2002-03 it has declined from 21.42 percent of the GCA to 14.15 percent of the GCA. After that till TE 2013-14 it has remained somewhat stable. Prior to year 2000 the data on pulses was available in the form of *kharif* pulses and *rabi* pulses only while recently pulse crop wise data is also available (Table 1). During TE 2013-14, although 15.95 per cent of the GCA is under pulses but it was mainly distributed only under three pulse, moth

Table 1: Decadal changes in area under pulses in Rajasthan.

						(Area in ha)
Crops	**TE 1972-73**	**TE 1982-83**	**TE 1992-93**	**TE 2002-03**	**TE 2010-11**	**TE 2013-14**
Moong	-	-	-	-	952982(4.05)	1028017(4.14)
Gram	1488080(9.00)	1638939(9.05)	1376708(7.17)	697316(3.93)	1309020(5.57)	1536788(6.18)
Moth	-	-	-	-	1362344(5.79)	1036465(4.17)
Arhar	31929(0.19)	29731(0.16)	26552(0.14)	21914(0.12)	19671(0.08)	16807(0.07)
Black gram	-	-	-	-	127127(0.54)	223095(0.90)
Cowpea	-	-	-	-	121234(0.52)	77091(0.31)
Other Kharif Pulses	2002165(12.11)	1788649(9.87)	1875766(9.76)	1762670(9.93)	2306(0.01)	1440(0.01)
Other Rabi Pulses	19013(0.12)	31531(0.17)	39043(0.20)	29751(0.17)	39888(0.17)	44404(0.18)
Total Pulses	**3541187(21.42)**	**3488850(19.26)**	**3318069(17.27)**	**2511651(14.15)**	**3934572(16.73)**	**3964107(15.95)**
Net Sown Area (NSA)	15100099	15501468	16268364	14479045	17625013	72030182
Gross Cropped Area (GCA)	**16533240 (100.00)**	**18113733 (100.00)**	**19213421 (100.00)**	**17748696 (100.00)**	**23520385 (100.00)**	**24859508 (100.00)**

Figures in parenthesis are the percentage to GCA.
Source: Government of Rajasthan, *Statistical Abstracts* (Various issues) (Anonymous, 2014).

(4.17 per cent), gram (6.18 per cent) and moong (4.14 per cent). Other pulse crops like arhar, black gram and cowpea etc. have less than one per cent of the GCA under their cultivation.

Nutrient use and subsidy in pulses across agro-climatic zone of Rajasthan: The role of inputs like fertilizers and irrigation has been recognized by the farmers now a days and accordingly they have started application of these inputs. Though the nutrient applications in pulses and the fertilizer and irrigation subsidy availed in pulse crops vary substantially across different zones of Rajasthan (Table 2). In arid western plains (zone 1) of the state where the minimum rainfall is less than 75mm, the major pulse crop is moth. The pulse k8crops like cowpea, gram and moth consumed zero nutrient and irrigation subsidy on sample farms. The second zone i.e. irrigated north western plains, the major pulses grown were gram(1,81,508 ha.), moth (11,099 ha.) and moong (21,222 ha.). In zone II, highest use of NPK was in pea (165.20 kg/ha) thus pea availed highest NPK subsidy of Rs.4,264.28/ha. Moth and lentil availed zero NPK and irrigation subsidy. In zone III also gram (4,82,059 ha), moong (3,59,386 ha) and moth (2,58,590 ha.) were the major pulses crops. Maximum nutrient use and nutrient subsidy was availed by moth (Rs.280.17/ha) while irrigation subsidy was highest in gram (Rs.79.29 ha.).

In semi arid areas of zone IV again gram and moong were the major pulse crops. In central Rajasthan (zone V), 46,883 hectare area was under black gram. The highest NPK consumption and maximum total subsidy per hectare was availed in pea (Rs 5,740.39/ha). This was followed by arhar (Rs.1,558.53/ha). Although gram and moong commanded sizeable area under their cultivation, yet the total subsidy (nutrient + irrigation) being used in these pulses was less than Rs.500/ha.

