

Managing the Transformation of Traditional to Organic Agriculture in Pune District: A Long Term Policy Framework

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ABSTRACT

Organic farming is a natural method of cultivation of farms. It improves soil fertility, environment, health of animals and human being. Due to green revolution and commercialisation of agriculture, farmers have focused more on yield and output of all crops. Farmers are using chemical fertilisers and pesticides for high yields, big size, good shape and colour of fruits, grains and vegetables. The aim of this study is to understand effect of chemical fertilisers on the crops, surrounding environment, soil fertility, health of animals and people in Pune district. The present study finds that the farmers of Pune district are using dung, poultry manure and chemical fertilisers. Those farmers are using the poultry manure have more physical and animal assets, land holding, irrigation facilities, expenditure on health, education, income and education and experience of farmers. The multinomial logit regression result shows that those farmers are using the chemical fertilisers have less education, age, irrigated land. Women are less educated in such families. The use of chemical fertilisers have adverse effect on soil fertility, soil layers', health of people and animals in district. Therefore, present study suggests to reduce the use of the chemical fertilisers for commercial crops. The state and central government, NGO's, researchers and organisations must come together to manage and form a policy to reduce the chemical fertilisers use and increase the use of organic pesticides, fertilisers. Women's education can play significant role in reducing the use of chemical fertilisers and pesticides in state. The availability of more credit facilities through banks, awareness through media, exports and domestic markets for organic products and encouragement to farmers to produce only organic products will help in this direction. In order to protect soil fertility, environment, water and air such policies are urgently required in India. For sustainable agriculture and economic growth, organic farming is most important.

KEYWORDS: *education, fertility, nutrition, water supply.*

JEL CLASSIFICATION: *Q01, Q12, Q24, Q57*

1. INTRODUCTION

The soil in farm is an important determinant of crop productivity. It is an integration of the physical, chemical and biological components (Kayode et al., 2017). Organic farming is a sustainable strategy for producing safe, healthy and cheaper food and for restoring soil fertility and mitigating climate change (Timsina, 2018). Organic agriculture promotes biodiversity and maintains the integrity of the ecosystem (Bilalis et al., 2013). The crop yield response to organic waste is highly variable and depends on the types of wastes, crop type and species, soil type and climate conditions (Adekiya and Agbede, 2009). Farmers are using different types of fertilisers and pesticides subject to nature of crops, land size, soil type and climatic conditions.

The small land holder farmers rarely apply adequate fertilizers because of high cost, limited availability and lack of awareness (Biratu et al., 2018). Most of the time, farmers use excessive

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fertilisers to crop for good yield and production. An oversupply with inorganic nitrogen and phosphorus compounds causes an increased nitrification, oxygen demand, intensification of the primary production of plankton including red tides, excessive growths of macro-algae and other water plants as well as formation of the toxic un-ionized ammonia. The negative impact of nutrient losses from agriculture on ecosystems in ponds, lakes, rivers as well as to seas and oceans varies (Kremser and Ewald, 2010).

At present, the pesticides have contaminated almost every part of our environment. Pesticide contamination poses significant risks to the environment and non-target organisms ranging from beneficial soil microorganisms to insects, plants, fishes, and birds (Biswas et al., 2014). Pregnant women, children, and old people are victims of pesticides and chemical fertilisers. Health effects of pesticides range from mild allergies, rashes, breathing difficulties, neurotoxicity and reproductive abnormalities to deadly chronic diseases like cancer (Sharma and Singhvi 2017). Moreover, a recent study demonstrated that neonicotinoids are able to increase the expression of the enzyme aromatase, which is engaged in breast cancer and plays an important role during developmental periods (Nicolopoulou et al., 2016). Farmers are using dung and poultry manure for different crops. Due to wells and tube wells, canals, ponds the irrigation facilities for farmers has increased and this contributed for enhancement in productivity of commercial crops. The organic fertiliser such as poultry manure has high content of nitrogen, potassium and phosphorus. Poultry manure contains nutrients elements that can support crop production and enhance the physical and chemical properties of the soil (Amanullah, Mohamed & Muthukrishnan, 2010). Key drivers for the growth of poultry meat production are shorter production cycles, cheaper prices, and better nutritional image (Andric et al., 2017). The poultry is a significant source of income, nutrition and security for the poorest of households. In particular, the importance of these systems to the livelihoods of women, children, the elderly (Wong et al., 2017). Therefore, few areas have high poultry and poultry manure production. The manure transfer to deficit areas takes place regularly. It results in the substitution of these surplus nutrients for commercial fertiliser nutrients. As a result, less total nutrients are applied to arable land in the surplus areas (Mkhabela, 2004). The challenges in disposing of poultry waste could be lack of transport, lack of farmer's knowledge of poultry waste management and insufficient space to enable construction of waste disposal pits on farms (Moreki and Keaikitse 2013). Few farmers are using excessive fertilisers and pesticides and water for commercial crops and earn maximum income. Therefore, sustainability of agriculture is in question now. The input-intensive nature of this system makes it less profitable under the ever-diminishing natural resources such as the declining water table and poor soil fertility (Singh et al., 2019).

Farmers are managing their own farms with traditional and modern methods of cultivations. They hold domestic animals and they have cows, bullocks, sheep's and goats. They sell the milk and collect dung. Such dung is stored for the whole year to provide planned crops. During May month, they provide dung to the farm. They plough the land and provide dung to maximum land. If the farmers do not have domestic animals and if they are rich, then they are buying the dung from the other farmers. Those farmers have more animals are selling dung to other farmers. Farmers clearly tell that dung is necessary for every crop. Therefore, they pay for dung and buy it regularly. Few farmers prefer to test the soil of land. Testing of soil helps to understand the content of nutrient in soil. They can use the fertilisers as per the need of soil and crop. Few farmers prefer the high yielding varieties of seeds. They do not go in soil related complexities but call poultry manure suppliers and buy the poultry manure for crops. The poultry manure is used for potatoes, tomatoes, groundnuts, sugarcane etc. Almost all crops, the poultry manure is provided. Such poultry manure is important to improve the quality of the product and productivity. The farmers buy poultry manure regularly. They have contacts to the poultry manure suppliers. Such suppliers of poultry manure are attached to poultry farm owners. The farmers buy the poultry manure because it certainly improves the production of all crops. A

