RESEARCH ARTICLE

ASSESSMENT OF TOTAL PRODUCTION AND ENVIRONMENTAL COSTS OF DIFFERENT VEGETABLE CROPS

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Abstract: The aim of the present study was to study the effect on production and return due to soil health deterioration and over use of chemical pesticides. For the purpose of present study, two districts were selected from 33 districts having maximum area of vegetable production. In the second stage, two blocks from each of these districts were selected according to production and in the third stage three per cent villages were randomly selected from each block. Environmental cost has been defined to include the cost of the effect on human health and soil degradation. The effect on human health is estimated to include the number of days lost, the loss in the work efficiency for those who experienced some health problems but did not take medicines. The result showed that total production and environmental cost was ₹. 733947.88 in Sri Ganganagar district and ₹. 722396.65 in Jaipur district. Out of that total cost, the production cost was ₹. 590683 and ₹. 657838 in Sri Ganganagar and Jaipur district respectively. Total environmental cost was ₹. 143264.88 in Sri Ganganagar district and. ₹. 64558.65 In Jaipur district. In per centage terms, the share of cost of production was as high as 91.06 in Jaipur and 80.47 per cent in Sri Gangangar district. In both the areas, urgent measures need to be taken to restore the health of the soils to promote ecological sustainability and economic viability of high cash crop cultivation.

Keywords: Environmental cost, Human health, Soil health

INTRODUCTION

Studies have shown that excessive use of chemical fertilizers and pesticides has impacted adversely on the soils. For example, according to (Oldeman *et al*., 1991) globally a total of 239 M ha is affected due to excessive and or imbalanced use of agro-chemicals. Out of such lands, 135 M ha is degraded due to loss of nutrients, 76 M ha is affected by salinity, 22 M ha is affected by chemical pollution and 6 M ha of land is affected by acidity. These estimates give a rough idea about the extent of chemical–related soil degradation worldwide. The adoption of monoculture by the farmers and the use of high yielding varieties in place of traditional varieties in commercialized agriculture have led to a significant loss of genetic diversity. The contribution of monoculture and intensification towards the loss of nutrients, chemical pollution and acidification is, however, not known. Here are growing concerns of pesticide risks to human health, natural environment and ecosystems (Atreya *et al*., 2012). These effects are increasingly manifested in loss of working efficiency of farm workers resulting in higher cost of production. The increased use of pesticides, deteriorating ecosystem health has advocated the need to change traditional and external input use in agriculture towards safe and sustainable production. In this context, the present study was aimed at measuring the extent of use of pesticides in commercial vegetable production and its direct impact on health.

The specific objectives of this research article were (i) To study the soil health deterioration and human health by extent of use of pesticides under commercial vegetable production in the study area; and (ii) To estimate the environmental cost.

MATERIALS AND METHODS

Selection of study area

Sri Ganganagar district and Jaipur district in Rajasthan state were purposively selected for the study because of maximum area and commercial production of selected vegetables (cabbage, cauliflower, tomato and peas). These vegetables are being cultivated since late sixties and early seventies until now in the study area. In the second stage, two blocks from each district were selected based on highest area and production. From these four blocks, 32 villages were selected using stratified proportional sampling method. Two Hundred farm households were selected randomly from these 32 villages in proportion to the area under vegetables in each village (Table 2). Cauliflower, cabbage, tomato and peas were cultivated by 77, 42, 37 and 34 farm households respectively among these 200 farms HHs. Interview schedule was developed specifically for the study keeping in view the objectives of the study. Primary data were collected from 2016 to 2019 using personal interview method on vegetable cultivation practices, plant protection techniques and other variables. The primary data were corroborated/ validated through focussed group discussions with

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key informants in each village and scientists from KrishiVigyan Kendra and agriculture officers working in Sri Ganganagar district and Jaipur district Published secondary sources were also used.