The highest nutrient consumption per hectare in pulse crops was in zone IX which is a humid south eastern plain. In this zone NPK was used in all the pulses viz gram, lentil, pea and black gram. The highest total subsidy was in pea (Rs.2,702.68/ha) followed by lentil (Rs.2,378.6/ha) and gram (Rs. 1,087.94/ha.).

The second highest nutrient consumption per hectare in all the pulses was in zone VII which is a sub humid zone. In this zone maximum pulse area was under gram (65,756 ha.) and black gram (62,986 ha.) but moong and lentil used maximum total subsidy on per hectare basis (Rs.1,248.33 and Rs.1,188.26 respectively).

Costs and returns of pulses at alternative price scenarios: Variable cost of cultivation (Cost A_1 + Cost of family labour) for different pulses and their net returns at three price scenarios are presented in Table 3. Net return at market price show the net return to farmer after accounting for variable cost of cultivation and cost of his family labour.

Due to different rainfall and agro-climatic conditions a great variation was observed in net returns of pulses across the zones. Pea in zone VI (flood prone eastern plains) gave highest net return at market prices i.e. Rs.96,462/ha. Arhar showed positive net return of Rs.30,795/ha in zone V and Rs.18,163 /ha in zone VIII but in zone VI it showed negative returns. (-) Rs. 6,057/ha. Crop failure at sample farms may be the reason for negative returns from pulses like lentil in zone II, moong and arhar in zone VI and moth in zone VIII where gross returns are zero.

Moong with net returns of Rs.2,445/ha and moth with net return of Rs.2,781/ha were the most profitable pulse crops among pulses in arid climate of zone I. Gram was the highest net return giving crop at market prices in zone III

Table 2: Nutrient use and subsidy in pulses across Agro-climatic zone of Rajasthan. **(TE 2010-11)**

Zone	Crops	Crop Area 2012-13 (in ha)	Crop AreaCoC Sample (in ha)	NPK Use (Kg/ha)	NPK Subsidy (Rs./ha)	Irrigation Subsidy (Rs./ha)	Total Subsidy (Rs./ha)
I	Cowpea	450	0.55	0	0	0	0
(Arid Western	Gram	579566.5	21.29	0	0	0	0
Plain)	Moong	205173	28.69	0.22	8.04	0	0
	Moth	626233.5	222.73	0	0	0	0
II	Gram	181508	67.78	27.61	996.4	4.98	1001.38
(Irrigated North	Moong	21222	16.84	3.62	130.31	0.78	131.09
Western	Moth	11099	2.39	0	0	0	0
Plain)	Lentil	2	0.56	0	0	0	0
	Pea	91	0.50	165.20	4264.28	37.3	4301.58
III (Transitional	Cow pea	49809	73.58	0.34	6.65	9.7	16.36
Plain of	Gram	482059.5	140.97	4.45	160.18	79.29	239.47
Inland	Moong	359386	145.82	2.71	96.42	0.73	97.15
Drainage)	Moth	258590.5	8.23	7.78	280.17	0	280.17
IV (Transitional	Cow pea	1080	1.81	0	0	8.9	8.9
Plain of	Gram	81354	9.47	16.22	584.55	6.81	591.36
Luni	Moong	200684	60.58	9.88	355.9	0.56	356.46
Basin)	Moth	30264	46.11	0	0	0	0
V (Semi-Arid	Cow pea	9404	11.40	0.7	25.29	0	25.29
Eastern	Gram	388575	39.01	11.91	411.93	3.32	415.25
Plain)	Moong	221399	76.97	10.46	363.07	0	363.07
	Moth	943	0.54	5.93	213.52	0	213.52
	Lentil	219	0.09	0	0	0	0
	Pea	9593	1.08	172.67	5662.14	78.25	5740.39
	Arhar	636	1.06	55.94	1546.7	11.82	1558.53
	Black gram	46883	2.71	3.72	111.49	0	111.49
VI (Flood	Gram	51711	27.57	1.50	54.36	0	54.36
Prone	Moong	292	0.12	0	0	0	0
Eastern	Pea	384	0.12	195	5107.83	0	5107.83
Plain)	Arhar	3214	0.36	0	0	0	0
	Black gram	5206	1.20	0	0	7.47	7.47
VII (Sub-Humid	Gram	65756	7.15	11.86	434.65	9.3	443.95
Southern	Moong	11540	0.37	34.59	1246.52	1.81	1248.33
Plain and	Lentil	6963	12.47	35.79	1171.81	16.45	1188.26
Aravali Hills)	Blackgram	62986	0.43	14.89	536.29	0	536.29
VIII (Humid	Gram	52651	21.30	13.54	468.04	5.28	473.32
Southern	Moong	54	3.07	0	0	12.98	12.98
Plain)	Moth	10	1.62	0	0	0	0
	Arhar	7258	0.30	0	0	0	0
	Black gram	28973	2.84	0	0	0	0
IX (Humid	Gram	40320	34.55	86.27	1086.52	1.42	1087.94
South-	Lentil	18660	1.19	78.15	2364.56	14.04	2378.6
Eastern	Pea	1405	0.48	81.04	2680.3	22.38	2702.68
Plain)	Black gram	47231	24.57	18.85	566.85	0	566.85

