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The Industrial Agricultural Conundrum in India

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Abstract

After independence India was facing the problem of food deficit i.e., mismatch of demand and supply of food grains. In order to sort out the problem intensive cultivation was adopted. It led to increase in demand of goods produced by industries (fertiliser, HYV seeds, insecticides etc.) on one hand and on the other increased cost of production for the farmers. Therefore, this paper aims at studying terms of trade between Indian agriculture and industry. The study is based on secondary source of information. In order to understand the relationship between use of inputs and its outcome various statistical tools like percentage and regression is used. Present paper is an attempt to study the impact of use of industrial goods on Indian agriculture. There are many industrial factors effecting agriculture i.e. fertilisers, insecticides, seeds machines and irrigation on agricultural sector. Due to paucity of time and money only fertilisers, insecticides and seeds were used for analysis. Present study aims at studying the role and effect of industrial input in agrarian development of India. The study found out that negative terms of trade between agriculture and industry due to more purchase of industrial inputs by the agricultural sector.

Keywords: *Food deficit, Fertilisers, High yielding variety seeds, Pesticides, Terms of trade.*

Introduction

The green revolution of 1960s made the problem of food deficit and import of food grains in India come to an end through a sharp rise in production (K.N.Ninan and H.Chandrashekhar, 1993). It made a change in the way of agriculture in India from use of domestic inputs to industrial inputs. This made the self-reliant farming communities movement towards dependence on industries. Green revolution was the event which brought about a remarkable change in use of fertilisers, insecticides, pesticides, high yielding seeds, water and machines. Earlier application of manures took place to provide macro and micro nutrients to the soil, homemade insecticides were used for pest and insects and farmers kept a part of the production to be used as seeds.(Rena Ravinder, 2004). Green revolution used industrial agriculture as a way to increase

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production. Industrial agriculture is the dependence of agricultural sector on industrial sector for provision of inputs in the form of fertilisers, insecticides, pesticides, high yielding variety seeds. It needs no emphasis that the agricultural sector has to depend on off farm expensive inputs for production(Leo Horrigan, Robert S. Lawrence and Polly Walker. 2002). Until now (since 1966) nothing was purchased by the cultivators in India all the inputs used were available at home for the agriculturists therefore whatever earned was their marketable surplus. But after 1966 they had to purchase capital inputs from industry leading not only to decline in their profits and driving out small farmers from the market but also deterioration of the environment. It needs no emphasis that the use of industrial inputs not only worsens the profit position of the farmers but also effects the environment adversely. It leads to development of monoculture in plants and animals and disturbs the biodiversity in the eco system. Use of synthetic fertilisers and insecticides are polluting the soil, water and air. The soil is eroding very fast by air and water taking all the fertile part of the soil with it. Water is consumed at a faster rate making the process of use unsustainable. One can say that profit maximisation for a single farmer is only a small part of the process but the fact is that it is ruining the environment which makes a concern for whole of the world. This paper is an attempt to examine the role played by industrial inputs towards the development of agriculture and possibility of its substitution by any other input which is relatively less expensive and more productive.

Objectives

a) To examine the role played by industrial inputs towards crop development in selected States(top five) of India.

b) To study the effects of these industrial inputs on Indian agriculture.

c) To explore the possibility of substitution of industrial inputs with some more productive inputs for Indian conditions.

Methodology

The study is based on secondary source of information. The data is collected from Statistical Agriculture at Glance, Economic Survey and various reports of Government regarding agriculture. The data collected are properly classified and tabulated. In order to analyse the data various statistical techniques like average, regression, correlation have been used.

Research question

India was facing a mismatch in demand and supply condition which made the researchers and scientists explore a new method of agriculture in order to overcome this problem of unbalance. Intensive method of cultivation was selected to deal with this problem. No doubt it increased production for some of the years after its adoption but it did not last long. On one hand it led to increased production for the farmers but on the other escalation of cost of production. It not

only led to increased cost of production for the farmers but also deteriorating environment and falling nutritious value for the consumer (LeoHorrigan, Robert S. Lawrence and Polly Walker, 2002). This paper deals with the role played by these industrial inputs in crop(both cash and staple foodgrains) development in India and possibility of its substitution by a new input more productive and less expensive.