Sampling Plan of Study Area

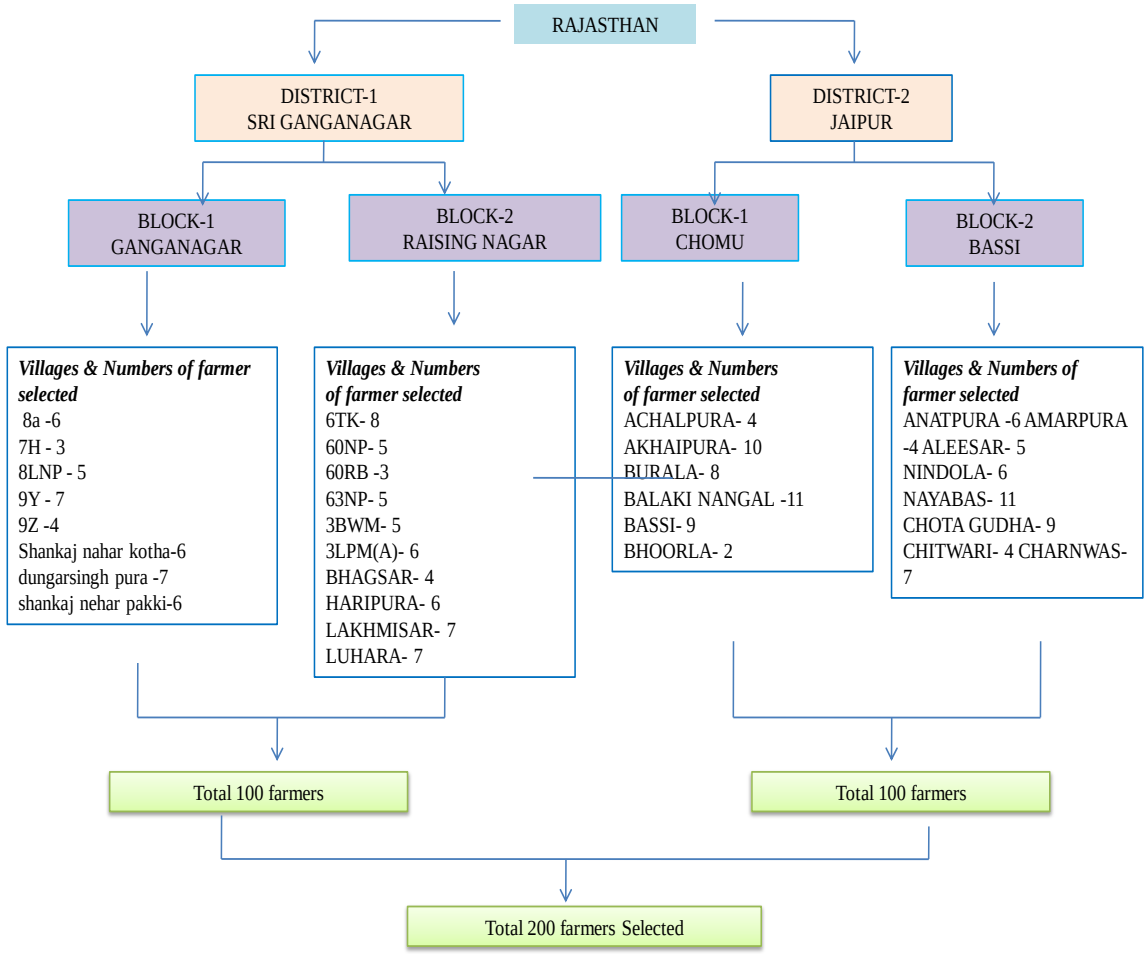

Table 1. Cumulative square root frequency

Class no.	Class interval(bigha)	Frequency (n)	√n	Cumulative square root frequency	Strata
A	1 to 5	A	√a	√a	First strata
B	6 to 10	B	√b	√a+√b	
C	11 to 15	C	√c	√a+√b+√c	
D	16 to 20	D	√d	√a+√b+√c+√d	Second strata
E	21 to 25	E	√e	√a+√b+√c+√d+√e	
F	26 to 30	F	√f	√a+……√f	Third strata
G	31 to 35	G	√g	√a+……√g	
H	36 to 40	H	√h	√a+……..√h	
I	41 to 50	I	√i	√a+……√i	
J	51 to 75	J	√j	√a+……√j	
K	76 to 90	K	√k	√a+……√k	
L	91 to 100	L	√l	√a+……..√l	
M	101 to 180	M	√m	√a+……..√m	

Table 2. Cumulative square root frequency method used for construction of strata

Class No.	Class interval (bighas)	Frequency (n)	√n	Cumulative square root frequency	Strata
A	1 to 5	45	6.70	6.70	First strata
B	6 to 10	61	7.81	14.51	
C	11 to 15	38	6.16	20.67	
D	16 to 20	31	5.56	26.23	Second strata
E	21 to 25	10	3.16	29.39	
F	26 to 30	7	2.64	32.03	Third strata
G	31 to 35	4	2	34.03	
H	36 to 40	3	1.73	35.76	
I	41 to 45	1	1	36.76	

The cumulative square root frequency method was used for the construction of strata as stated in Table 2.