(transitional plane of inland drainage) and zone IV (transitional plane of luni basin). In the sub humid southern plains of zone VII lentil gave the highest net return at market prices (Rs.25,028/ha). While in humid south eastern plains zone IX pea (Rs.34,857/ha) followed by Lentil (Rs.11,203/ha) and Black gram (Rs.11,019/ha) yielded highest net return at market price.

Net return at economic price is the net return of crop from the society's point of view as it also accounts for nutrient and irrigation subsidy as cost to the society. After subtracting the cost of subsidies from net return at market prices, net return at economic prices were estimated and are presented in Table 3.

The crops which gave the highest net returns to the society were moth in zone 1 (Rs.2,781/ha) ; moong is zone II (Rs.12,062/ha); gram in zone III(Rs.12,837/ha); gram in zone IV (Rs.10169/ha); arhar in zone V (Rs.15,012/ha); pea in zone VI(Rs.91,354/ha); lentil in zone VII (Rs.23,840/ha);

Table 3: Cost and returns of pulses at alternative price scenarios across agro-climatic zone of Rajasthan (TE 2010-11) (Rs./ha).

Zone	Crops	Gross Returns	Variable cost (cost A1+FL)	Net Return at Market Price (NRMP)	Net Return at Economics Price (NREP)	Net return at(NR NRV)
I (Arid Western Plain)	Cowpea	3405	3237	167	167	2190
	Gram	2385	3811	-1426	-1426	-196
	Moong	7198	4753	2445	2437	3925
	Moth	9299	6518	2781	2781	2571
II (Irrigated North Western Plain)	Gram	17337	7791	9546	8545	9774
	Moong	20922	8728	12193	12062	13550
	Moth	7953	9145	-1191	-1191	-1401
	Lentil	0.00	1525.49	-1525.49	1525.49	1735.49
	Pea	21000	19782	1217	-3083	-1805
III (Transitional Plain of Inland Drainage)	Cow pea	12288	8877	3411	3395	5417
	Gram	25105	12028	13076	12837	14066
	Moong	11694	7758	3935	3838	5327
	Moth	7133	5691	1441	1161	951
IV (Transitional Plain of Luni Basin)	Cow pea	1503	5867	-4364	-4372	-2350
	Gram	34848	24088	10760	10169	11398
	Moong	8666	6480	2186	1829	3318
	Moth	5924	3845	2079	2079	1869
V (Semi-Arid Eastern Plain)	Cow pea	7686	6266	1419	1394	3416
	Gram	18000	10655	7345	6930	8160
	Moong	14543	10473	4069	3706	5194
	Moth	6800	2554	4245	4032	3822
	Lentil	18055	20404	-2348	-2348	-2558
	Pea	31283	25010	6273	532	1810
	Arhar	40070	9275	30795	29237	33362
	Black gram	10997	9069	1928	1816	5796
VI (Flood Prone Eastern Plain)	Gram	24032	8965	15066	15012	16242
	Moong	0	7124.22	-7124.22	-7124.22	-7124.22
	Pea	133333	36870	96462	91354	92632
	Arhar	0	- 6057.84	6057.84	-6057.84	-6057.84
	Black gram	10765	12505	-1739	-1747	2232
VII (Sub-Humid Southern Plain and Aravali Hills)	Gram	23374	11741	11632	11188	12418
	Moong	10833	8491	2341	1093	2581
	Lentil	39258	14230	25028	23840	23630
	Blackgram	4108	7578	-3470	-4006	-27
VIII (Humid Southern Plain)	Gram	17088	9461	7627	7154	8383
	Moong	12031	4702	7328	7315	8804
	Moth	0	803.24	-803.24	-803.24	-803.24
	Arhar	24027	5863	18163	18163	22288
	Black gram	4952	6968	-2015	-2015	1963
IX (Humid South-Eastern Plain)	Gram	16904	10166	6738	5650	6879
	Lentil	22268	11064	11203	8824	8614
	Pea	50000	15142	34857	32155	33433
	Black gram	20722	9702	11019	10452	14431