Review of literature

The paper entitled "Green Revolution Dry land Agriculture and Sustainability: Insights From India"(K.N. Ninan and Chandrashekhar,1993) deliberates upon instability in growth rate in Indian agriculture after adoption of green revolution. The paper deals with the problems like salinity, alkalinity of soil, use of more sub soil water and desertification of soil after implementation of green revolution. The paper entitled "Fertiliser Best Management Practices Concept, Global Perspectives and Application(Majumdar K, Satyanarayana T, Sudhashan D, Roberts T,2013)" talks about use of best possible proportion of inputs for crop production for not only benefitting the farmers but also the environment. The paper entitled "Rejuvenation of Bio fertilisers for Sustainable Agriculture and Economic Development" (Pallabi Mishra and Debi Prasad Dash, 2014) aimed to bring into light the bad effects of chemical fertilisers on the whole eco system and studies the impact of Azolla , an organic fertilisers on the crop of paddy. Paper entitled "Sustainable Agriculture"(John P Reganold, Robert I and Papendick and James.F Parr, 1990) tries to explore an idea of combination of modern techniques with traditional ones in order to reduce dependence of the farmers on harmful chemicals for increase in production. Paper entitled" Modelling Impacts of Chemical Fertiliser on Agricultural Production: A Case Study on Hooghly district, West Bengal India"(Suman Patra,Pulak Mishra. S.C Mahapatra and S.K Mithun,2016) analyses the process of changed agriculture and intensification of the use of fertilisers leading to decline in productivity in Indian agriculture. The paper tries to measure the negative impact of fertilisers on agriculture through statistical modelling in Hooghly district of West Bengal. The modernisation of agriculture led to increase in production for some of the years but at the same time it had led to decline in productivity therefore present paper attempts to study the impact of chemicals in form of fertilisers & insecticides on one hand and seeds on the other and explore the possibility of substitution of the chemicals with organic inputs.

Table I deals with the terms of trade between agriculture and industry. In 2004-05 the index of prices received by the agricultural sector was 62.35 while the price paid was 71.03 that means the terms of trade(TOT) was against agricultural sector. During the time period covered in the above table the TOT had remained against agriculture and favourable for industry. No doubt the prices of both agricultural commodities sold to non-agricultural sector and goods purchased by agricultural sector have risen. The prices received by the agricultural sector rose from 62.35 in 2004-05 to 153.11 in 2017-18. But the TOT was against agriculture because the spending was more by the farmers on non-agricultural goods. The prices of both the sector rose but the rise for non-agricultural sector was more as compared to agricultural sector. The final consumption rose

from 80.18 to 151.35. The highest rise was in the group of intermediate commodities used by the agriculturists for production like fertilisers, insecticides, pesticides and machines.

The main reason for the comparatively greater rise in the prices of intermediate and fixed capital goods was liberal extension of agricultural credit to the farmers after 1999-2000 and increase in direct institutional finance after 1999-2000 for agriculture.That means in order to increase production on farm the farmers are using more industrial commodities. No doubt it increased the production on one hand but on the other it led to escalation of cost of production for the farmers.

Table I Index of terms of trade between farmers and non farmers

(Base:TE: 2011-12)

Year	Index of Prices Received	Index of Price Paid for				Index of Terms of Trade
		Final Consumption	Intermediate Consumption	Capital Formation	Combined Index	
Weight		38.19	43.44	18.37	100.00	
1	2	3	4	5	6	7
2004-05	62.35	80.18	62.12	73.06	71.03	87.78
2005-06	61.40	80.31	64.60	74.53	72.2	84.77
2006-07	63.97	77.66	67.75	78.37	73.48	87.05
2007-08	72.06	82.80	71.52	84.11	78.14	92.22
2008-09	82.06	85.61	74.72	92.10	82.07	99.98
2009-10	90.89	91.75	89.09	92.71	90.77	100.13
2010-11	101.29	97.31	98.94	99.33	98.39	102.95
2011-12	107.82	110.95	111.98	107.96	110.84	97.27
2012-13	119.49	119.80	128.36	115.21	122.67	97.40
2013-14	131.67	128.28	144.83	117.84	133.55	98.60
2014-15	138.21	132.49	157.70	122.70	141.64	97.58
2015-16	142.78	139.46	164.85	121.90	147.26	96.96
2016-17	151.04	144.15	172.36	122.67	152.46	99.07
2017-18(P)	153.11	151.35	176.98	125.99	157.83	97.01

Source: Directorate of economics and statistics DAC&FW also see agricultural statistics at glance 2018p 215, p: provisional

Table II deals with the variable inputs used by farmer to increase the production intensively. The variable inputs used by the farmers are mainly seeds, fertilisers and insecticides. The certified seed used by farmers in 2001-02 was 91.80 thousand tonnes which increased almost four times to 352.01 thousand. The application of fertilisers increased from 92.32 Kgs /hec in 2001-02 to 128.02 Kgs in 2017-18. Application of pesticides increased from 47.02 thousand tonnes in 2001 to 58.16thousand tonnes in 2017-18. It should however be pointed out that all these are the industrial commodities used by the farmers in order to increase production. Earlier they were not the part of farmers cost of production since all the goods mentioned were manufactured by the farmers at their home organically. They kept a part of the production to be used as seeds, prepared manure and insecticides at their own without any incurring any cost. So, whatever price they received was their net profit but now they have to spend on these industrial goods as their

inputs is not only increasing their cost of production but also making the terms of trade against themselves.

Profit maximisation is effecting only farmer in the community but application of chemicals in the form of chemical fertilisers and pesticides indiscriminately not only effects the profits of an entrepreneur but also effects the profile of soil. India is passing through this phase where not only application of fertiliser is more than the desired quantity but also use of pesticides is increasing except for some of the years. Now the question arises as to application is done in the desired proportion or not. In Indian condition the use of the fertilisers is desirable in the ratio of 4:2:1. That means the application should be done 4 Kg for nitrogenous fertilisers, than 2Kgs should be phosphatic, fertilisers and 1Kg for Potassic fertilisers. Table III deals with proportion of fertilisers used in India.