The households were divided into two strata:

First strata = $\frac{\sqrt{a}+\sqrt{b}+\cdots\cdots\cdots+\sqrt{I}}{3} = X \quad (say)$

First strata = 36.76/3 = 12.25

X lies in between Class interval 11 - 15 in class C. Therefore, all respondents owning up to 15 bighas of land fall under first strata and second strata include up to 25 big has and the remaining households fall in the third strata.

The classification of households into small and large categories based on table 2 and their number in respective category and the basis for classification is presented in table 3.

Table 3. Classification of farm households based on farm size (ha)

Category	Land holding (ha.)	Sample size		
		Ganganagar	Raisingh Nagar	Total
Small	Up to 3.07	56	50	106
Large	>3.07	44	50	94
Total	-	**100**	**100**	**200**

The small farmers were those who had land up to 3.07 ha and the large farmers having land more than 3.07 ha.

Cost and returns analysis

The cost and returns were worked out following farm management cost concepts like Cost A1, cost A2, cost C1, Cost C2 and Cost C3. The definitions of these concepts have been explained below.

Cost A1:

1. Value of human labour
2. Value of Bullock labour
3. Value of seed
4. Value of manure
5. Value of fertilizer
6. Value of chemicals
7. Machinery
8. Depreciation of farm equipment, calculated as 10 per cent of total value of farm equipment, annually
9. Irrigation charges
10. Land revenue
11. Interest on working capital for half of the growth period of the crop

Cost A2: A1 + rent paid for leased-in land.

Cost B1: Cost A1 + imputed interest on owned fixed capital (excluding land).

Cost B2: Cost A2 + imputed rental value of owned land (less land revenue) + imputed interest on owned fixed capital (excluding land).

Cost C1: Cost B1 + imputed value of family labour.

Cost C2: Cost B2 + imputed value of family labour.

The net returns from different crops were estimated over different costs. The calculations were made on per hectare basis. The details of procedure followed to compute the returns are explained below.

The net returns of the crop were calculated by using following method.

NR = GR – Costs

Where,

NR = Net returns over cost

GR = YMPM + YBPB

Where,

GR = Gross returns per hectare of the crop

YM = Yield level of the main product of the crop

PM = Price per quintal of the main product of the crop

YB = Yield level of the by-product of the crop

PB = Price level of the by-product of the crop

PB = Price per quintal of the by-product of the crop and different costs over which net returns have been worked out and it include Cost A1, Cost A2, Cost B1, Cost B2, Cost C1 and Cost C2

Valuation of environmental cost

Environmental cost has been defined to include the cost of the effect on human health and soil degradation. The effect on human health is estimated to include the number of days lost, the loss in the

work efficiency for those who experienced some health problems but did not take medicines, the yearly medical expenditure of the person who handled the pesticides and the value of kit. For computing monetary value of the degradation of soil health, the soil status was compared with the recommended doses in the packages of practices ofvegetable crops. If the status of a particular nutrient in the soil was high, then recommended dose, given in the package of practices, was reduced by 25 per cent. In case of medium status, the recommend was the same as given in the package of practices. If the status of a particular nutrient was low, 25 per cent was added to the recommended dose. These doses were now considered as optimum doses for a particular nutrient.

Thereafter, actual dose used by the farmer was compared with the recommended dose; the difference for different nutrients from their recommended doses could either be excess or deficit. The excess or deficit amount then was converted into monetary value by multiplying the price of a particular nutrient with the excess or deficit amount. The total environmental cost then was apportioned among different crops in proportion to the area under these crops. As mentioned above, all the soil samples in Jaipur were collected from the area under vegetable crops. Therefore, the environmental cost in Jaipur was apportioned only among vegetable crops.

RESULTS AND DISCUSSION

Production and environmental cost

Table 4 shows that total production and environmental cost was ₹. 733947.88 in Sri Ganganagar district and ₹. 722396.65 in Jaipur district. Out of that total cost, the production cost was ₹. 590683 and ₹. 657838 in Sri Ganganagar and Jaipur district respectively. Total environmental cost was ₹. 143264.88inSri Ganganagar district and. ₹. 64558.65 in Jaipur district. In per centage terms, the share of cost of production was as high as 91.06 in Jaipur and 80.47 per cent in Sri Gangangar district.