farmer raises the yield and production of crops. Farmers are selling the crops in the market and get good profit. Farmers are also using the chemical fertilisers for different crops. They go to shops where chemical fertilisers are sold and they explain the trader to provide such fertilisers and pesticides for particular crop. They use chemical fertilisers to increase yield and production of different crops. Few chemical fertilisers are giving the short-term effects but in long terms the excessive use of chemical fertilisers has adverse impact on the soil, health of people and environment. Farmers with more age and experience use dung and poultry manure. At younger age, they are using the chemical fertilisers. The younger farmers are managing crops with their knowledge and inputs. They are using fertilisers that are more chemical in nature. Small household size helps farmers to use different fertilisers. More educated male and female farmers prefer poultry manure. More experience in agriculture, the farmers use poultry manure. They understand which fertilisers have to use for which crop. High land holding means farmers are using more poultry manure. The application of poultry manure not only supplies micronutrients to the soil, but also leads to increase in micronutrient composition of the harvested crop. The increase in the application of poultry manure may have resulted to high concentration of minerals in the soil (Ezeocha et al., 2014). The farmers those have lower household size are using the dung and chemical fertilisers. Farmers those are using the poultry manure have more physical assets in house such as fan, radio, television, sewing machine, mobile, internet, computer fridge, air condition, washing machine, clock, bicycle, air condition and tractor. The farmers using dung and chemical fertilisers have more number of hand pump and thresher. Farmers those have more cows are using dung and chemical fertilisers. Similarly, such farmers have more hand pump and threshers. Farmers those have more cows are using dung and chemical fertilisers and vis-a-vis. More goats at home mean farmers are using the dung for farm. Farmers have taken farm related training, tested soil and using High Yielding Varieties (HYV) of seeds are using more amount of poultry manure regularly. The dung using farmers are using the traditional seeds. Farmers with irrigated land are using more poultry manure. The farmers with un-irrigated source of the land are using more amounts of chemical fertilisers. The production expenses are more with farmers using poultry manure. They are spending more amounts for poultry manure. The profit from agriculture is higher with poultry manure. Medical expenses for their members are higher with the poultry manure using farmers. Farmers with dung and chemical fertilisers are spending more on children's education. Their children's are studying at tahasil place and in good schools. Loans are also taken by the farmers those are using the poultry manure. They are investing more on the commercial crops and trying to get more profit out of investment. Due to more profit from commercial crops, farmers are spending on health and education of family members. But excessive use of chemical fertilizers and pesticides is affecting on soil, water and air quality. Organic fertilizers are essential for the proper development of plants, vegetables, flowers and fruits, as they offer rapid growth with superior quality to all species. They have the nutrients necessary for better development. In addition, the organic matter serves as nutrients and energy sources for soil microorganisms. The suitability and usefulness of organic fertilizers has been attributed to high availability of NPK content, which capable to enhance soil fertility. They also act as a substrate for soil microorganisms which lead to increase microbial activity, where of increasing the rate of organic material decomposing and releasing nutrient for plant uptake (Zayed et al., 2013). Aim of this study is to understand the current farming practices and use of the fertilisers by farmer in Pune district. Most of the farmers in district have stopped the use of organic fertilisers and pesticides. Due to decline in domestic animals, they rely more on the chemical fertilisers. But chemical fertilisers have adverse effect on the soil fertility, growth of earth worms, health and reproduction of human being, birds and animals. The major objective of this paper is to examine the current fertilizers use by farmers. Second objective of paper is to study the effect of various fertilizers on commercial crops of farmers in Pune district. The third objective is to examine the socio-economic and demographic characteristics of farmers and its relationship with use of

various fertilizers and pesticides. The first part of the paper explains the data collection and methodology of this study. Second part explains about the types of fertilizers use and socio-economic and demographic characteristics of farmers. Third section of research paper examines the regression results and last part deals with policy implication and conclusion.

2. DATA COLLECTION IN PUNE DISTRICT

This study is based on primary survey of farmers those are using different fertilizers and pesticides in Pune district. We collected primary data of 343 households from different tehsils of Pune district. Such data is collected during January and May 2019. We interviewed few poultry farm owners of different tehsils in Pune district. This study is conducted in Ambegaon, Rajgurunagar and Shiror tehsil of Pune district. We interviewed sarpanch, agriculture officers, social workers, teachers, doctors of villages. During entire fieldwork, qualitative and quantitative data is collected related to rainfall, climatic conditions, rivers, dams, canals, agricultural markets, transportation facilities and commodity prices etc.

3. ECONOMETRIC FRAMEWORK

We developed econometric framework with different socio-economic and demographic variables for use of fertilisers and pesticides for Pune district.

$$Y_i = \alpha + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 + \dots + \varepsilon \tag{1}$$

Total production by any farmer is co-related to land size, seeds, irrigation facilities, credit facilities, fertilizers and pesticides etc. We are studying the use of fertilizers and pesticides with total production.

$$Y_i = \alpha + \beta_1\chi_1 \tag{2}$$

The production of the crops is linked to the use of fertilisers and pesticides by farmer in district.

$$Y_1 / \chi_1 \neq D_{mp} + M_{MRTS} \neq MP \tag{3}$$

Total production is related to number of inputs used by the farmer. It is assumed that the use of fertilisers will increase the marginal productivity of crops. Farmers are also using technology for high yield of crops. We have added marginal rate of technical substitution to keep marginal productivity of crops at high level. Farmers keep high marginal productivity of crops with the help of chemical fertilisers and pesticides.

$$AP \approx C \int_1^0 (\chi_1^1, \chi_2^1, \chi_3^1) / S_n \tag{4}$$

Average productivity of the different crops is related to variable cost to farmers. We considered the three seasons for farmers with different crops.

$$P \approx C \int_1^0 (\chi_1^1, \chi_2^1, \chi_3^1) * \lambda - \sum_{i=n}^{i=n} o \tag{5}$$

Profit from the production in each season is related to cost of each season. It is further reduced from output sold in the market.

$$\sum_{i=1}^n p = \alpha + \sum_{i=n}^i (\chi_1^1, \chi_2^1, \chi_3^1) \tag{6}$$

But profit is not always related to crops cultivated and input provided to crops. Few unobserved factors α also play significant role.

$$\chi_1^1 = \left(\frac{\chi_1^1}{pm + d}, \frac{\chi_1^1}{pm + cf}, \frac{\chi_1^1}{d + cf} \right) \tag{7}$$

Each season, farmers have different crops. In each season, different combinations of fertilisers are used by farmers. The use of fertilisers is combinations of sets to farmers. We considered as

poultry manure and dung, poultry manure and chemical fertilisers and dung with chemical fertilisers. Farmer decides the use of fertilisers to each crop.

$$\chi_2^1 = \left(\frac{\chi_2^1}{pm+d}, \frac{\chi_2^1}{pm+cf}, \frac{\chi_2^1}{d+cf} \right) \quad (8)$$

In the second season, the farmer could decide the three different combination fertilizers such as poultry manure and dung, poultry manure and chemical fertilisers and dung with chemical fertilisers.

$$\chi_3^1 = \left(\frac{\chi_3^1}{pm+d}, \frac{\chi_3^1}{pm+cf}, \frac{\chi_3^1}{d+cf} \right) \quad (9)$$

In each season, the farmer could decide the use of poultry manure and dung, poultry manure and chemical fertilisers and dung with chemical fertilisers. Farmer takes decision about use of fertilizer.

$$\sum_{i=n}^t P = \sum_{i=n}^t C - \sum_{i=n}^t O_{MR} \quad (10)$$

At the end of year, farmer calculate the cost incurred on chemical pesticides and fertilizers. It is further reduced from the output sold in the market.

$$\sum_{i=n}^t L = \sum_{i=n}^t C - \sum_{i=n}^t O_{MR} \quad (11)$$

If the cost is not recovered out of total sale of output in the market, then farmer has no choice but to take loan from the bank or other sources.

$$\sum_{t=1} A_t = \sum_{t=n} A + \sum_{t=n} P \quad (12)$$

If farmer earns good income from commodity production, then he will buy number of physical and animal assets for the next season.

$$\sum_t IS_{t+1} = \sum_{t=1} A_t - \sum_{i=n}^t C \quad (13)$$

If the loans are not repaid and farmer does not feel to keep the assets, then he sells certain animal and physical assets. We have adopted such econometric model to study the organic farming in Pune district.