Figure 1 shows the application was 10.8:1.3:1 in 1955-56 which declined to 6.0:2.4:1 in 1990-91. After a decade in 2010-11 the ratio became 4.7:2.3:1 which increased to 7.2:2.9:1 in 2015-16 and finally in 2017-18 the proportion became 6.12:2.4:1. One thing that is clear is, the use of potassic fertiliser was always in the desired proportion while there was a small difference in application of phosphatic fertiliser in actual and desired use, the most disproportionate use amongst the fertilisers is nitrogen .The reason behind this is that the nitrogenous fertilisers were subsidised more as compared to the potassic and phosphatic fertilisers (Economic Survey 2007-08). Although the Government has changed its policy from subsidy oriented to nutrient based subsidy in order to promote application of chemical fertilisers in desired quantity. The nutrient based subsidy of fertilisers was initiated in 2010. Even after adoption of this policy the application of chemical fertilisers was far away from the desired composition.

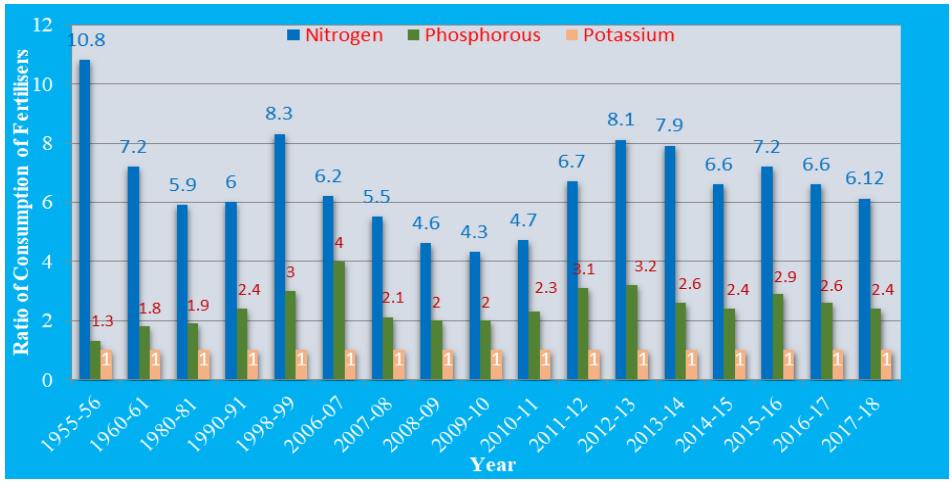

Figure 1. Ratio of consumption of fertilizers source: economic survey government of India, ministry of finance, 1998-99, 2006-07,department of fertilisers, ministry of chemical and fertilisers,2015

Table III deals with the comparative analysis of consumption of fertilisers all over the world. The fertiliser consumption was 60.1 Kg/hec in Canada in 2014 which increased to 60.9 in 2016. In France it was 106.4 Kg/hec which declined to 104.1 Kg/hec in 2016-17. In UK it was 88.2 Kg/hec which increased to 88.4 Kg/hec in 2015-16. If we compare the position of India with China main one can very easily find out that China is consuming less of every fertiliser in each and every year mentioned in the table and it should be noted that its per hectare production of many crops is more than India. The whole world taken together used 37.1 kg/hec fertiliser which increased to 38.1 Kg. In 2014-15 India consumed 142.4 Kg/ hec which increased to 144.4 in 2016-17. It should however be pointed out that application of more fertilisers leads to reduction marketable surplus for the farmers as it leads to increase in cost of production. Most of the low income countries of sub-Sahara and Asia are applying fertilisers indiscriminately which makes their position more vulnerable due to their limited financial means and risk taking abilities, poor and expensive distribution system for fertilisers, lack of knowledge of using local phosphate rocks (Appleton, 2001). Disproportionate use of fertilisers in India leads to more application of other plant nutrients because of complementarities of application of other nutrients essential for growth of plants (Heerink et al.,2001)which ultimately leads to increased cost of production for the farmers on one hand and a favourable terms of trade for the industries.

Table IV Application of fertilisers, pesticides and farmyard manure by major size groups

Size Groups(Hectares)		Gross Cropped Area	Area Treated with Fertilisers	Area Treated with Pesticides	Area with Farmyard Manure
Marginal	I	24008	21408	10431	4694
Below 1.0	UI	23134	15221	8315	6523
	T	47142	36629	18747	11217
Small	I	18975	16962	8904	3912
1.00-1.99	UI	23655	16448	10060	5850
	T	42630	33409	-	-
Semi Medium	I	19925	17909	9714	3632
2.0-3.99	UI	24780	16836	10486	5467
	T	44706	34745	20201	9100
Medium	I	18090	16328	9676	2855
4.00-9.99	UI	21169	12748	8232	3936
	T	39258	29076	17908	6791
Large	I	6999	6372	4125	956
10.0 and above	UI	9019	3747	2924	1292
	T	16018	10119	7049	2248
All Groups	I	87997	65000	42851	16049
	UI	101757	78979	40017	23069
	T	189754	143978	82869	39118

Source: Department of agriculture, cooperation & farmers welfare (input survey 2011-12), also see agricultural statistics at glance,2018,,pp 374-375

Notes: I - Irrigated, UI - Unirrigated, T - Total of I & UI.

