CHAPTER 3: REVIEW OF RELATED LITERATURE

To shed light on many concerns and facts about fertilizer pricing policies, this chapter explores various empirical research in relation to the influence of changes in fertilizer prices on consumption, production, and cropping pattern.

3.1 Introduction

In order to increase agricultural productivity, the New Agriculture Plan gave great attention to the use of "essential inputs," such as irrigation, fertilizer, and HYV, with a focus on the use of chemical fertilizers in particular. Realizing the importance of chemical fertilizers in augmenting agricultural production, the government has come out from time to time with more conducive policies mainly to promote fertilizer use in the cultivation of all crops across all regions, leading to a spectacular increase in the fertilizer consumption from 69, 8000 tons in 1950- 51 to 414.41 Lakh MT in 2016-17.

If one observes the trends in fertilizer consumption over a period, it becomes evident that there was a sharp decrease in consumption levels in the 1970s, when prices shot up in the face of the oil crisis. However, Later, in 1977, a sharp increase was noted in the consumption of fertilizers when the government extended support to the fertilizer sector in the form of subsidies, particularly with a view to making it more affordable to the poor farming community. The use of fertilizers in the 1990s later increased significantly because of this. However, the new economic policies re-examined the policy of maintaining subsidies to the fertilizer sector, and eventually, a reduction in fertilizer subsidies in a progressive way was proposed, leading to changes in fertilizer prices in the subsequent year. Several social groups strongly objected to the price changes for fertilizer, claiming that they would negatively affect fertilizer use, agricultural output, crop patterns, agricultural revenue, and especially the poor and marginal farmers. The decision to stop providing fertilizer subsidies and the subsequent rise in the price of such products sparked intriguing debates, arguments, and conclusions. Arguments in favor of an increase in the fertilizer prices were on the contention that it was leading to wasteful consumption causing environmental and other problems, while, arguments against an increase in fertilizer prices were on the ground that the small farmers would be affected thereby their production and yield and that as soil fertility had got reduced over the years because of sustained cultivation of lands, it was necessary to restore soil fertility by the application of

fertilizers and hence necessary to promote its use at affordable prices. Further, the policy of decontrolling P and K has seriously distorted the nutrients use ratios and inclined towards N which is relatively priced less.

A quick review of the relevant literature would help shed light on a variety of topics, including the role of fertilizers in agricultural development, fertilizer subsidy, balanced use of fertilizers, factors influencing fertilizer consumption, increasing fertilizer use efficiency, the role of fertilizers in determining output levels, farming practices, and the impact of fertilizers. This chapter attempts, through a variety of empirical research, to explore numerous topics relating to the impact of changes in fertilizer costs on consumption, production, and cropping patterns. The following subheads represent a review of the literature organized by topic.

3.2 Factors Influencing Fertilizers Consumption

Nitin Sharma, et al (2023) collaborative work tries to explain that as other resources like land and water are under critical strain, fertilizer must play a significant role in the enlargement of agricultural output in the future. Their work demonstrates that the growth trend in NPK consumption in Haryana across four divisions, during period-I, period II, and period III was found positive except for phosphorus in period III. Among all the fertilizers, higher growth was observed in potash and has the highest variability as compared to other fertilizer nutrients. The variability in consumption of different nutrients (N, P, and K) in Haryana has shown that during periods I, II, III and overall nitrogen consumption was steadier, while potash consumption was highly unsteady during all the periods.

Dhanai, Negi & Singh (2019) this paper summarizes the results of an adoption study conducted between 2014 and 2016 in the district Rudra Prayag, Uttarakhand, to determine the level and extent of adoption of selected technologies. This study aimed to identify the reason for low adoption rates and policy lapses in the adoption of technologies for the future conduct of research and research-extension linkages. A sample of 604 households from 64 villages was randomly selected from three different blocks of the district to determine the distribution of adoption of the technologies. Semi-structured questionnaires and interview methods were used to collect the primary data and survey questions were used to identify the factors that affect farmers' decision on adopting technology. The adoption rate was highest for the cases of inorganic fertilizer (52.21%), improved seed (19.48%), bio/vermicompost (11.03%), polyhouse (9.93%), and water harvesting tank (6.99). The high rates of adoption may be due

to the extensive diffusion of technology. The results of the logistic regression model show that the age and education of household head (HHAge and HHEdu), land size (TLand), institutional support for adopting the new technology (InsSupp) and farmers' cosmopolite ness (Cosmopo) are the main determinants of the adoption of new farm technology. The model shows that after keeping the other variables constant, the effect of variables such as age and education of the household head, area of agriculture land, institutional support, and cosmopolites, favors adoption. This study will assist the policymakers to develop and extend area-specific suitable technology with proper technical know-how for higher extension and adoption of the technology.