4. TOTAL AVAILABLE DUNG WITH FARMERS IN PUNE DISTRICT

Every farmer in India holds domestic animals for agricultural work and milk purpose. The domestic animals eat crop residuals and provide milk and dung to farmers. The domestic animals are in different size and shape and age. Farmers provide the fodder to animals and collect dung. Such dung is stored every day near house and it is given to all crops every year. Farmers decides the quantity of dung to each farm based on size of farm, types of crops in the next season, fertility of soil and last year's dung supply.

From the Table 1, we can see that in Ambegaon tehsil, 24.02 per cent farmers have 0-1500 kg of dung of domestic animals. In Shiror tehsil only 6.34 per cent of the farmers have 0-1500 k.g of dung stock. The farmers of Rajgurunagar tehsil have (1500-7500 kg) 63.64 per cent of dung. The farmers have 7500-15000 k.g of dung and they are from (26.26 per cent) Ambegaon tehsil. The farmers have 15000-22500 kg dung but they are 21.13 percent and from Shiror tehsil. In Shiror tehsil, famers with 22500-30000 kg dung are observed with 4.23 per cent. Farmers with 37500-45000 kg dung is found with the 2.82 per cent in the Shiror tehsil. We can observe that maximum farmers in three tehsil have 1500-7500 kg of dung (33.82 per cent) every year. The dung availability depends upon the total domestic animals, size of land, irrigation facilities,

education of farmer etc. If farmers do not have sufficient stock of dung and they have planned commercial crops, then they are buying poultry manure.

Table 1. Total dung production by domestic animals

Dung (Kg)	Ambegaon	Shiror	Rajgurunagar	Total
0-1500	24.02	6.34	9.09	15.74
1500-7500	28.49	35.92	63.64	33.82
7500-15000	26.26	23.94	13.64	24.49
15000-22500	12.29	21.13	9.09	15.74
22500-30000	2.79	4.23	4.55	3.50
30000-37500	2.79	2.82	0.00	2.62
37500-45000	2.23	2.82	0.00	2.33
45000<	1.12	2.82	0.00	1.75

Source: Primary data

The table 2 presents that 44.69 per cent farmers do not buy any kind of poultry manure for crops in Ambegaon tehsil. We can observe that in Shiror tehsil, 48.59 per cent farmers do not buy poultry manure. In Rajgurunagar tehsil, 18.18 per cent farmers do not buy the poultry manure. In Ambegaon, 28.49 per cent farmers are buying 5000 kg of poultry manure regularly. Nearly half of the farmers in the Rajgurunagar tehsil are buying 5000 kg of poultry manure. In Rajgurunagar tehsil, only 27.27 per cent farmers are buying around ten thousand kg of poultry manure regularly. In Ambegaon tehsil, 4.47 per cent farmers are using above thirty thousand kg and above poultry manure. In Shiror tehsil, 2.11 per cent farmers are using above thirty thousand kg. poultry manure for crops. Such high use of poultry manure for crops could be problem in this tahasil. Manure over-application, beyond crop needs, has been shown to increase nutrient losses, through leaching and runoff, to surrounding ground and surface water. Such nutrient losses lead to the degradation of water quality (Sharara et al., 2018). But it also depends on the size of land and cost of poultry manure to farmers.

Table 2. The total quantity of poultry manure

Poultry manure (kg)	Ambegaon	Shiror	Rajgurunagar	Total
0	44.69	48.59	18.18	44.61
1-5000	2.23	1.41	4.55	2.04
5000	28.49	28.17	50.00	29.74
10000	13.97	12.68	27.27	14.29
15000	3.35	3.52	0.00	3.21
20000	1.68	0.70	0.00	1.17
25000	1.12	2.82	0.00	1.75
30000	4.47	2.11	0.00	3.21

Source: As per table one

The table 3 shows that half of the farmers in Ambegaon and Shiror tehsil do not pay anything for poultry manure and they do not buy poultry manure. In Rajgurunagar tehsil only 18.18 per cent farmers do not pay anything for poultry manure. We can observe that 17.32 per cent farmers from Ambegaon tahasil are paying up to Rs. 15 thousand regularly.

Table 3. The price paid by farmers to poultry manure

Rupees (Thousand)	Ambegaon	Shiror	Rajgurunagar	Total
0	50.84	48.59	18.18	47.81
0-0.15	17.32	17.61	45.45	19.24
0.15-0.30	17.88	17.61	22.73	18.08
0.30-0.45	8.38	7.75	9.09	8.16
0.45-0.60	2.23	3.52	4.55	2.92
0.60-0.75	2.23	2.11	0.00	2.04
0.75-0.90	1.12	2.11	0.00	1.46
0.90<	0.00	0.70	0.00	0.29

Source: As per table one

In Rajgurunagar tehsil, 45.45 per cent farmers are paying Rs.15 thousand regularly for poultry manure. The payment to poultry manure is depends on the nature of crops cultivated by farmers. In Ambegaon tehsil, 8.38 per cent farmers are paying Rs.30 to 45 thousand. In Rajgurunagar tehsil, 9.09 per cent are paying Rs. 30 to 45 thousand. In Ambegaon tehsil, 1.12 per cent farmers are paying Rs.75 to 90 thousand. In Shiror tehsil, 2.11 per cent farmers are paying Rs. 75 to 90 thousand regularly. We found only 0.70 per cent farmer are paying more than Rs. 90 thousand for poultry manure. They are big farmers and cultivating crops such as sugarcane, pomegranates, cabbage, banana etc. Poultry litter is a good source of nutrients and organic matter for growing crops. Poultry Manure is made up of faecal droppings, wood shaving (bedding), waste feed and high load of microbes. It is commonly used by vegetable producing farmers as organic fertilizer (Okiki et al., 2010). Poultry manure is available in different quality. Nutrient values of poultry manure vary considerably depending upon the conditions under which it is processed. The ratio of litter to manure and the moisture content caused considerable variation among manures from different houses. Poultry manure is used as a source of N, P and K but litter also contains Ca, Mg, S and some micronutrients. In fresh poultry excreta, uric acid or urate was the most abundant nitrogen compound while, urea and ammonium was present in small quantities (Amanullah et al., 2007). Farmers buy poultry manure from different poultry manure suppliers. Farmers are also using the chemical fertilisers for different crops.

Table 4 shows that 45.81 per cent farmers in Ambegaon tehsil are using up to 1 bag on chemical fertilisers. Such use of chemical fertiliser changes according to crop. In Shiror tehsil, 51.41 per cent farmers are buying and using up to 1 bag of chemical fertilisers. In Rajgurunagar tehsil, 18.18 per cent of the farmers are using 5-10 bags of chemical fertilisers. In Ambegaon tehsil, we can find that 14.53 per cent of the farmers are utilising 10-15 bags of chemical fertilisers. In Rajgurunagar tehsil, 13.64 per cent of the farmers are using the 15-20 bags of chemical fertilisers.

The use of chemical fertilisers is very high as far as 20-25 bags of chemical fertilisers are concerned. We found that 22.73 per cent farmers are using the 20-25 bags of chemical fertilisers. Such use of chemical fertilisers is biggest concern in tehsil. In Ambegaon tehsil, 2.23 per cent of the farmers are utilising 35-40 bags of chemical fertilisers. In Shiror tehsil, 7.75 per cent of the farmers are using the 50 above bags as chemical fertilisers.