N: Nitrogen, P: Phosphorus, and K: Potassium

-Not Available

Total may not tally due to rounding off.

Table IV deals with application of fertilisers, pesticides and farmyard manure or organic fertilisers manufactured at home by the farmers. Amongst the marginal farms having assured irrigation facility area treated with fertilisers was 89 percent while only 65.79 percent was treated for unirrigated area. For small land holdings 89.39 percent was treated with chemical fertilisers having irrigation facilities while 69.53 percent land was treated without irrigation facilities. In case of medium farms 90.25 percent land was treated with chemical fertilisers while 60.22 percent land was treated with fertilisers without irrigation facilities. In case of large land 91 percent land among the irrigated category was treated with chemical fertilisers while 41 percent land was treated with fertilisers which were not having irrigation facilities. If we look at pesticides, it is clearly visible that 43 percent of the marginal land was treated with pesticides while 35 percent of the marginal land without assured irrigation facilities was treated with pesticides. 53 percent of medium irrigated and 38.88 percent of the unirrigated land was treated with pesticides. 58.93 percent of the irrigated and 32.42 percent of unirrigated large land was treated with pesticides. Only 19 percent of the marginal irrigated and 28.19 percent of the unirrigated land was treated with farmyard manure. On the other hand 13.65 percent of the irrigated and 14.32 percent of the unirrigated large land farms used farmyard manures. One thing that is clear from the table is that land having assured irrigation facilities of any category is using more chemicals as compared to unirrigated land may it be in the form of fertilisers or pesticides. On the contrary, the unirrigated farms are using more of organic manures as compared to irrigated land. That means the farms using more chemicals require more water for making the land productive. On the other hand organic manures make less use of water. The use of water is an extra cost for the farmers who are dependent on the purchase of chemical fertilisers and insecticides as compared to the farmers who are treating their land with farmyard manure. It not only reduces the net profits for the farmers (using chemicals) but also wastes the underground water and makes the process of agriculture less sustainable.

The model

$$Y = \beta 0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + u$$

Where

Y is the Yield

X_1 is the Seed

X_2 is the Fertilisers

X_3 is the Insecticides

u is the error term

In order to understand the relationship between productivity and profitability with independent

variable viz. fertilisers, high yielding variety seeds and pesticides a multiple regression analysis was undertaken for five best producing States as a sample. The crops selected for the purpose were staple food grains (wheat and rice) and cash crops (cotton and sugarcane). The results that are visible from the table V are, a positive relation was found between productivity and application of seed β_1(23.925) and fertilisers β_2 (20.608) while negative with insecticides β_3(-.054) in Haryana for wheat. Slope of seed β_1(-180.281) shows an inverse relationship with yield of wheat crop in Madhya Pradesh while fertilisers and insecticides (β_2=30.457, B_3=3.740) show a positive impact on yield. In Punjab on one hand seed and fertilisers (β_1=139.600, β_2=8.486) indicate a positive impact on yield while on the other insecticides β_3(-.046)has an inverse relationship. Rajasthan shows the slope coefficients of seed and insecticides (β_1=3.957, β_3=.409) having a positive impact on the yield of wheat crop and slope of fertilisers β_2(-.363)are having an inverse relationship. The slope coefficients of Seed and fertilisers (β_1= -80.880, β_2= -23.801)in Uttar Pradesh shows an inverse and insecticides (β_3= 2.169) positive relationship with yield.

In case of rice, the slope of seed β_1 (-1.543) and fertilisers β_2 (-9.929) are negative indicating an inverse relationship with yield of rice and the slope of insecticides β_3 (.328) indicates a positive relationship in West Bengal. Uttar Pradesh witnesses β_2 (-6.243) an inverse relationship between fertilisers and the yield of rice (Y) while slope of insecticides β_3 (.043) is positive indicating a positive relationship. Andhra Pradesh has a positive relationship with seed (β_1=26.610) and insecticides (β_3=0.458) and the slope of fertilisers β_2(-5.279) is negative indicating an inverse relationship between fertilisers and the yield of rice (Y) . In Punjab the result highlights that the slope of fertiliser (β_2=1.324) and insecticides (β_3= 0.038) are positive indicating a direct relationship between fertilisers and the yield of rice (Y). Tamil Nadu experiences a negatives slope of seed β_1 (-17.786) and a positive slope of fertilisers (β_2 = 43.830) and insecticides(β_3= 0.127).

