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Effect of Fertilizers and Pesticides on Agricultural Production of West Bengal During 2001-02-2012-13: An Empirical Analysis

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ABSTRACT

It is well established that fertilizers & pesticides increase agricultural production. Many research works have been made on the environmental aspect of fertilizers & pesticides. In this paper, author has made an attempt to assess the impact of fertilizers and pesticides on agricultural production of West Bengal during 2001-02-2012-13 with the help of multiple regression analysis (along with ratio analysis & theoretical study). Regression analysis clearly indicates that fertilizers and pesticides bear negative relationship with agricultural production.

Introduction

The importance of fertilizers and pesticides for agricultural production is proved & needless to emphasize. The point is how far these inputs supported by latest available technologies would be able to produce more agricultural production in order to serve increasing global population. At the same time, the harmful effects of fertilizers and pesticides on environment has been proved, thus it becomes very important to make a balance between the demand of agricultural production and application of fertilizers and pesticides.

Objective of the Study

In this paper an attempt has been made to assess the impact of consumption of fertilizers and pesticides on agricultural production of West Bengal, a State of India.

Review of Literature

Today, use of fertilizers is seen as a necessary agricultural technology[1]. Because soil can restore nutrients[1]. However, firstly soil analysis should be performed carefully[1]. After then, fertilizer should be given to soil[1]. The structure and chemical content of the soil should be identified and the most appropriate type of fertilizers should be selected[1]. The most suitable method should be processed[1]. Otherwise, the fertilizer should be noted that errors will result in the loss of both energy and finance[1]. Fertilizing should be done in time, should not be inappropriate times[1].

Modern agricultural practices use many kinds of chemicals such as fertilizers, pesticides, cleaners, crop preservatives to produce and keeping large amount of high-quality food[2]. But every single of these chemicals has dangerous and unforeseen side-effects as like toxicity to non-target organisms which causes to ecological imbalance[2]. As described on the top, wrong agricultural practices cause to environment pollution in important dimensions[2]. In other words, agricultural technical especially modern technical could make environment pollution in the event unless human would sensitive[2]. For this reason, humanity developed a new perspective to decrease the negative effects of agriculture[2]. Sustainable agriculture which is a

new agricultural technique seems environmentally friendly and it is supported by developed countries[2]. Environmentally friendly agriculture has three common applications[2]. These are good agricultural practices, organic agriculture and precision agriculture[2].

Our approach to the use of pesticides should be pragmatic[3]. In other words, all activities concerning pesticides should be based on scientific judgment and not on commercial considerations[3]. There are some inherent difficulties in fully evaluating the risks to human health due to pesticides[3]. For example, there are a large number of human variables such as age, sex, race, socio-economic status, diet, state of health *etc.* – all of which affect human exposure to pesticides[3]. But practically little is known about the effects of these variables[3]. The long-term effects of low-level exposure to one pesticide are greatly influenced by concomitant exposure to other pesticides as well as to pollutants present in air, water, food and drugs[3].

Pesticides are often considered a quick, easy, and inexpensive solution for controlling weeds and insect pests in urban landscapes[3]. However, pesticide use comes at a significant cost[3]. Pesticides have contaminated almost every part of our environment[3]. Pesticide residues are found in soil and air, and in surface and ground water across the countries, and urban pesticide uses contribute to the problem[3]. Pesticide contamination poses significant risks to the environment and non-target organisms ranging from beneficial soil microorganisms, to insects, plants, fish, and birds[3]. Contrary to common misconceptions, even herbicides can cause harm to the environment[3]. In fact, weed killers can be especially problematic because they are used in relatively large volumes[3]. The best way to reduce pesticide contamination (and the harm it causes) in our environment is for all of us to do our part to use safer, non-chemical pest control (including weed control) methods[3].

The small amounts of pesticides that remain in the food supply will cause no immediate reaction but could cause health problems if routinely consumed over a long period[4]. An answer to this is the bio fertilizers, an environmentally friendly fertilizer which is being used in many countries[4]. Hence, there is an urgent need to transfer this technology on the farmer's field and in to an industry by producing these fertilizers on large scale[4].