Table 4. Use of Chemical fertilisers (Percent)

Number of bags*	Ambegaon	Shiror	Rajgurunagar	Total
0-1	45.81	51.41	18.18	46.36
1-5	7.82	4.23	13.64	6.71
5-10	8.94	9.15	18.18	9.62
10-15	14.53	4.23	9.09	9.91
15-20	4.47	5.63	13.64	5.54
20-25	10.61	13.38	22.73	12.54
25-30	2.79	1.41	4.55	2.33
30-35	0.00	1.41	0.00	0.58
35-40	2.23	0.00	0.00	1.17
40-45	1.12	0.70	0.00	0.87
45-50	1.68	0.70	0.00	1.17
50<	0.00	7.75	0.00	3.21

*As per central government norm, one bag of urea is equal to 45 kilograms.

Source: As per table one

The use of chemical fertiliser declines with number of bags. The number of bags used as chemical fertilisers is depending upon the size of land, nature of crop, education and age of farmer etc. Most of the farmers are using chemical fertilisers to increase productivity and production of crops. It is their regular habit of giving chemical fertilisers to crops. But during discussions, farmers repetitively telling that the crops cannot come without the use of chemical fertilisers. We were telling the farmers not to use the chemical fertilisers to all crops but it was no use. It will take time by farmers to adopt the organic farming techniques and understand the cropping pattern. Such move to organic farming will improve the health of people and animals, soil fertility etc.

5. THE SOCIO-ECONOMIC CHARACTERISTICS OF THE FARMERS USING DIFFERENT FERTILISERS

Farmers are using variety of fertilisers for the commercial as well as regular crops. According to them, if a crop is given more and expensive fertiliser means it will grow more and provide good yield. They plan to give fertilisers before planting the crop. Therefore, the requirement of fertilisers start before the harvest. Few farmers use dung which is available through domestic animals. Few farmers buy the poultry manure from different suppliers. If farmers do not have money to buy poultry manure and dung, they buy the chemical fertilisers for different crops. Poultry manure has been used for generations as a source of plant nutrients as well as to enhance and maintain soil quality (Rees et al., 2011). The use of the fertiliser for specific crops is depends on number of factors such as type of crop, land, education and experience of farmer, climate condition, irrigation facilities etc. Farmers are cultivating variety of crop every season. Therefore, they know which fertilisers they have to use for specific crop. Their aim is to maximise productivity and production of crops.

5.1 Age of the farmers in district

Age is the significant determinant of the fertiliser use. Higher is the age of the farmers more is the experience is expected for farmer. At younger age, farmer does not understand which fertiliser he has to use for different crops. However, older age helps him to get more experience about cultivation of crops and provide various inputs including fertilisers. Table 5 shows the relationship between age of farmers and use of fertilisers in Pune district.

Table 5. Age of the farmers and fertilisers use (per cent)

Age (Years)	Poultry Manure	Dung	Chemical fertilisers
20-30	7.18	6.59	6.01
30-40	13.33	15.27	15.32
40-50	31.28	30.54	30.63
50-60	21.54	21.56	21.32
60-70	18.46	20.06	20.42
70-80	5.13	5.39	5.41
80-90	0.51	0.60	0.90

Source: primary data

As far as age of the farmers and fertilisers are concerned then in 20-30 age group (7.18 per cent) farmers are using more poultry manure as compare to dung and chemical fertilisers. In 30-40 age groups (15.32 per cent) farmers are using chemical fertilisers. In 40-50 age groups, total 31.28 per cent farmers are using the poultry manure. In 50-60 age group, nearly 21.56 per cent farmers are using dung as fertiliser. In 60-70 age groups, total 20.42 per cent are using chemical fertilisers. In 70-80 age groups, 5.41 per cent farmers are using the chemical fertilisers. We can say that young farmers are using the poultry manure more in their farm as compare to dung and chemical fertilisers. But as age increases, the trend is more towards dung to chemical fertilisers.

5.2 Household size of farmers

The household size is significant determinant of the fertilisers use. Larger family size helps for cultivation of various crops, as there is shortage of work force in the agriculture sector. Larger household size forces farmers to use power full fertilisers so that they can increase the production and productivity of crops. Large family size required more food and money. The small household size also helps to use the powerful fertilisers. It also depends on the money availability with the households.

Table 6. Household size and use of fertilisers (per cent)

Household size (Number)	Poultry Manure	Dung	Chemical fertilisers
2-4	48.42	51.95	51.20
4-8	38.95	37.54	38.25
8-10	6.84	6.31	6.33
10-12	4.74	3.60	3.61
12-14	1.05	0.60	0.60

Source: As per table 1

Household size is very small then farmers (2-4 members in family) use dung (51.95 per cent) which is shown in table 6. But as the size of household increases from 4 and above, all farmers are preferring poultry manure as compare to dung and chemical fertilisers.

5.3 Education of the head of the household

Head of the household decides about use of the fertilisers. His knowledge and experience is the significant aspect in the use of the types of fertilisers. Most of the educated head discuss the use of the fertilisers with the other family members. The head of the household goes to chemical fertiliser shop and buy the fertilisers. He is deciding to use the dung or poultry manure and chemical fertilizers based on his knowledge, information processing and guidance, training.

Table 7. Head of the family's education and fertilisers use (per cent)

Head of the family's education	Poultry Manure	Dung	Chemical fertilisers
Primary	13.25	15.73	15.41
Secondary	10.60	10.11	10.53
High secondary	7.28	12.73	13.91
Graduation	45.03	39.70	39.10
Post- graduation	23.84	21.72	21.05

Source: As per table 1

The head of household decides the use of the fertilisers in farm. We found in table 7 that if the farmer has primary education then he uses the dung in (15.73 per cent) farm. Those farmers have completed the secondary school; they are using more poultry manure (10.60 per cent). If the farmers completed higher secondary school, then they use (13.91 per cent) chemical fertilisers. But those farmers are graduate (45.03 per cent) are using more poultry manure as compare to dung and chemical fertilisers. The post-graduate farmers (23.84 per cent) are using the more poultry manure as compare to the other farmers those are using the dung and chemical fertilisers.

5.4 Females education in households and use of fertilisers

Highly educated women always prefer good fertilisers. High education helps to understand the side effects of chemical fertilisers and good effects of organic fertilisers. The health of the all members is very important and only women with higher education can understand it. At lower education women do not understand the negative impact of chemical fertilisers. Highly educated women always influence of decision making in each household. We can find relationship of female education with fertilisers use in table 8 for Pune district.

Table 8. Female education and fertilisers use (per cent)

Female education	Poultry Manure	Dung	Chemical fertilisers
Primary	14.63	18.35	18.60
Secondary	4.88	8.72	8.84
High secondary	27.64	28.44	28.37
Graduation	39.84	33.03	32.09
Post- graduation	13.01	11.47	12.09

Source: As per table 1

The role of female's education is very important in use of fertilisers in district. Most of the time, the joint decisions are taken about the use of the fertilisers. If the women have primary education (18.60 per cent) and secondary education (8.84 per cent) then they will insist more for

chemical fertilisers. The female with secondary school education will insist more on the (28.44 per cent) use of dung. But more education, that is graduation (39.84 per cent) and post-graduation (13.01 per cent), the women prefer poultry manure in their farm.

5.5 Agriculture experience of the farmers

Highly experience farmer uses the fertilisers very wisely and adequate. Farmer has more experience and takes various suggestions of friends, experts, and more experienced farmers. Therefore, high experience contributes more knowledge and good crops and money to farmer. But lower experience of farmer may effect on knowledge gain, income.