In Gujarat the slope of seed β_1(45.211) and fertilisers β_2(1.906) is positive indicating a direct relationship with yield of Cotton (Y) and the slope coefficients of insecticides β_3(-.018) has an inverse relationship. Karnataka has a negative slope of Seed β_1(-60.078) showing a negative relationship with yield. On the other hand, slope coefficients of fertilisers β_2 (.279) and insecticides β_3 (.021) are positive indicating a direct relationship with yield. Maharashtra experiences a positive slope of seed β_1(72.038), insecticides β_3(0.21) and negative relationship with fertilisersβ_2 (-.309). Madhya Pradesh experiences a negative slope of seed β_1(-1587.656) and fertilisers β_2(-.692) and the slope coefficients of insecticides β_3(.045) is positive with yield. In Punjab the slope of seed β_1(167.780) and fertilisers β_2(1.466) are positive and the slope coefficients of insecticides β_3 (-.049) is negative.

Andhra Pradesh witnessed a negative slope of seed β_1 (-19.224) and fertilisers β_2 (-13.558) with yield and a positive relation was found between insecticides β_3 (1.733) and yield. Maharashtra experiences a positive relation of seeds β_1(40.571) with Y. On the other hand the slope of fertilisers β_2 (-9.365) insecticides β_3 (-9.659) are negative indicating an inverse relationship between

fertilisers & insecticides with Y. Tamil Nadu highlights that the slope of seed β_1(113.873) indicating positive relationship with Yield of sugarcane crop (Y) while fertilisers β_2(-87.326) and insecticides β_3(-33.076) are negative indicating there is inverse relationship with (Y). Uttar Pradesh highlights that the slope of seedβ_1(62.114) and insecticidesβ_3 (0.032) have a positive relationship with yield while the slope of fertilisers β_2(-349.490) indicates negative relationship with yield. In Uttarakhand the result indicates a negative slope of seed B_1 (-246.772) and insecticides β_3 (-8.792) with Y. On the other hand the slope of fertilisers β_2 (24.044) is positive indicating a direct relationship between fertilisers(Y).

It is clearly visible that the application of fertilisers, insecticides and HYV seeds are either having negative effect or not having much effect on production except for rice in West Bengal (.797) and sugar cane in Uttar Pradesh (0.740). It means one percent increase in application of above mentioned inputs is able to increase production by only 0.79 percent and 0.740 percent respectively.

Table VI In order to understand the relationship between profit as an independent variable and fertilisers, insecticides, pesticides and seeds as independent variable a multiple regression was used on four crops belonging to staple food grains (rice and wheat) and cash crops (cotton and sugarcane). For calculating profit (TR-TC), TR is calculated from yield/hectare X msp while TC/hec is taken from report of Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Government of India the model is given as

$$Y= \beta 0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+u$$

Where

Y is the Profit

$X_1$is the Seed

X_2 is the Fertilisers

X_3 is the Insecticides
u is the error term

In case of wheat, slope of seed β_1(428.645) and fertilisers β_2(424.976) are positive showing a direct relationship with profit of wheat crop (Y) in Haryana the best producing State in India. The slope coefficients of insecticides β_3 (-13.392) is negative indicating an inverse relationship between insecticides and profit. Second best State of Madhya Pradesh reveals that the slope of seed β_1(553.201), fertilisersβ_2(197.423) and insecticidesβ_3(98.209) are positive indicating a positive relation between dependent and independent variables. In Punjab the slope of seed β_1(370.829) and coefficient of insecticidesβ_3(7.636) are positive indicating a direct relationship profit of wheat crop (Y) while the slope of fertilisersβ_2 (-215.186) shows that there is a negative impact on profit of Y. Rajasthan the next in ladder,

highlights that the slope of seed β_1(178.940) has a positive impact on profit of wheat crop (Y) while the slope of fertilisersβ_2 (-268.997) and insecticidesβ_3(-26.007) have a negative impact on profits. The result of Uttar Pradesh indicates that the slope of seed β_1(-2397.364) and fertilisersβ_2(-412.103) are negative showing an inverse relationship with profit of wheat crop (Y) while the slope of insecticidesβ_3 (79.195) has a positive impact in Uttar Pradesh.

In this model the slope of seed β_1 (26.610) and insecticides β_3 (.458) are positive indicating a positive impact while fertilisers β_2 (-5.279) has a negative impact on profit of rice crop (Y) in Andhra Pradesh, the best producing State. In Punjab the slope of fertilisers β_2(1.324) and insecticides β_3(.038) are positive indicating a positive impact on profit of rice crop (Y). In Tamil Nadu seed β_1 (-17.786) and fertilisers β_2(-43.830) are having a negative impact on profit of rice crop (Y) while insecticides β_3= (.127) is having a positive impact. Uttar Pradesh witnessed, fertilisers β_2 (-6.243) is having a negative impact while the slope coefficients of insecticides β_3 (.043) shows a positive impact on profit of rice crop (Y). West Bengal indicates seed β_1(-1.543) and fertilisers β_2(-9.929) have a negative impact on profit of rice crop (Y) while the slope coefficients of insecticides β_3 (.328) is having a positive impact on profit of rice crop (Y).