The per cent share of environmental cost was less than 9 per cent in jaipur and 20 per cent in Sri Ganganagar. Apportioning the environmental costs to different crops according to their share in the cultivated area, Table 4.51 shows that in Sri Ganganagar district, cost of cauliflowerwas ₹. 67758, followed by cabbage (₹. 47766.88), tomato (₹. 25400) and pea (₹. 2340). In Jaipur district, cost of tomato was ₹. 22732, followed by cauliflower (₹. 18339), cabbage (₹. 14047.65) and pea (₹. 9440).

Table 4. Production and environmental cost

1. Cost of production	**Sri Ganganagar**	**Jaipur**
Cauliflower	171000	221687
Cabbage	138230	161386
Tomato	129998	134443
Pea	151455	140322
a) Sub total	590683	657838
Environmental cost of different crops		
Cauliflower	67758	18339
Cabbage	47766.88	14047.65
Tomato	25400	22732
Pea	2340	9440
b) Sub total	143264.88	64558.65
Total (a+b)	733947.88	722396.65

Return over production and environmental cost of high value cash crops

The total returns over production and environmental costs, given in Table 5 were ₹. 90585.12per hectare in Sri Ganganagar district and ₹. 215670.35 in Jaipur district. The returns from cauliflower, cabbage, tomato and peas were ₹.59242, ₹31343.12, ₹. -15398 and pea ₹.-14915 respectively in Sri Ganganagar while in Jaipur these were ₹. 124314 ₹.39906.3516, ₹. 13875 and ₹. 37575 respectively.

Thus, the results show that if both the costs are taken into account, the cultivation of tomato and peas in Sri Ganganagar and cauliflower and cabbage in Jaipur are economically non-viable. Therefore, in both the areas, urgent measures need to be taken to restore the health of the soils to promote ecological sustainability and economic viability of high cash crop cultivation.

Table 5. Returns over production and environmental costs

Returns over cost of production and environmental costs	Sri Ganganagar	Jaipur
1. Returns over cost of production		
cauliflower	127000	142653
Cabbage	79110	53954
pea	8639	36607
tomato	1002	49955
a) Sub total	215751	283169
2. Return over environmental costs		
cauliflower	230242	346001
cabbage	169573.12	201292.35
Pea	136540	177897
Tomato	114600	148318
Sub total	650955.12	873508.35
3. Returns over cost of production + Environmental costs		
cauliflower	59242	124314
Cabbage	31343.12	29906.35
Pea	-14915	37575
Tomato	-15398	13875
Total	90585.12	215670.35

Health and Environmental costs of pesticide use in vegetable

The monthly data set contains 200 observations, of which 51% were pesticide spraying events, while the rest were non-spraying. Mixing more than one chemical before an application was common. Individuals were mainly exposed to fungicides, particularly that of mancozeb; thus, the magnitude of pesticide-induced illness and associated health and environmental risks estimated for this study may be incomparable to the other studies where the organochlorines and organophosphates dominate the pesticide use pattern.

Table 6 shows the areas under vegetables, frequency of pesticides application, workload during spraying and non-spraying days, and opportunity cost of spraying time all were found statistically higher in Sri Ganganagar areas. The households in Sri Ganganagar area, therefore, have higher risk of pesticide exposure because of higher number of pesticides applications and work load. The hypothesis that Jaipur area has higher pesticide use intensity and frequency could be rejected. Besides Jaipur area, empirical research on pesticide use for other areas of India is hardly available. But we found significant geographical variation in the pesticide.

Table 6. Pesticide use and working hours

Category	Areas	Mean	SD	t Test significance
Total areas under vegetables (ha/household)	Sri Ganganagar	5.15	2.90	0.011
	Jaipur	4.20	2.40	
Frequency of pesticides application (No/household)	Sri Ganganagar	11.20	1.60	0.016
	Jaipur	9.50	9.70	
Work hours on farm per spraying day (h)	Sri Ganganagar	3.36	4.20	<0.001
	Jaipur	1.20	1.58	
Work hours on farm per non-spraying day (h)	Sri Ganganagar	7.11	0.66	<0.001
	Jaipur	2.40	0.90	
Opportunity costs of spraying time (₹/household)	Sri Ganganagar	420.40	322.44	0.017
	Jaipur	340.87	127.57	

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