Table 9. The agriculture experience and use of fertilisers (per cent)

Expenses for crops (Rs. thousands)	Poultry Manure	Dung	Chemical fertilisers
0-10	13.16	13.47	13.81
10-20.	27.37	25.75	25.53
20-30.	31.05	32.04	32.43
30-40	15.79	15.57	15.02
40-50	11.58	12.28	12.31
50-60	1.05	0.90	0.90

Source: As per table 1

Experience of farming is very important in use of various fertilisers, we can see it in table 9. Farmers with less experience (0-10 years) are using (13.91 per cent) more chemicals fertilisers. But 10-20 years of experience, the farmers are using the (27.37 per cent) poultry manure. As the experience increases from 20-30 years, farmers are using the (32.43 per cent) chemical fertilisers. In 30-40 years' experience, the farmers are using (15.79 per cent) dung. With 40-50 years of experience, the farmers are using the (12.31 per cent) chemical fertilisers. In 50-60 age groups, one per cent farmers are using the poultry manure. We found the mix response in the use of fertilisers as far as age of the farmer is concerned. A suitable combination of organic and inorganic sources of nutrients is necessary for sustainable agriculture that can ensure food production with high quality. An integrated use of organic manure and chemical fertilisers would be quite promising not only in providing greater stability in production but also in maintaining better soil fertility (Sarkar et al., 2015).

5.6 Total land holding of family and fertilisers use

Total land holding is important determinant of types of crop, total fertilisers and food security. More the size of land with farmers then more is the chance that farmer will cultivate cash crop. However, total irrigated land holding by farmer is positively co-related to the total production and productivity of crops. Therefore, famers with more land are earning more profit. They are most advanced farmers. However, it also depends on their efforts, education and support of other farmers. Many farmers are cultivating the flowers and vegetables commercially. Floriculture has become very lucrative and money spinner industry. Pune district has a long tradition of cultivating flowers and these are being cultivated throughout the country on small holdings. In commercial floriculture, bulbous ornamental crops are an important group of plants (Kumar et al., 2018). In Pune, Farmers are cultivating flowers and vegetable commercially and sell in Mumbai market. They also export flowers to different countries. But the crop cultivation depends upon the size of land, source of irrigation, market and credit access.

Table 10. Total land holding of family and fertilisers consumption (per cent)

Total land (Acres)	Poultry Manure	Dung	Chemical fertilisers
1-10.	83.16	89.22	89.19
10-20.	5.79	4.19	3.90
20-30.	6.84	4.19	4.20
30-40.	3.16	1.80	2.10
40-50.	0.53	0.30	0.30
50-60.	0.53	0.30	0.30

Source: As per table 1

Table 10 shows that the total land holding is important in deciding the use of fertilisers. We found that if total land holding is between 1-10 acres then 89.22 per cent farmers are using more dung. But as the land ownership increases from 10-20 acres to 50-60 acres, the use of poultry manures increases. It means farmers with lower land holding use dung. But as land holding increases, farmers find more scope of using the poultry manure for crops.

5.7 Physical asset holding and fertilisers

Fan in house is useful for good air and comforts. Farmers use it for comforts. They work hard in farm and after returning home they get good relief through fan. Radio is useful to listen different kinds of news and speeches. Farmers use radio to listen various programs related to agriculture. Farmers get lot of information related to farm at morning and evening. Every day, good programs are coming on radio which is for farmers only. The television helps farmers to get lot of information related to the farm. Every day, farmer listens and watches good programs on the television at evening and morning. They use such knowledge in the crop cultivation. Good agricultural experts are directly giving advice to farmers on television and radio. The swing machine helps to stitch cloths of farmers. The women do such kind of work during off season. But it depends upon the experience of tailoring and training of women. Most of the households do not give importance to swing machine. Mobile is very useful for calling and receiving call and other information. Most of the farmers are using the mobile for asking the current price of the farm produce. They are also asking the agricultural officer about various information. They inquire various inputs required from relatives, friends and markets. Many farmers give order of poultry manure on cell phone and they follow with the poultry manure supplier. The computer is very useful for various kinds of learning. Farmers keep various up dates with the computer. If they have internet, then they get the information and best world practices in the world. Farmer's often use the best medicines and the seeds available in the market. All the research information is used by the farmers. The fridge is very useful to preserve food. Most of the vegetables, milk, ice cream, curd and chocolates are preserved by the farmers. They required continuous cooling. Farmers are using the refrigerators for different purposes. Air condition is very useful to sleep. During summer, in order to protect from hot climate most of the farmers have purchased the air conditioner. Washing machine is useful to wash the cloths. Most of the rich farmers buy the washing machine for washing the cloths. Clock is very useful to understand the time. Farmers usually keep the watch in the house. They do number of activities on time such as milking cows, switch on motor and provide fodder to animals. Bicycle helps the farmers for movements. It helps for carrying fodder, the different bags of urea, carry milk. Bicycle is physical moveable asset for the poor farmers. Car is very useful for movements with in villages. The rich farmers go to different places therefore they buy the car. Having car means the farmer is wealthy and rich in village. He can afford to buy any kind of fertiliser. For drinking water, the government provides the hand pump at various places. Therefore, government solves the water scarcity through hand pump. The farmers using hand pump may

not use the modern fertilisers. For crop cutting, the thresher is very useful. It helps the farmer to work more in short period. Most of the farmers prefer the thresher during harvest period. The farmers use the tractor for ploughing, levelling, sowing, planting crops etc. Therefore, having tractor is very useful to farmers for different tasks. Farmers hire the tractor for different purposes. They pay to tractor owner after work as per the number of hour work.

The physical asset holding with farmers is shown in table 11. Physical asset holdings are more with the farmers using the poultry manure in their farm. The poultry manure using farmers have fan (96.84 per cent), Radio (92.11 per cent), television (80 per cent), sewing machine (21.58 per cent) mobile (91.58 per cent), internet facility (17.37 per cent) and computer (4.2 per cent). The availability of fridge (23.16 per cent), air condition (6.32 per cent) washing machine (11.05 per cent), clock (81.58 per cent), bicycle (78.42 per cent), in their house. The ownership of motor cycle (82.11 per cent), car (21.05 per cent), tractors (32.63 per cent) is more with the poultry manure using farmers in Pune district.

Table 11. Physical asset holding and use of fertilisers (per cent)

Physical assets	Poultry Manure	Dung	Chemical fertilisers
Fan	96.84	94.61	94.89
Radio	92.11	91.02	90.69
Television	80.00	77.84	77.78
Swing machine	21.58	20.96	20.72
Mobile	91.58	89.22	89.49
Internet	17.37	13.77	13.81
Computer	4.21	2.99	3.00
Fridge	23.16	18.86	18.32
Air conditioning	6.32	3.89	3.90
Washing machine	11.05	8.98	9.31
Clock	81.58	81.44	81.08
Bicycle	78.42	75.15	74.47
Motor	82.11	76.35	75.08
Car	21.05	14.97	14.41
Hand pump	1.05	1.50	1.50
Thresher	0.53	0.90	0.90
Tractor	32.63	26.35	26.43

Source: As per table 1

6. REGRESSION RESULT FOR FARMERS OF PUNE DISTRICT

We use the multinomial logit regression model to find the relationship between dependent and independent variables. Such model is used when the dependent variable is nominal in nature with more than two categories. Multinomial regression is also called as multi-equation model. It is based on logit function. For a nominal dependent variable with k categories, the multinomial regression model estimates k-1 logit equations (Greene, 2003). We used multinomial logit model for this study to find correlation between use and non-use of organic fertilisers and socio-economic and demographic factors of farmers. Such model also allows us to compare the farmers using different fertilisers. The reference group in this model is considered as the farmers using the poultry manure for different crops. This is because those farmers using the poultry manure, they are producing more per acre crop output and yield. Such farmers have more

economic assets and they have high socio-economic standard in villages. But those farmers are using dung and chemical fertilisers do not get the much yield and income from crops.