The slope of seed β_1(-22744.035), fertilisers β_2(-86.575) and insecticides β_3(-5.053) shows that there are inverse relationship between seed, fertilisers and insecticides with profit of cotton crop (Y) in Gujarat. In this model the slope of seed β_1(9962.958) is positive indicating a direct relationship between the seed and the profit of cotton crop (Y) while the slope of fertilisers β_2(-91.344) and insecticides β_3(-10.534) indicates have a negative impact on profit of cotton crop in Karnataka. In Maharashtra slope of seed β_1(-29868.125), fertiliser β_2=(-94.937) and insecticides β_3(-7.807) shows an inverse relationship between seed, fertilisers and insecticides with (Y). The slope of seed β_1(-3270.189) and insecticides β_3(-3.155)have a negative impact while the slope of fertilisers β_2(63.813) has a positive relationship with profit of cotton crop (Y) in Punjab.

Andhra Pradesh, the best sugarcane producing State indicates, seed β_1(-1069.589), fertilisers β_2 (-30.486) and insecticides β_3(-5.735) have a negative impact on profits. The slope of seed β_1(39.840)have a direct relationship with profit of sugarcane crop (Y) while fertilisers β_2(-252.597) and insecticides β_3(-8.678) have a negative impact on profits in Maharashtra. In this model the slope of seed β_1(-1044.724), fertilisers β_2 (-770.012) and insecticides β_3(-110.455) have a negative impact on profits from sugarcane crop (Y) in Tamil Nadu. In Uttar Pradesh seed β_1 (-266.769), fertilisers β_2= (-1991.767) and insecticides β_3= (-7.880) have a negative impact on profits of sugarcane crop (Y). Uttarakhand witnessed ,slope of seed β_1 is 724.404 indicating a direct relationship between seed and profits while the slope of fertilisers β_2(-328.648) and insecticides β_3(-4.214) are having a negative impact.

Conclusion

It is clear from the analysis that the application of industrial inputs viz. fertilisers, insecticides,

HYV seeds are leading to not only decline in productivity but also profitability of agriculturists. All these inputs are not only an item of cost for present generation farmers but also for the future farming community. Fertilisers are creating a special problem for Indian agriculture during the time of this pandemic. Nitrogen is the topmost fertiliser sold in India and almost 75 percent of its price comes from subsidy. For the current year the fertiliser subsidy is estimated at Rs80,000/- crores and the worst thing is now Department of fertilisers will be able to spend only 80 percent of the allocated budget. It needs no emphasis that application of industrial goods are adding to the problems of agricultural sector in India. According to American scientists Stephen Bushman and GeririNabhan almost 90 percent of the food grains are effected due to reduction of nectar collecting insects especially honey bees and birds. Applications of chemicals are one of the most important factors responsible for it. It has been found that indiscriminate use of chemicals on crops leads to killing of earthworms and other micro-organisms responsible for making the land fertile. Application of these inputs is creating problems for the poorer. Day by day the agrarian process is becoming difficult for the small and marginal farmers therefore they are giving up their profession. In Britain during a period of 3 decades the numbers of farms have declined from 4,54,000 to 2,42,300. This has encouraged mechanisation on large farms. America's 50 percent of the agrarian land is being controlled by 0.1 percent large farmers. It has been very rightly felt by United Nations small farmers have the capacityto increase productivity/hec at a lower cost. Since the small farmers use less machines and chemicals for cultivation therefore on one hand it leads to increase in productivity/hectare and on the other decline in cost of production and inequality in distribution of land. One of the cause of concern is use of HYV seeds by the farmers which is not only increasing the cost of production for the farmers but also declining bio diversity. Traditionally various types of seeds were available according to the needs of the soil which use to maintain bio diversity but now only one type of seed is available for all types of soil. As the seeds are prepared by non- agricultural sector therefore the farmers are not able to regulate it.

It needs no emphasis that in an over populous country like India, one is not in the position of stopping the use of chemicals, pesticides, HYV seeds etc. because it may reduce the production to some extent. Therefore, what is required is to moderate the use of chemicals, some part of the chemicals should be substituted by their organic counterparts. Chemical using technology is continuously ruining the soil. This technology has disturbed the biological composition. To increase production chemical fertilizers and pesticides needs to be used with manure and organic pesticides. Presently, use of fertilisers are more in India as compared to world therefore it needs to be moderated. It should be noted that not only the use of fertilisers needs to be reduced but also provision of macro and micro nutrients should be kept in mind before use of any fertiliser. Emphasis needs to be made on 'balanced fertilisation' which means use of nutrients according to the need of the soil. Integrated nutrition management of the soil needs to be maintained not only to increase the productivity of the soil but also profitability for the farmers. Here the initiative should be taken by the Government to encourage integrated nutrient management through

various schemes and incentives. Prolonged use of chemicals in the form of fertilisers and pesticides results into deterioration of soil profile, human health hazards and pollution. Therefore, it is in the broader national interest to substitute the chemicals to its organic substitutes which will not only reduce their cost of production but also improve the health of the soil.

Conflict of interest

The authors declare that there is no competing interest.