arhar in zone VIII (Rs.18,163/ha) and pea in zone IX (Rs.32,155/ha).

The last column of Table 3 shows net return of pulse crops at natural resource valuation (NRV). In other words this is net return to the environment. The net return at NRV was estimated by deducting the cost of green house gas emission from pulses and the value added in the form of nitrogen fixation by pulses on per hectare basis. The pulse crops providing maximum net returns while causing no harmful effect to the environment were moong in zone I and II (Rs.3,925/ha and Rs.13,550 /ha respectively), gram in zone III and IV (Rs.14,066/ha and 11,398/ha respectively), arhar in zone V(Rs.33,362/ha, pea in zone VI (Rs.92,632 /ha) , lentil in zone VII (Rs.23,630 /ha), arhar in zone VIII (Rs.22,288 /ha) and pea in zone IX (Rs.33,433/ha).

Resource use efficiency of sample farmers in pulse cultivation in Rajasthan: The mean technical efficiency of sample farmers for cultivation of different pulses (Table 4) showed a range of a maximum of 0.82 for lentil followed by 0.69 for arhar to a minimum of 0.23 for moong. The mean

Table 4: Resource use efficiency of sample farmers in pulse cultivation in Rajasthan (TE 2010-11).

Crops	Technical Efficiency	Allocative Efficiency	Cost Efficiency
Black gram	0.54	0.57	0.31
Cowpea	0.44	0.57	0.25
Gram	0.53	0.66	0.35
Lentil	0.82	0.63	0.52
Moong	0.23	0.74	0.17
Moth	0.31	0.74	0.23
Arhar	0.69	0.87	0.60

technical efficiency worked out as 0.23 for moong implies that, on an average, the respondents were able to obtain around 23% of potential output in moong from a given mix of inputs. Considering 1.0 as the frontier level of technical efficiency attainable, this also implies that around 77% of production, on an average, is foregone due to technical inefficiency or due to the factors that were within the control of the farmers. Cost or economic efficiency results suggest that arhar (0.60) is the most cost efficient pulse crop followed by lentil (0.52). Moong (0.17) is the least cost efficient pulse crop in Rajasthan. The result of cost efficiency analysis implied that even in the most economic efficient pulse crop arhar where the cost efficiency index is 0.60, farmers on an average could achieve additional profit of 40% [1-(0.60/1.0)] at the same level of input use. The estimated results indicate that the farmers were not operating at optimal scale. There is large scope for reducing the cost of inputs or maximizing the output on the same level of inputs.