The model is defined as follows:

$$\Pr (y_i = j) = \frac{\text{Exp} (X_i B_j)}{1 + \sum_j^J \text{exp} (X_i B_j)} \tag{14}$$

and

$$\Pr (y_i = 0) = \frac{1}{1 + \sum_j^J \text{exp} (X_i B_j)} \tag{15}$$

Where for the i^{th} farmer, y_i is the observed outcome and X_j is a vector of explanatory variable. The parameters B_j are estimated by maximum likelihood. The positive and negative parameters are compared with the reference category farmers.

6.1 Use of chemical fertilisers by farmers in Pune district

We have run three different regressions to three types of fertilisers. The results are presented in the following table.

Table 12. Regression result for chemical fertiliser

Variables	Co-efficient (Standard error)	Test
Female education	-0.64**(0.39)	2.68
Buffalo	-0.68**(0.30)	5.19
Household size	2.09***(1.38)	2.27
Cows	-0.02(0.04)	0.28
Constant	3.63**(2.06)	3.09
	-2 Log likelihood = 51.48 Cox and Snell R ² = 0.04	Nagelkerke R ² = 0.19

* Significant at 1 per cent, ** significant at 5 per cent, *** significant at 10 per cent

Female education is negatively co-related with use of chemical fertilisers in table 12. Females have less education in such households. They do not understand the adverse effects of chemical fertilisers. The male members or head of family take the decision about the use of chemical fertilisers for crops. They use such fertilisers to crop without giving information to female members. Higher education helps women to take strong decision in the family. They easily understand the benefits of organic farming. Those households use chemical fertilisers do not own buffalo. Buffalo requires more food and gives good fat milk. But those farmers use more chemical fertilisers do not own any buffalo. Household size is positively co-related with the chemical fertilisers. Higher household size forces the head of the household to produce more crops. It is the pressure on head of household to take more crops and feed to animals and members. The number of cows with the farmers is not significant with chemical fertilisers in the above regression.

6.2 Regression result for Poultry manure by farmers

We have used poultry manure use by farmer as dependent variable. It is regressed on the other socio-economic variable of the farmer. The results are presented in the table 13.

Table 13. Regression result for Poultry manure using farmers

Variables	Co-efficient (Standard error)	Test
Household size	0.437**(0.238)	3.36
Female education	-0.27**(0.13)	4.37
Total land	1.52**(0.64)	5.34
Mobile phone	1.34**(0.61)	4.74
Computer	1.96***(1.24)	2.47
Cows	-0.05***(0.03)	2.17
Goats	-0.14**(0.07)	3.35
Un-irrigated land	-0.24**(0.09)	6.07
Cannel irrigation	0.28**(0.13)	4.26
Organic farm	1.29**(0.60)	4.58
Motorcycle	0.51(0.36)	2.07
Constant	-5.33*(1.17)	20.67
	-2 Log likelihood =237.70 Cox and Snell R ² =0.24	Nagelkerke R ² = 0.33

* Significant at 1 per cent, ** significant at 5 per cent, *** significant at 10 per cent

From table 13, we found that household size is positively co-related to poultry manure. Higher is the household size, higher will be pressure on the head of the household to produce more for the family. Therefore, they are buying more poultry manure and produce more output. The female education is negatively co-related to poultry manure. It means that women may have less education but still the head of the household is using more poultry manure. Total land is positively co-related to the use of the poultry manure. Higher is the land holding with the farmers more is the chance that the farmers are using the poultry manure. The mobile phone is positively co-related to the use of the poultry manure. Farmers easily call through mobile phone to the poultry manure suppliers. They ask for the supply of the poultry manure. The farmers those are using the poultry manure have computer at home. They are using computer for various activities. Children are learning the computer at home. The numbers of cows are negatively co-related to the use of the poultry manure. It is mainly because cows provide more dung and they do not think that there is need to use poultry manure. However, less cows at home forcing farmers to use more poultry manure. The goats at home are negatively co-related to the use of poultry manure. It means those farmers have more goats at home are least interested in use of poultry manure. The goat dung is also more powerful manure for crops. The un-irrigated area is negatively co-related to the use of poultry manure. It means that farmers do not use the poultry manure to the un-irrigated land. Poultry manure use to different crops required irrigated source. The cannel irrigation is positively co-related to the poultry manure. More farmers with cannel irrigation are using the poultry manure. Those farmers are believing on the organic farming; they are using the poultry manure fertilisers. It is mainly because they believe on the organic farming and produce crops for it. The farmers are using the poultry manure and they have motor bikes at home. They are using the motorcycle for different purposes. It is the mobility of the farmer, which helps them to get more poultry manure.

6.3 Regression result for dung used by farmers in district

We have used the dung use of farmers as dependent variable and social economic variables as independent variables.

We found in table 14 that the heads education is positively co-related to the use of the dung. The highly educated farmer is using the more dung in the farm. The female education is negatively co-related to the use of the dung. It means that the women with less education do not understand

the importance of the dung. The total land is negatively co-related to the use of the poultry manure. It means that the more land requires more dung. However, the farmers do not have that much dung available with them. Therefore, it is negatively co-related. The agricultural experience of farmer is positively co-related to the dung. It means that higher the experience of the farmers then higher is the use of the poultry manure. The numbers of cows are positively co-related to the dung. Cows eat grass and produce more dung to farmers. The more number of cows means more the use of dung to the farm.

Table 14. Regression result for dung using farmers

Variables	Co-efficient (Standard error)	Test
Head of households' education	1.57**(2.66)	2.66
Female education	-1.38**(0.93)	2.23
Total land	-1.91**(0.96)	3.94
Agriculture experience	4.47**(2.59)	2.96
Cows	0.99***(0.70)	2.51
Constant	-1.67 (3.80)	0.19
	-2 Log likelihood = 16.851 Cox and Snell R ² = 0.106	Nagelkerke R ² = 0.594

* Significant at 1 per cent, ** significant at 5 per cent, *** significant at 10 per cent

7. ESTIMATION OF FERTILISERS USE IN PUNE DISTRICT

We have estimated the total quantity of dung, poultry manure and chemical fertilisers for Pune district. The estimation for current year is based on the total cultivators in district, agricultural land holding by cultivators, total type of livestock in district and tehsil.

7.1 Dung estimation in Pune district

Every farmer holds the domestic animals. The cows, buffalos, sheep's and goats provide milk and dung. Animals at home is related to land size, grazing land, total persons, dairy distance, fodder availability, regular water source, availability of veterinary doctors.