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Table II Production and use of agricultural inputs in India

Programmes	Units	2001-02	2005-06	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Production of Breeder Seeds	Thousand quintals	45.54	68.64	118.5	123.38	110.20	82.29	86.21	90.37	110.12	105.08
Production of Foundation Seeds	Lakh Quintals	5.44	7.40	18.06	22.26	16.17	17.43	15.76	14.95	22.09	19.54
Distribution of Certified/Quality Seeds	Lakh Quintals	91.80	126.75	277.34	294.85	313.44	301.19	303.12	304.04	348.58	352.01
Consumption of Fertilisers											
Nitrogenous	Thousand Tonnes	11310	12723	16558	173.00	16821	16750	16946	17372	16735	16958
Phosphatic	Thousand Tonnes	4382	5204	8050	7914	6653	5633	6098	6979	6705	6854
Potassic	Thousand Tonnes	1667	2413	3514	2576	2062	2099	2532	2402	2508	2779
N+P+K	Thousand Tonnes	17360	20340	28122	27790	25536	24482	25576	26753	25949	26591
Per Hectare	KGs	92.33	105.40	142.52	142.33	130.79	121.80	128.94	130.66	123.41	128.02
Consumption of Pesticides (Technical Grade Material)	Thousand Tonnes	47.02	39.77	55.54	52.98	45.62	60.28	56.12	54.12	52.75	58.16

Source: Department of agriculture, cooperation &farmers welfare, consumption from state government, also see agricultural statistics at glance 2018,p310-11

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Table III Fertiliser consumption per hectare of agricultural land in selected countries

Continent/Country	2014				2015				2016			
	N	**P_2O_5**	**K_2O**	**Total**	**N**	**P_2O_5**	**K_2O**	**Total**	**N**	**P_2O_5**	**K_2O**	**TOTAL**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Egypt	82.15	13.23	4.60	364.8	83.51	12.12	4.38	385.2	82.20	13.34	4.42	427.0
Canada	65.72	24.13	10.15	60.1	64.5	26.11	9.55	62.8	63.54	25.45	11	60.9
USA	58.2	20	21.8	50.0	57.25	20.23	22.52	52.4	56.53	20.27	23	51.3
Brazil	27.62	33.87	38.51	49.6	26.89	33.62	39.47	46.1	29	32.95	38.04	53.1
Bangladesh	55.91	25.68	18.41	259.7	5.33	27.38	19.31	257.4	52.45	27.20	20.34	250.7
China, Main	51.80	31.35	16.84	94.4	55.61	24.25	20.02	94.4	54.58	24.86	20.66	90.5
India	66.29	23.87	9.90	142.4	65.33	26.22	9.05	148.0	64.47	25.83	9.69	144.4
Japan	16.61	34.53	27.26	229.6	35.41	34.04	30.58	225.6	36.93	32.98	30.07	230.4
Malaysia	28.39	15.72	55.87	282.4	23.75	16.89	59.35	220.2	25.95	16.4	57.64	225.0
Nepal	68.35	30.31	1.32	37.6	76.40	21.23	2.06	33.9	94.74	5.26	-	3.8
Pakistan	76.61	22.54	0.75	119.3	72.21	27.20	0.58	102.2	73.97	25.14	0.80	136.8
Sri Lanka	54.74	20.25	25	132.8	58.04	16.61	25.34	152.3	64.55	13.49	22.06	85.2
France	71.71	13.34	14.94	106.4	73.47	14.21	12.30	104.8	74.92	12	13.06	104.1
Germany	70.55	11.65	17.79	154.5	73.26	9.60	17.06	139.5	71.50	9.97	18.52	139.3
Spain	57.01	22.68	20.44	67.0	56.98	22.42	21.50	65.1	55.34	23.39	21.11	70.1
UK	68.93	13.15	17.91	88.2	68.77	13.08	18.14	87.1	68.77	12.78	18.43	88.4
Australia	55.56	36.51	9.52	6.3	52.85	37.14	10	7.0	56.94	33.34	9.72	7.2
New Zealand	46.67	38.90	14.30	82.5	48.76	36.38	14.97	80.8	49.05	34.66	16.27	84.8
World	56.33	25.34	18.32	37.1	57.2	23.94	19.14	37.6	56.7	24.15	19.2	38.1

Source: Agricultural statistics at a glance 2017and 2018

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Table V Relationship between productivity and industrial inputs