Chittaranjan Nayak (2018) Despite the rapid increase in the consumption of fertilizers in India, the domestic production has not increased at par. There has been an increase in imports of fertilizers and feedstocks. He says that there is an increase in import prices of urea, phosphoric acid, ammonia, and Sulphur, whereas the gate prices have not been revised continuously. So, the subsidy amount has increased. He later suggests that to achieve the fiscal consolidation, the Government should target the subsidy in a better way, like urea pricing can be decontrolled and steps should be taken to ensure that subsidies are given only to small landholders. The identification can be done through the digitization of land records and only the small and marginal farmers may be listed for the benefits of fertilizer subsidies.

Sunny, Huang & Karimanzira (2018) Proper nourishment is fundamental for satisfactory crop growth and production. However, for efficient crop production, it is important to understand the soil environment, recognize the limitations of that environment, and ameliorate them where possible without damaging the soil quality. Soil Testing and Fertilizer Recommendation Facilities (STFRF) can help farmers to achieve environmental and economic sustainability by assisting them in recognizing their soil condition, reducing agrochemicals usage, using an appropriate amount of fertilizer, minimizing input costs, and achieving higher yield. These facilities are not new in the context of Bangladesh, yet the adoption rate among farmers is low and its determinants have rarely been empirically tested based on micro-level data. Therefore, this study examined those factors underlying the adoption of soil testing and fertilizer recommendation facilities using field surveyed data of 176 individual farmers. Our evidence shows that young farmers with less farming experience are more likely to adopt these facilities. Additionally, small-scale farmers, higher education, having more farming income, and having more knowledge about these facilities and the fees of these facilities were found to have a

significant effect on the adoption. On the other hand, gender, land ownership, and secondary income were found to be insignificant about the adoption of soil testing and fertilizer recommendation facilities. Our results also revealed that most adopter farmers not only focused on profitability but were additionally concerned with environmental well-being.

Goswami, Choudhary & Bisht (2017) Crop diversification is an important strategy for overall agriculture development in the country. The present study was an attempt to identify the factors affecting crop diversification in Uttarakhand state of India. The present study is based on primary data. A multistage stratified random sampling technique was followed to select 45 farmers from the hill region and 30 farmers from the plain region. Multiple linear regression was used to examine the factor affecting crop diversification. The major factors responsible for the change in crop diversification were fertilizer consumption, gross irrigated area, road length, mechanization, and certified seeds, at districts, divisions, and state levels. In the case of farm households age of the household head, size of farm households, distance to market, off-farm/non-farm income and fertilizer effects crop diversification. The creation of basic infrastructural facilities is an essential prerequisite for crop diversification and fostering the process of agricultural development.

Hosein, Moarefi & Nojavan (2017) Pollution by fertilizers containing nitrogen is one of the most significant sources of water pollution, and the agriculture sector has a considerable share in this type of pollution. In this study, factors affecting the level of contamination of surface and underground water resources by agricultural activities were examined. Data of 254 wheat farmers in the plain of Mashhad in Khorasan Razavi province in Iran were used for investigating the effect of some explanatory variables on the level of water pollution utilizing Ordered Logit Regression Model. The results show that main activity of farmers, years of experience, the level of education, awareness of organic farming, level of income, price of fertilizers and irrigation method have significant effect on the number of fertilizers utilized by farmers and hence the level of water resources pollution. Efforts for decreasing pollution of water resources require strategies such as changing the main activity of farmers, increase the cost of using chemical fertilizers, create economic incentives for organic farming, and increase general information and knowledge of farmers.