We estimated dung based on following methodology,

$$\sum_{t=1..n} Nc = \sum_{i=1..n} TC \tag{16}$$

Number of cattle at time t with particular farmer depends on the total cultivable land with the farmer.

$$\sum_{t=1..n} Nc = \sum_{i=1..n} TC(C + B + S + G + \varepsilon) \tag{17}$$

The number of cattle's are divided as cows, buffalos, sheep's and goats with farmers. Every cattle eat fodder and give the dung.

$$\sum_{t=1}^n Dn = \sum_{t=n}^n TC * P_n \tag{18}$$

Total dung with farmer is related to total number of domestic animals multiply by per capita dung of animal.

$$PCD = \sum_{t=n}^n Dn / \sum_{t=n}^n Tca \quad (19)$$

Per capita dung availability to farmer in district is equal to total cattle's dung (Dn) in districts divided by the total cultivators (Tca) in district in particular period. Census data provides the number of cultivators in each district. We will get the per capita dung available to farmers in district.

7.2 Poultry manure estimation in Pune district

Poultry manure use by farmer is function of land owned by farmer, continuous water availability, road connectivity, market rate for poultry, education of farmer, worker's availability, investment, climatic conditions, bank loans, availability of chick and their food. We tried to link different variables of poultry farming in district.

$$\sum_{t=i...n}^n D = \sum_{i=n}^n T \quad (20)$$

District has particular population of poultry. It varies according to different tehsils.

$$\sum_{t=1...n}^n T = \sum_{i=1...n}^n T(Pp) \quad (21)$$

Total poultry birds in district comprise as total number of birds in different tehsils at time t. Livestock census provides the total number of birds in tehsils, district, state and India level.

$$\sum_{t=1}^n TPM = \sum_{t=n}^n Pp * P_{cn} \quad (22)$$

All hens produce the manure daily. Such hens manure production is depending on the total birds multiply by per capita manure production.

$$\sum_{t=i...n}^n De = \left(\sum_{i=n}^n PCPM - Npa \right) \quad (23)$$

Deficit in the poultry manure at particular time t is related to the per capita poultry manure minus the number of cultivators in the district.

$$PCPM = TCPM * 2 \quad (24)$$

We assumed that only half of the farmers are using the poultry manure in district. Therefore, we multiplied the actual per capita calculated poultry manure with actual availability of the poultry manure in Pune district.

7.3 Chemical fertilisers use in Pune district

We have estimated the chemical fertilisers for the Pune district. It is as follows.

$$\sum_{i=n}^n CF = \sum_{i=n}^n (U + D + M + SSP + TC + TM) \quad (25)$$

Total chemical fertilisers use in the district comprises as different quantities of urea, DAP, MOP, SSP, Total complexes, Total mixtures.

$$\sum_{i=1}^n pcd_d = pc_n * Ac \quad (A) \tag{26.1}$$

Per capita daily requirement is equal to per capita norms daily multiply by actual cultivators.

$$PCd = \sum_{i=1}^n TC_u / \sum_{i=1}^n TC_a \quad (B) \tag{26.2}$$

Per capita daily deficit is related to the total chemical fertilisers divided by total cultivators in the district.

$$\sum_{i=1}^n D = A - B \tag{27}$$

In order to calculate the deficit in district, we have used annual requirement minus the annual deficit. The deficit is calculated as (A) equation 26.1 minus (B) equation 26.2.

$$\sum_{i=1}^n CF = Nc * Pcn \tag{28}$$

Chemical fertilisers required in period t is related to number of cultivators and per capita requirement of the farmer. It varies with each farmer based on the size of land and nature of crops. Following table shows per capita availability of the dung, poultry manure to farmers according to tehsil in Pune district.

Table 15 shows that the per capita dung is available more in the Maval (7660 kg) tehsil of Pune district. It is because in Maval tehsil, the number of cattle are more. The area under grazing is also more and density of population is lower. More animals mean more dung available for agriculture. The lowest dung is found in the Purander tehsil. It is a very dry tehsil of the district and state. In this tehsil, very less animals found with per cultivator.

Table 15. Dung and PM in tehsils of Pune district (Kg)

Tehsil	Dung	PM	Per capita PM*
Maval	7660	2187	4374
Mulashi	6756	763	1526
Bhor	5607	461	922
Velha	6496	232	464
Junnar	4182	781	1562
Ambegaon	4722	665	1330
Khed	4665	658	1316
Baramati	6591	1098	2196
Indapur	7050	102	204
Shiror	6284	531	1062
Haveli	5267	1676	3352
Purander	4109	947	1894
Daund	6466	514	1028
Total	5622	760	1520

* Only 50 Per cent farmers are using Poultry Manure (PM) in district

Source: Calculated from data

The poultry farms are found in humid climate. The tehsils such as Maval, Mulshi, Ambegaon and Junnar, the dams are built in last few decades. They are good source of water to farm and poultry business. Therefore, such poultry manure provides more manure to farmers. In Baramati (2196 kg), Indapur (204 kg), Purander (1894 kg), Daund (1028 kg), Shiror (1062 kg), the per capita availability of poultry manure to farmers is very low. The climate is very hot in these tehsils. Therefore, the hens cannot survive in such climatic condition. Secondly, the mortality of birds is very high. Poultry manure is not available to farmers. Farmers buy poultry manure from poultry manure dealers. They borrow poultry manure from longer distance. We have studied the use of chemical fertilisers in Pune district.

Table 16 shows that 2013-14 period, government controlled organisations are providing the 135803.4 metric tons chemical fertilisers in Pune district for both the seasons. The private organisation are providing 203706 metric tons of chemical fertilisers in district for both the season in Pune district. We can see that the private organisations are providing more chemical fertilisers in district as compare to government organisation. Actually state government provides chemical fertilisers at subsidised rate. But farmers are getting irregular supply of chemical fertilisers. We found that government and private organisations in Indapur (17253.6, 25880 Metric Tons) and Baramati (16632.8, 24949 MT) tehsil of Pune district are providing more chemical fertilisers to farmers in both seasons.

Table 16. Chemical fertilisers in different tehsils (Metric Ton)

Tehsils	Government organisations			Private organisation		
	Kharip	Rabbi	Total	Kharip	Rabbi	Total
Junnar	7548.4	7656	15204.4	11323	11484	22807
Ambegaon	5814.8	5862	11676.8	8722	8793	17515
Shiror	6903.2	9720	16623.2	10355	14580	24935
Khed	6200.8	6256	12456.8	9301	9384	18685
Maval	1544.4	1058	2602.4	2317	1587	3904
Mulshi	1321.2	1067	2388.2	1982	1601	3583
Haveli	5038.8	6507	11545.8	7558	9761	17319
Pune city	0	0	0	0	0	0
Daund	6512.4	9458	15970.4	9769	14187	23956
Purandar	3816.4	5408	9224.4	5725	8113	13838
Velhe	532	157	689	797	235	1032
Bhor	1985.6	1550	3535.6	2978	2325	5303
Baramati	6812.8	9820	16632.8	10219	14730	24949
Indapur	7257.6	9996	17253.6	10886	14994	25880
Total	61288.4	74515	135803.4	91932	111774	203706

Source: District Socio-Economic Survey 20013-14

We can see the chemical fertilisers use in Pune district during 2016-17 in table 17. The lowest use of urea is found in the Velha as 711 MT in 2016-17. The use of the DAP was 2133 MT in Junnar and Shiror tehsil of Pune district. The MOP use in Junnar was 1374 MT during 2016-17. The use of the SSP was 2679 MT in Shiror tehsil of Pune district. The lowest SSP use is found in 223 MT in Velhe tehsil of Pune district. Total complexes use was 5348 MT in Shiror and Junnar tehsil. Total mixture was 16436 MT in Junnar and Shiror tehsil of Pune district. Total use of all fertilisers was 21816MT in Junnar and Shiror tehsil respectively of Pune district. The lowest use of fertilisers was in Velh tehsil of (1818 MT) Pune district. These chemical fertilisers

are mixed in the soil. The pesticides are sprayed on the plants. They are also called as plant protection chemicals.