Chemical fertilizer is known to be one of the most important inputs of fertilizers in agricultural production[5]. When it is applied inadequate, rates of productivity and quality are caused significant losses[5]. When it is too much applied, it causes air pollution by nitrogen oxides (NO, N2O, NO2) emissions[5]. Nowadays, there are some gases in the atmosphere namely water vapor, carbon dioxide, methane, hydrogen sulfide (H2S) with chloro-fluoro hydrocarbons, such as halon gases associated with these compounds[5]. These gases are contribution to the greenhouses effect[5].

The unintended environmental consequences of intensive agricultural practices and inputs are varied and potentially severe[6]. In some cases, sustaining or increasing agricultural productivity depends upon reducing impacts to the environment, such as maintaining productive soils by avoiding salinization from irrigation water[6]. In other cases, however, eliminating negative environmental impacts may involve unacceptable tradeoffs with providing food and viable livelihoods, or other development goals[6]. Determining the appropriate balance of costs and benefits from intensive agricultural practices is a location-specific exercise requiring knowledge about, and a valuation of, natural, economic, and social conditions[6].

Fertilizer is one of the major inputs in the agricultural production[7]. In order to meet the food requirements of the country Government has encouraged the use of chemical fertilizers by subsidizing the chemical fertilizers in the early years of independence[7]. After attaining the food subsidy, the policy is oriented towards attaining sustainability in agriculture sector[7]. Present study has analyzed the trends in the fertilizer consumption and food grain production in India[7]. The major finding of this study is that there is a long run relationship between fertilizer consumption and food grain production in India[7]. Due to this, the fertilizer consumption increased at a higher rate in the early years[7]. With the introduction of new agricultural policy where greater emphasis is given on promotion of organic cultivation, there is a considerable reduction in the growth rate of chemical fertilizer consumption after 2000-2001[7].

There are many technologies and techniques such as: Integrated Pest and Nutrient (IPNS) which is near to organic farming[8]. Among them vermi-compost and botanical pesticides have been found easy and adoptable means of chemical free farming while comparing the people's perception and practice from last three years in Rupandehi and Nawalparasi districts[8]. This research measured the effect of both organic means; botanical pesticide and vermi-compost on perception of farmers and its adaptation concerning to yield, cost of production and raw material availability[8]. The result indicated farmers changing practice in vegetable farming as 100 percent of farmers started to adopt Integrated Pest and Nutrient Management (IPNM)

practices which further moved towards chemical free vegetable farming system[8]. It was found that 45% and 60% of people adopting botanical pesticide and vermi-compost respectively[8]. About 83.3% of the farmers seemed to be motivated to the required level[8]. In case of vermi-compost, farmers were found comparatively more motivated than that of botanical-pesticides[8]. From the survey we can say that about 20% farmers felt high risk of losing crops if they followed only organic farming[8]. This could be attributed to insecurities of farmers towards vermi-compost and botanical pesticides[8].

The yield trends observed so far showed that lower rates of application of pesticides may be more desirable as they reduce the pesticide burden on the environment and are more economical as far
as cost of pesticides is concerned[9].

The study recognizes that education is important for improving farmers' awareness regarding health implications of agrochemicals use[10]. It is therefore recommended that field training and practical educational programs on good and safety use of agrochemicals should be adopted by agencies to raise farmer's awareness level of the risk associated with agrochemical use[10]. The use of the mass media has shown to be effective in educating and creating awareness[10]. Intervention to increase farmer's awareness of health implication of agrochemicals use in the study area should consider interactive radio programs in local languages[10]. Also, health implications of agrochemical use should be incorporated into our education curriculum[10]. Lastly, farmers should be educated on the importance of adhering to safety standards of agrochemical use as it increases maize output[10].