Nasrin & Bauer (2016) Government of Bangladesh follows a universal subsidy policy and implicitly subsidizes the fertilizer market to keep prices within the purchasing capacity of farmers. The study aims to explore farmers' perceptions of the fertilizer subsidy policy and to

estimate the influence of determinants that affect farm-level fertilizer usage in Bangladesh. 299 respondents from three parts of the country were surveyed to gather primary data. They were divided into four categories according to the size of their farms: marginal, small, medium, and big 1. The study uses both descriptive and econometric techniques to reach its objectives. When it comes to farmer opinion, around 72% of studied marginal farmers don't know that the government offers significant subsidies on the fertilizer market, which is primarily because of inefficient extension services. Overall, only 31 percent of farmers were satisfied with current policy and market prices which highlights uneven distribution of subsidy benefit. According to ordinary least square regression, the amount of fertilizer used by various farm size groups is significantly influenced by output prices relative to the fertilizer price farmers receive, off-farm income, labor utilization, and extension services. Farmer's financial conditions and their purchasing capability are crucial in deciding about the amount of fertilizer to be used. Based on research findings, it was recommended that policy makers should revise the subsidy policy to reduce the distortions of resource allocation and also to secure the welfare of the farmers.

Amaliyar & Singh (2016) a study was conducted between February 2016 and May 2016 on a sample of 200 farmers selected on convenience from 20 villages of four talukas of Anand and Narmada districts of Gujarat. Primary data were collected by survey method on pretested semi-structured schedules, and appropriate tools were used to analyze data. The findings suggested that about 90 per cent of farmers in the Narmada district used Water Soluble Fertilizers (WSFs). More than 80 per cent of farmers used Calcium Nitrate and NPK (19:19:19) grade of WSFs. The annual market potential of water-soluble fertilizers in the Anand and Narmada districts came out to the tune of Rs 14 crore and Rs. 50 crores, respectively. In Anand, GSFC was the leading company and in Narmada, Nagarjuna was leading in the sales of WSFs. Most farmers were using WSFs for more than seven years. Around 31 per cent of farmers in Anand and 59 per cent of farmers in Narmada District used drip irrigation method on their farms. On the other hand, 52 per cent farmers in Anand and 18 per cent farmers in Narmada did foliar application of WSFs. About 55 per cent of farmers preferred to purchase WSFs from local retail shops. At the time of purchase, the experience highly affected the farmers. Satisfaction level towards using WSFs was high among farmers as they found that WSFs application gives high yield, and small quantities of these fertilizers are sufficient, making it economic for the farmers.

Singh (2013) The author's study work concentrated on the role that chemical fertilizers had in enabling the country to produce enough food grains on its own. Research has been conducted on issues such India's demand for and supply of fertilizer, consumption trends, and growth determinants. According to the author, both price and non-price factors (better seeds, irrigation, and finance) have an impact on the demand for fertilizers. According to the study, non-price factors (better seed, irrigation, and finance) have a greater influence on increasing the demand for fertilizers than price factors.

Muchai et al (2013) analyzed the influence of education levels on dissemination of soil fertility management information in the central highland of Kenya. A cross-sectional survey approach was used to collect data by using a schedule consisting of both open ended and close ended questions. The result shows that the most used SFM practices are crop rotation, animal manure etc. Use of compost and green manures are the least used technologies. The majority of the farmers had attained primary education (59.6%). The major findings of this study show that education is quantitatively important in predicting the dissemination of soil fertility management information. Extension agents showed interest in increasing their communication with farmers, mainly with more educated farmers.

Guruswamy & Kubendran (2012) Organic farming is one of the production systems of agriculture. It relies upon crop rotations, crop residues, animal manures, legumes, green manures, and off-farm organic wastes. It excludes all chemical fertilizers and pesticides. In India, only less than 2% farmers are practicing organic farming. Organic farming growth is losing ground and existing farmers are withdrawing from the practice. Hence a study on growth issues was taken. The objectives of the study are to study the major factors affecting the growth of organic farming practices and to arrive at required solutions to overcome the above issues. Survey was done in person with a structured interview schedule regarding growth issues of organic farming from sample organic farmers of Tamil Nadu. Collected data was compiled and tabulated. For those factors which affect the growth of organic farming, intensity values were calculated and ranked. Organic farmers' suggestions were collected and compiled. A category of farmers was made, and cross-tabulation analysis was done. Hypothesis were formulated and tested. Kendall's Coefficient of Concordance test was applied. The analysis reveals that the different land-holding categories of organic farmers rank the issues differently. It was concluded that organic farming requires effective planning and implementation of

various measures and support from the Government and the Universities for the growth of organic farming as well as to attract more farmers to switch over to organic farming practices.