State	Model Fit			Coefficients				t (P value)			
	F value	Adjusted R^2	SE	Unstandardized B							
				Constant	Seed	Fertilisers	Insecticides	Constant	Seed	Fertilisers	Insecticides
Wheat											
Haryana	.380	-.303	357.36996	-2342.410	23.925	20.608	-.054	-.179	.340	.678	-.029
MP	2.875	.413	352.24734	19784.955	-180.281	30.457	3.740	.476	-.519	1.478	.354
Punjab	1.968	.266	234.72783	-12238.744	139.600	8.486	-.046	-1.144	1.416	.437	-.084
Rajasthan	.196	-.432	126.57939	2473.059	3.957	-.363	.409	1.521	.350	-.056	.465
UP	.861	-.055	297.46991	18699.922	-80.880	-23.801	2.169	1.522	-1.154	-1.194	.800
Cotton											
Gujrat	2.042	.281	42.18755	221.634	45.211	1.906	-.018	1.241	.516	2.253	-.735
Karnataka	.956	-.017	75.99528	473.891	-60.078	.279	.021	1.380	-.890	.190	.603
Maharashtra	.297	-.358	72.66591	210.127	72.038	-.309	.021	1.006	.626	-.383	.379
MP	2.297	.327	118.20191	2276.553	-1587.656	-.692	.045	2.220	-1.857	-.240	.879
Punjab	2.078	.288	91.31439	130.410	167.780	1.466	-.049	.269	1.228	.898	-2.257
Rice											
WB	11.440	.797	52.64557	3998.277	-1.543	-9.929	.328	2.981	-.074	-3.439	2.683
UP	.665	-.091	174.17996	3270.213	0	-6.243	.043	2.768	0	-1.014	.039
AP	1.949	.262	181.41782	1426.813	26.610	-5.279	.458	.502	.921	-.774	2.071
Punjab	.254	-.229	104.89473	3531.389	0	1.324	.038	3.925	0	.351	.678
Tamil Nadu	.640	-.156	698.27926	13506.668	-17.786	43.830	.127	1.472	-1.316	-1.156	.129
Sugarcane											
AP	1.523	.164	2957.85917	80795.188	-19.224	-13.558	1.733	23.372	-.321	-1.246	1.011
Maharashtra	.829	-.068	4281.57099	90672.868	40.571	-9.365	-9.659	5.319	.189	-.309	-1.536
Tamil Nadu	.855	-.057	7297.69143	156391.769	113.873	-87.326	-33.076	2.057	.424	-.657	-1.183
UP	8.588	.740	1663.97603	128878.602	62.114	-349.490	.032	5.695	.564	-3.150	.009
Uttarakhand	.886	-.045	3590.71568	67538.094	-246.772	24.044	-8.792	10.163	-1.382	.486	-1.169

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Table VI Relationship between profitability and industrial inputs

State	Model Fit			Coefficients				t (P value)			
	F value	Adjusted R^2	SE	Unstandardized B							
				Constant	Seed	Fertilisers	Insecticides	Constant	Seed	Fertilisers	Insecticides
Wheat											
Haryana	3.586	.492	3524.17349	-117901.618	428.645	424.976	-13.392	-.915	.618	1.418	-.727
MP	3.132	.444	2164.73986	-90178.804	553.201	197.423	98.209	-.353	.259	1.559	1.514
Punjab	2.261	.321	2171.25474	13810.336	370.829	-215.186	7.636	.140	.407	-1.199	1.508
Rajasthan	1.420	.136	4756.56307	6323.253	178.940	-268.997	-26.007	.103	.421	-1.112	-.787
UP	1.488	.155	6070.54403	409841.578	-2397.364	-412.103	79.195	1.635	-1.676	-1.013	1.432
Cotton											
Gujrat	8.829	.746	4445.35730	30606.200	-22744.035	-86.575	-5.053	1.627	-2.465	-.971	-1.930
Karnataka	12.304	.809	5948.20177	-28195.534	9962.958	-91.344	-10.534	-1.049	1.885	-.794	-3.922
Maharashtra	8.562	.739	7773.29867	42306.978	-29868.125	-94.937	-7.807	1.893	-2.425	-1.099	-1.329
MP	28.762	.912	5705.61565	-65175.929	59181.386	-181.500	-6.852	-1.317	1.434	-1.301	-2.785
Punjab	1.444	.143	8355.78830	-33646.523	-3270.189	63.813	-3.155	-.760	-.262	.427	-1.586
Rice											
AP	1.949	.262	181.41782	1426.813	26.610	-5.279	.458	.502	.921	-.774	2.071
Punjab	.254	-.229	104.89473	3531.389		1.324	.038	3.925	0	.351	.678
Tamil Nadu	.640	-.156	698.27926	13506.668	-17.786	-43.830	.127	1.472	-1.316	-1.156	.129
UP	.665	-.091	174.17996	3270.213		-6.243	.043	2.768	0	-1.014	.039
WB	11.440	.797	52.64557	3998.277	-1.543	-9.929	.328	2.981	-.074	-3.439	2.683
Sugarcane											
Andhra Pradesh	5.686	.637	18170.71207	64581.752	-1069.589	-30.486	-5.735	3.041	-2.907	-.456	-.545
Maharashtra	3.035	.433	15483.37670	154409.591	39.840	-252.597	-8.678	2.505	.051	-2.308	-.382
Tamil Nadu	1.768	.224	22812.52976	480264.470	-1044.724	-770.012	-110.455	2.021	-1.245	-1.853	-1.264
UP	6.138	.658	11430.08183	433000.940	-266.769	-1991.767	-7.880	2.785	-.353	-2.613	-.324
Uttarakhand	6.723	.682	12805.37957	67457.462	724.404	-328.648	-4.214	2.846	1.137	-1.864	-.157