Application of pesticides and fertilizers in agriculture has several benefits which range from yield increase of agricultural crops and soil fertility to pest management and crop protection[11]. Cultivated crops are challenged with several biotic (weed, insect and pest infestation) and abiotic stresses (reduced soil fertility) which are managed by extensive use of fertilizers and pesticide[11]. The application of these agrochemicals has resulted in increased soil fertility and insect/pest management with consequent yields of crops during the last 40 years[11]. Studies indicate that fertilizers and pesticide use in agriculture have been substantially increased both in developed and developing countries in recent years for attaining maximum yields of crops[11]. Nevertheless, there is a growing concern worldwide over the use of synthetic fertilizers and pesticides in agriculture because of their toxicity to human, environment, and ecosystems[11].

A new, significant area of work will also open up for agricultural research[12]. Great emphasis will be placed on fundamental research as well as issues of applied research; existing technologies need to be further developed and optimized and adapted to local environments[12]. Key areas that need to be addressed when it comes to introducing sustainable intensification of cropping systems include[12]:

(i)Improving the quality of soil humus content and its humic acid composition by managing and controlling composting processes[12].

(ii)Developing mechanical, chemical, microbiological and organic processes to solubilize phosphate rocks for small-scale mineral fertilizer production facilities as an alternative to the large-scale processes that use sulphuric acid to make superphosphate[12].

(iii)Developing cropping systems which not only achieve high yields but also fix sufficient quantities of nitrogen so that the synthetic version can be dispensed with (leguminous underseed, mixed cultures, agroforestry systems)[12].

(iv)Optimizing composting processes for domestic urban waste and analyzing the fertilizing impact of this material[12].

(v)Developing processes to recycle human faces back into agricultural land use systems[12].

In the paper it was shown how the use of pesticides affects agricultural sustainability through several externalities[13]. One externality that was shown to affect agricultural productivity was the development of resistance of targeted pests of pesticides[13]. Pesticides reduce pest infestations and chemical control creates disequilibrium in the agricultural system[13]. Not only does the control of pests become unsustainable, but it also extracts an environmental penalty[13]. The health costs of pesticide use are also high[13]. The prevailing agricultural system has 'locked in' farmers in the system of pest control technology which has resulted in their 'entrapment' in pesticides[13].

The use of agricultural chemicals has increased greatly in the prairie region[14]. Pesticide use increased 7.6 percent per year from 1948 to 1991, slowing down only after 1985 with depressed conditions in the grain economy[14]. The relatively rapid growth in agricultural chemical use in prairie agriculture over the past four decades is clearly evident, especially in the period from 1971 to 1985[14]. However, since 1985, pesticide use has been relatively stagnant[14]. The average productivity of pesticides has generally declined over time, particularly since the early 1970s, as pesticide use accelerated and diminishing returns in pesticide use occurred[14]. Estimated aggregate production functions for prairie agriculture and the prairie crop sector provide crop output elasticities with respect to pesticide use[14]. They range from 0.43 to 0.89 under different production function specifications over the time period from 1971 to 1991[14]. The estimates in general imply a relatively high degree of responsiveness of output to pesticide use[14]. However, it is difficult to accurately separate the effects of pesticides from the effects of other inputs, especially when pesticides are part of a wider and more intensive technological package[14].

There is a significant association between mass inorganic fertilization and technological non-advancement, a lack of scientific knowledge, a shortage of proper information, and smallholder farm size[15]. Gains in crop yield and higher earnings are positively correlated with intensive fertilizer use[15]. The socio-economic conditions of Bangladesh lead to broadcasting significant amounts of fertilizer[15]. Researchers have developed urea super granules (USG) technology suited to Bangladeshi agriculture, but its adoption rate is very low as it is a labor intensive and time-consuming technology[15]. Farmers cannot apply it, in consideration of their low turnover[15].

The agricultural growth experience of India since Independence was essentially an outcome of the massive efforts aimed at ensuring availability and use of quality seeds, chemical fertilizers, irrigation, pesticides, farm machinery and equipment, agricultural credit, etc[16]. Quality seeds are crucial for enhancing agricultural production[16]. It is estimated that quality seeds contribute to around a quarter of the overall increase in productivity[16]. Efficacy of all other agricultural inputs, such as fertilizers, pesticides and irrigation, etc., as well as impact of agro-climatic conditions on the crop, is largely determined by the quality of the seed used[16].