Okoboi and Barungi (2012) illustrated the challenges, including low productivity due to declining soil fertility, faced by Uganda's agriculture. The study used data from the Uganda Census of Agriculture 2008/9 to provide insights into the unknown constraints of not utilizing organic and inorganic fertilizers. The bivariate probit model was used to estimate the maximum likelihood method. The estimated coefficients of the regression were reported as marginal effects. Explanatory variables with continuous values were transformed into natural logarithms to make the data normally distributed and/or their variances homogenous. In particular, the values of the following variables: years of education, distance to market, and distance all-year gravel road, were transformed into natural logarithms. The econometric results of the bivariate probit regression demonstrated that most of the farm-households use inorganic fertilizers and apply organic fertilizers. Regarding factors influencing adoption of fertilizer, lack of knowledge on the use of and market information on fertilizer due to limited access to fertilizer-specific extension services were found to be perhaps the most limiting factor irrespective of fertilizer type. Low access to credit and constrained access to input and output markets due to distance were also key constraints to fertilizer use. Household characteristics including education level, household size, share of adults in the household, and ownership of livestock/poultry also stand-out as influencing factors on fertilizer adoption decisions. Results suggested that targeted interventions including extensive and intensive extension training and visits, and access to affordable credit will be pertinent in the promotion fertilizer use in the country.

Teka (2012) empirically investigated variables impacting Bahir Dar ZuriaWoreda's smallholder farmers' use of fertilizer (specifically in Robit and Gonbatkebeles). A structured questionnaire was utilized to obtain the primary cross-sectional data. A three-stage random selection approach was used to choose 100 sample respondents from each of the two kebeles, one farmer's agricultural cooperative, and two kebeles. The analysis section of the paper used econometric analysis and descriptive statistics. The descriptive statistics show that less fertilizer was used than recommended in the research region. With the aid of a multiple linear regression model, the variables affecting respondents' fertilizer usage were identified. There were 10 explanatory factors in all, however only 5 were found to be statistically significant. Revenue from conversation, interactions with extension agents, the respondent's saving habits

(all of which are favourable), and loan availability have a negative effect on fertilizer use based on these various livestock holding levels. The study suggests that, in light of its findings, some of the most important areas for policy prescription in the promotion of yield-enhancing technologies in agriculture include strengthening the livestock sector, encouraging saving habits, improving extension projects and farmers' habits of extension contact, strict follow-up in the utilisation of credit, and reallocating resources to chat production.

Beshir et al (2012) In two areas of Ethiopia's southern Wollozone region, the factors impacting the likelihood of adoption and amount of use of inorganic fertilizer were assessed. In order to investigate the relationships among farmers' physical attributes, market access, socioeconomic and institutional background, and likelihood and intensity of using inorganic fertilizer, the study used cross section data. A double hurdle model was run using information acquired from 252 randomly selected farmers between July 2009 and November 2009. The primary data were supplemented with additional information. Only 29.6% and 19% of the total cropland that was cultivated, respectively, was utilized in South Wollo and Ethiopia, according to the research. The econometric results of the study provided empirical evidence of the beneficial effects of extension and credit services, age, farmland size, education, livestock, off-farm income, and gender on encouraging the adoption of inorganic fertilizer. Because inorganic fertilizers save time and money on transportation, physical variables such as the distance between farmers' houses and markets, highways, financing options, and sources of input supply were important in the adoption of these products. The study's conclusions indicate the need to raise the frequency and intensity of inorganic fertilizer application in order to meet the top priorities of smallholder farmers and to address the problem of the nation's overall and local food scarcity.

Sharma and Thaker (2011) In their research report, the authors found that although chemical fertilizers have been crucial in helping the nation become self-sufficient in the production of food grains, there is still a significant imbalance between the supply and demand for fertilizers. Future demand forecasting is necessary, as is expanding the capacity for fertilizer usage. The authors looked at several factors that either directly or indirectly influence fertilizer consumption. The study concluded that, when compared to the price factor, non-price factors (better seeds, irrigation, and credit) have a greater impact on fertilizer demand. The government should therefore pay more attention to non-price factors. Infrastructure has to be upgraded, agricultural research and development programs should be prioritized, and irrigation funding should be increased to boost productivity.

Taya (2011) A summary of the fertilizer industries' current state and fertilizer regulation were provided in his paper, "Competition Assessment of Fertilizer Sector: India" (in India). After obstacles and issues in the fertilizer sector, the author added a study of the sector covered by Porter's Five Forces. According to him, the government's regulations, which mostly focus on restrictions over fertilizer pricing, distribution, and transportation, have had a significant impact on the growth of the fertilizer industry in India.