Cost efficiency can be decomposed into allocative and technical components as it considers inputs, outputs and their respective prices. Allocative efficiency is a measure of how well farmers combine both inputs and outputs given their respective prices. The values of allocative efficiency for various pulses in the state suggest that in most of the pulses, on an average, the overwhelming cause of inefficiency is technical rather than allocative. These results have important implications, because they suggest that more gains in economic efficiency (i.e. profit) can be made through interventions addressing the technical production process rather than policy measures that address allocative efficiency. Profit inefficiency is the additive combination of allocative and technical inefficiency. Lower level of use of inputs like fertilizers and irrigation in pulses (Table 2) seem to be the reason for lower technical efficiency as 70% area of the state is rainfed and capital deficient.

CONCLUSION

Gram, moth and moong are three important pulse crops of Rajasthan. During triennium ending 2013-14, 15.95 % of the Gross cropped area of Rajasthan was under pulses. Over the years more and more area has shifted from pulses towards other crops. Arhar was cultivated in semiarid and flood prone eastern plains (zone V, VI & VIII). The area under blackgram concentrated in eastern and southern humid plains. The nutrient applications in pulses and the fertilizer and irrigation subsidy availed in pulse crops vary substantially across different zones of Rajasthan. The highest nutrient consumption per hectare in pulse crops was in zone IX which is a humid south eastern plain. In this zone NPK was used in all the pulses *viz* gram, lentil, pea and black gram. The highest total subsidy was in pea, lentil and gram. Across zones pulses like lentil, moth moong and cowpea were cultivated with zero or low level of fertilizer application under rain fed conditions thus the advantage of NPK subsidy and irrigation subsidy availed by these crops is low. These crops were cultivated mainly for fodder purposes and green manuring purposes in the state. Pea, arhar, lentil and blackgram were the pulses providing highest net return to the farmer at market price. After deducting the cost of subsidies which is a cost to the society, moong and gram in arid and semiarid zones and pea and arhar in central and south eastern humid zones gave highest net return at economic price. Pulse crops providing maximum net returns while causing no harmful effect to the environment were moong in zone I and II , gram in zone III and IV , arhar in zone V and VIII, pea in zone VI and IX and lentil in zone VII. The estimated results for technical, allocative and cost efficiency indicated that the farmers were not operating at optimal scale and there is large scope for increasing output through factors which are under control of farmers. Lentil and arhar were most technical and cost efficient pulse crops while moong is the least technical and cost efficient pulse. In most of the pulses, on an average, the overwhelming cause of inefficiency is technical rather than allocative. These results have important implications, because they suggest that more gains in economic efficiency (i.e. profit) can be made through interventions addressing the technical production process rather than policy measures that address allocative efficiency.

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REFERENCES

Anonymous(2003) Pulses in new Perspective, In Proceedings of the National Symposium on Crop Diversification and Natural Resource Management, Kanpur,20-22.

Anonymous (2014) Statiscal Abstract, Govt of Rajasthan.

Anonymous (2014) Dynamic Groundwater Resources of India, Central Groundwater Board, Ministry of Water Resources, River Development and Ganga Reju vention, Government of India, Faridabad.

Anonymous (2014), GHG Emission from Indian Agriculture: Trends, Mitigation and Policy Needs. Centre for Environment Science and Climate Resilient Agrivulture:16.

Coelli, T. (1998), A Multi-Stage Methodology for the solution of Orientated DEA Models, Operation Research Letters, **23**(3-5): 143-149.

Mousavi, A. SH; Rafiee, S., Jafari A, Mohammadi A. (2011) Optimization of energy consumption for soyabean production using Data Envelopment Analisis (DEA) approach. *Applied Energy*. **35**: 2156-2146.

Peoples, M.B. ; Herritage, D.F. and Ladha, J.K (1995). Biological nitrogen fixation : An efficient source of nitrogen for sustainable agricultural production Kluwer Acadmic Publishers.**174:** 3-28.

Raju S.S.; Singh.S; Sinha,D.K.; Yadav, D.B.; Chinnadurai,.M.K.; Burak,S.S.; Chandrakanth, M.G.; and Deka, N *et al*, (2015). Manual on Methodological Approach For Developing Regional Crop Plan" National Institute of Agricultural Economics And Policy Research, New Delhi: 1-5.