One-third of 6,000 amphibian species worldwide are threatened[17]. Besides habitat loss, overexploitation or introduced species, amphibians are affected by the pollution of surface waters with fertilizers and pesticides from agriculture (IUCN 2009)[17]. In the USA, spray drift of hexazinone, a triazine herbicide, was considered" likely to adversely affect" the endangered red-legged California frog and its habitat (US EPA 2008)[17]. Atrazine is moderately toxic to some fish species. It can indirectly affect aquatic ecosystems by damaging aquatic plants[17]. A review concluded that further study is needed on the potential hormonal effects of atrazine on frogs or fish (US EPA 2006)[17]. In Europe, the authorization for atrazine has been withdrawn due to health and environmental risks (EC 2003)[17]. Urea herbicides such as isoproturon and diuron often contaminate rivers, lakes, and groundwater[17]. Most breakdown products of diuron were more toxic to cellular microorganisms than the parent compound (Bonnet *et al* 2007)[17]. Fungicides based on copper are highly toxic to aquatic organisms[17]. In fish and some other aquatic organisms, the risk of copper accumulating may be high (EFSA 2008)[17]. The EU aims eventually to eliminate copper in organic vineyards and apple orchards (REPCO 2007)[17].

The future historians will be amazed to know that for killing of few unwanted species we contaminated the whole environment[18]. That is why Rachel Carson in her Classic book "*Silent Spring"* says that "The chemical war is never won and all life is caught in its violent crossfire" (Carson, 2002, p. 8)[18]. The greatest weaknesses of Indians are food but have we ever thought that the food we are consuming today has been adulterated with pesticides. We are blindly ingesting these cocktails of poisonous chemicals[18]. The amount of pesticide in our food is way more than an average American or a European diet[18]. Humans have been most affected by pesticides[18]. Hence let us not pass on this pesticide poisoning to our next generation[18]. Since the effects of these chemicals on the environment are not evident that easily, perhaps that is the reason why we fail to check on their adverse Pesticides Use in Question: An Indian Perspective 7435 effect until a threshold level is reached[18]. Agriculture production is possible without using any pesticide and we must work towards building the world without pesticide[18]. The pesticide-free world is definitely a possibility but the only needed is commitment and desire[18]. We all now know that we have that power to destroy nature but instead, can we use nature to help us live a sustainable life[18]. So the question is do we want this country to be a sick nation or a healthy one[18]? The choice is ours[18]. This frightening truth about the poisoning of India may not have easy solutions but the longer we take to find solutions the shorter will be our lives[18].

With changing farming technologies, farmers are increasingly following input intensive agricultural practices[19]. However, greater use of modern inputs like chemical fertilizers does not necessarily result in sustainable growth of agriculture sector, particularly in respect of production and yield[19]. Empirical evidences from Hooghly district of the Indian state of West Bengal show that greater use of chemical fertilizers, has failed to enhance agricultural production and yield[19]. It is also found that agricultural production has fluctuated in the area possibly due to use of N–P–K fertilizer (N-P-K stands for "nitrogen, phosphorus, and potassium) in inappropriate composition and application of these chemical fertilizers beyond the assimilative capacity of soil[19]. Improper use of chemical fertilisers seems to have caused environmental degradation and erosion of soil fertility as well[19]. Greater crop diversification in the district has also enhanced use of more chemical fertilizers further[19].

Increased per capita income as well as increasing participation in primary sector in river bank districts may have a direct linkage with the cropping pattern, fertilizer usage and irrigation practices in these places[20]. Tendency to grow high yielding variety crops may lead to more usage of water[20]. There may also be a tendency to use more pesticide and fertilizers indirectly posing a threat to the river ecosystem[20].