Table 17. The use of chemical fertilisers in Pune district (2016-17) (MT)

Taluka	Urea	DAP	MOP	SSP	Total complexes	Total mixtures	Grand Total
Ambegaon	8177	2044	1220	2567	5156	15751	20907
Baramati	7110	1778	1061	2232	4483	13697	18180
Bhor	2133	533	318	670	1345	4109	5454
Daund	6755	1689	1008	2121	4259	13012	17271
Haveli	6399	1600	954	2009	4035	12327	16362
Indapur	7110	1778	1061	2232	4483	13697	18180
Junnar	8532	2133	1374	2679	5380	16436	21816
Khed	8177	2044	1220	2567	5156	15751	20907
Mawal	1778	444	266	559	1121	3424	4545
Mulashi	1778	444	266	559	1121	3424	4545
Purandhar	3911	978	584	1228	2466	7533	9999
Shirur	8532	2133	1273	2679	5380	16436	21816
Velha	711	178	106	223	448	1370	1818
Total	71104	17776	10605	22321	44835	136965	181800

Source: District Socio-Economic Survey 20014-15 (Metric tons)

From the 18 table, we can observe that Carbaril was used as 290 MT in Pune district in 2011-12. In 2016-17, carbaril use was 426 MT. It is toxic to the nervous and respiratory system of human body. An excess use of it can cause nausea, stomach cramps, diarrhoea and excessive salivation. But farmers do not know about such effects. The use of carbendizyn was 456 MT in 2016-17. It causes respiratory and cardiovascular diseases and neuropsychiatric complications. It includes eye irritation, skin diseases and cancer. The use of the Trichoderma was only 71 MT in 2016-17. It is adversely affecting on the human and animal's health.

Table 18. The use of Plant Protection Chemicals in Pune district (MT)

No	Pesticides used	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1	Carbendizyn	283	311	342	377	414	456
2	Monocrotophos	204	187	210	120	100	75
3	Metalaxil -mancozeb	142	156	172	189	198	208
4	Fifronil	187	206	226	249	261	274
5	Carbaril	290	319	351	386	405	426
6	M 45	80	88	97	106	112	117
7	Pholidol	69	76	83	92	96	101
8	Cypermethrin- Chloropiriphos	244	268	295	325	341	358
9	Trichoderma	44	48	53	59	64	71
10	Others	488	537	590	650	674	685
	Total	2031	2196	2419	2553	2665	2771

Source: ADO ZP, Pune

8. CONCLUSION

Since ancient times, organic farming is considered as the most suitable and affordable method of farming. The organic matter affects soil physical, chemical and biological properties and is thus agronomically important because these factors affect crop yields. Organic amendments such as manures, composts and plant residues are frequently used in crop production systems as alternatives to inorganic fertilizers, to restore degraded soils and ameliorate physicochemical constraints (Celestina et al., 2019). After green revolution in India, many farmers started using chemical fertilisers and pesticides to increase the yield of various crops. In Pune district, few farmers have adopted the use of organic fertilisers and pesticides for different crops. Most of the farmers do not apply techniques of organic farming because yield of various crops is low and income insecurity is observed. Those farmers are research oriented and believe on organic farming, they are managing production through slurry, duck manure, poultry manure, decomposer and other organic fertilisers.

Normally, the farmers are expected to do different experiments and apply various management practices in their farm. They have traditional cows, bullocks, sheep's, goats and other animals. They can easily prepare the slurry and other organic fertilisers and pesticides. Though these organic methods, they can increase the yield and production of various crops. They have residuals of different crops so they can make readymade decompose fertiliser and develop earthworms for crops. It helps to increase soil fertility and crops productivity. Now the production of all crops is in commercial nature. The milk plants are collecting the milk of hybrid cows. They give fodder to hybrid cows and cut the amount from milk supply to dairy owner. The dairy owners mainly collect milk of hybrid cows. They do not have system to-collect milk of traditional cows. The yield of traditional cows is very low. Few farmers have started the traditional cow's project. However, the market chain for milk of traditional cows is not developed yet in district. Few farmers are highly research oriented as far as commercial crops concerned. They produce crops purely based on the organic farming. They are the exporters of commercial crops such as grapes, sugarcane, Pomegranates, onions, cabbage and other products. They take maximum care in terms of growth and yields of fruits. They use maximum organic insecticides and pesticides on crops. Therefore, they also earn good income from commercial farming through exports. The number of domestic animals, farmer's education, credit availability, markets for products are important. Such farmers must be example for other farmers in District and States in India. They should educate the other farmers for export of crops such as fruits, vegetables, milk etc. Central Government must support farmers to manage the transformation of traditional to organic farming. Organic farming improves the fertility of soil and improves health of people. Therefore, government must provide subsidy on use of poultry manure, decomposing methods. Buying poultry manure and decomposing is very costly for poor farmers in district. Therefore, state government must give subsidy to buy poultry manure regularly to poor farmers in district. Such amount must be provided directly as bank transfer in farmer's savings account. Farmers must be given the information about organic farming through cell phone, television and radio. Government must start organic farming related programs on radio, television channels. Such channels must provide live case studies of farmers those are exporting commodities, speeches of experts, Experts from agricultural Universities, agricultural officers and agricultural exhibitions and traders of commodities of various agricultural markets. Government must start investing in technology from farm gate till the final consumer in urban areas. The state and centre must play critical role for farming technology, water conservation and information of products and other information. Every famer must use technology for all kinds of production and sell of commodities in markets. They must get information on their cell phone about the markets, demand for products, types of consumers. It will help them to understand the demand and price information of products and get good price for products and income. The role of NGO's is crucial in terms of management and transformation of agriculture

from chemical to organic fertilisers. The NGO's working on the issue of organic farming must train farmers for organic production and exports of crops. They must create the groups of farmers in different tehsils and districts. NABARAD and government officers must get link of these groups. Every group must work sincerely on production of organic food, finding organic commodity markets, improve soil fertility, health of people, animals and birds in region. Researchers and policy makers must work out the transformation plan for farmers from chemical to organic farming in Pune and other districts. They must work with farmers and help to transform chemical to organic farming through active research. They must guide farmers for a decade to transform from traditional agriculture to organic farming. They must work on sustainable management of organic farming for next decade. Regular speeches, knowledge or updates related to organic fertilisers and pesticides must be given to farmers in rural areas. Excessive use of chemical fertilisers and pesticides are adversely affecting on growth and development of worms, butterflies, birds, domestic animals and human beings. The sustainable agricultural techniques will help quickly to transform chemical agriculture to organic agriculture. Few decades ago, people had high life expectancy and they were living longer and healthy life. But due to over use of chemical fertilisers and pesticides for crops, the occurrence of morbidity and mortality have increased among people. Now farmers are cultivating number of crops with high yield varieties of seeds. They get money in short period but the health and land fertility aspect ignored. The farmers do not get guidance from researchers and agriculture economists. Therefore, it is right time to manage and transform all farmers from traditional farming to complete organic farming.

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