Methodology

This study is based on empirical analysis & theoretical study. Empirical Analysis is based on fitting multiple regression equation & ratio analysis. In multiple regression equation, an attempt has been made to estimate effect of fertilizer consumption (x_1) & pesticide consumption (x_2) on agriculture output (y) of West Bengal, an Indian State with the help of following equation (Please See Table One):

$\hat{y}=a+b_1x_1+b_2x_2$……………………………………(1)

Where, x_1 and x_2 are independent variables and y is dependent variable. b_1 and b_2 are slopes associated with x_1 and x_2 respectively and a is y-intercept.

Normal equations:

$\sum y= na+b_1\sum x_1+b_2\sum x_2$……………………………………(2)

$\sum x_1y= a\sum x_1 +b_1\sum x_1^2 +b_2\sum x_1x_2$…………………………(3)

$\sum x_2y =a\sum x_2 +b_1\sum x_1x_2 +b_2\sum x_2^2$…………………………(4)

Here, n=number of data points in the sample

Putting figures from Table One these equations were solved.

a=165.82

b_1= -0.000002438

b_2 = -0.00076

Putting these values in equation (1) it could be written

$\hat{y}=165.82-0.000002438_1x_1-0.00076x_2$

Now, Standard Error of Estimate could be found using the following equation:

$S_e =\sqrt{\sum(y- \hat{y})^2/(n-k-1)}$

Here, k= number of independent variable

s_e is found using figures from Table One

s_e =±5.082

Two ratios namely food production/ fertilizers consumption and food production/ pesticides consumption were found using figures in Table Three. For empirical analysis data collected from official website of Government of West Bengal[1].

For theoretical study several journals were consulted and references of these journals have been given in reference section.

Results and discussion

The slopes of regression equation are negative (b_1 = -0.000002438; b_2 = -0.00076). It simply indicates a negative relation between agricultural production (y=dependent variable) and fertilizer (x_1=independent variable) & pesticide (x_2=independent variable) consumption. Although the negativity of the slopes is not so high but it is an alarming situation. However, as per regression equation if independent variables viz. fertilizer (x_1) & pesticide (x_2) are zero, estimated agricultural production ($\hat{y}$) would be 165.82 lakh MT. It means even if fertilizers and pesticides are not applied agricultural production would be 165.82 lakh MT. It is to be noted that Standard Error of Estimate (s_e) is quite high (s_e=±5.082). Ratio analysis (Table Three) clearly indicates that benefits from fertilizers and pesticides have decreased over the period (2001-02-2012-13).

Theoretical study reveals lot of valuable information. Research report strongly suggests that chemical fertilizers or pesticides cause massive damage on environment. Organic fertilizers may be treated as a viable alternative to chemical fertilizers. Awareness of farmers has been proved pivotal in applying fertilizers in appropriate composition and also shifting towards environment-friendly organic fertilizers. At the same time, study reports are showing that application of fertilizers and pesticides has been proved immensely beneficial to mankind in terms of increase in agricultural output. It is expected that proper attention to be given on research on agriculture.

Conclusion

Empirical results clearly indicate that in West Bengal, during the study period (2001-02-2012-13), consumption of fertilizers and pesticides have negatively affected production of food grains in India. This result is extremely significant and need urgent attention of policy makers. Theoretically study reveals that generally fertilizers and pesticides affect positively production of food grains. Theoretically study also reveals that use chemicals cause huge damage to environment. This paper is based on secondary data. This paper did not take into consideration many important factors viz. rainfall, quality of seeds, agricultural credit, flood, draught etc. which deeply influence agricultural production of West Bengal. This result is quite significant. It is recommended that Government of West Bengal may constitute a research team composed of eminent scientists from relevant fields with adequate experience in this area. A proper scientific investigation is required in this area.

Scope for Further Research

A study based on field work (primary data) after taking into consideration all relevant factors may produce better results.

About the Author(s)

Author is teaching in Jogesh Chandra Chaudhuri Collegefor last 20 years since 2001. His research areas include Accountancy, Financial Management, Marketing Management, Banking, Sustainable Development, Agriculture, Women Empowerment etc.

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