Narkhede et al (2011) made comparative analysis on "effect on chemical fertilizers and vermicompost on growth of chili pepper plant". It was found from study that use of vermicompost is more effective than use of chemical fertilizers to growth and development of plant. Vermicompost not only strengthens soil fertility but also increases production.

Muthusamy & Karpagalakshmi (2011) in their research paper studied sales trend and cost component of Indian private fertilizer company. It was found from the analysis that power and fuel cost are the most influencing factors in the cost structure of Private Fertilizer Company.

Badugu & Chauhan (2011) in their Paper mentioned that majority of India's population lives in rural area. Today rural India has huge untapped marketing opportunity. Rural market of India is rising by leaps and bounds. So, there is need to understand the Indian rural market potential. It was found that the brand, size of the product, price of the product and the product features are important factors which influence rural consumers' purchasing decision. Researchers identified the 4A approach (availability, affordability, acceptability, and awareness) are major challenges for companies which need to be concentrated.

Thuo et al (2010) Observed the steadily dropping agriculture output in Senegal's Peanut Basin, which calls for deliberate efforts to buck the trend. The use of fertilizer and the proportion of land used for fertilizer use (intensity) in the production of peanuts and millet were examined using econometric methods such pooled cross-section time-series data and Probit and Tobit models. The findings demonstrated that the likelihood of applying fertilizer rises in areas where household heads have higher levels of literacy, larger families, and larger farms, but falls in areas where they earn a living off-farm. The amount of rainfall was also strongly correlated with the type of fertilizer used, which varies by region. According to the analysis, peanut and millet farmers used less fertilizer over the study period of 1998–2005, both in terms of adoption and intensity. The results revealed that a sensible policy choice was to concentrate on market-oriented interventions that encourage farmers to invest in more advanced agricultural

technologies.

Adeola (2010) in a study "Influence of socio-Economic Factors on the adoption of soil conservation measures in Ibadan/Ibarapa agricultural zone of Oyo state", analyzed the factors that influence the adoption of soil conservation in Nigeria based on primary data. To bit Regression model was used for analysis. The study shows that the main soil conservation measures in the study area are contour ridging, cover crops, and mulching, contour vegetative hedges of vetiver, multipurpose tree hedgerous and minimum tillage. Educational level, contact with extension agent, farming experience and farm size were the socio-economic factors found to have significant influence on the adoption of soil conservation measures among the farmers in the study area.

Shetty et al (2010) had conducted intensive survey involving 1039 farmers belonging to 28 districts in 12 Indian states which were carried out in pesticide use predominant regions to study the influence of farmer's awareness, education and practices related to pesticide use as well as Integrated Pest Management (IPM) measures. Data were gathered by trained field investigators using pre-tested routines, and the results were analyzed using the appropriate statistical software. The results revealed that though overall consumption of pesticide decreased, the expenditure incurred on pesticides remained high. Most of the respondents in the surveyed area followed their own spraying schedules and pesticide doses to manage ever increasing insect pests and disease problems. More than 50 per cent of the respondents applied both single and cocktail pesticides to manage their crop pests. A greater number of the literate farmers had strong perception of the negative impacts of pesticides on soil, water, air, and beneficial organisms. Only 20 per cent of the respondents obtained their information on the plant protection aspect from the agricultural extension officer and the remaining 80 per cent of the farmers used unreliable information in crop production of surveyed areas. The respondents in the study regions believed chemical methods of pest control are very effective in combating serious pest infestation. In the study area, it was observed that only 3 per cent of the respondents followed organic farming in a successful way. The total area under organic farming in India is negligible. There is a tremendous scope for agricultural extension activity through which stewardship can be achieved in these pesticide predominant regions. Nevertheless, costs on ever increasing safety measures for pesticide applicators would be an additional burden which is to be considered seriously under resource, poor, small, and medium holding systems in India.

Waithaka et al (2007) 253 farm households in the Vihiga district of western Kenya were sampled to examine the variables influencing fertilizer and manure use at the farm level. The relationship between manure and fertilizer usage and household factors was studied using two Tobit models. According to the econometric model's findings, household characteristics had a significant impact on how much manure and fertilizer are used, and these findings also suggest that manure and fertilizer use were endogenous. The burden of farming independently in rural areas must be lessened, the use of more expensive but higher-value inputs like fertilizers encouraged, access to markets for inputs and products increased, and farmer education to assist sustainable soil fertility management supported. Sustainable soil fertility programs can be more successfully focused with better understanding of the biophysical and socioeconomic context of smallholder systems.

Farouque and Takeya (2007) studied the farmer's perception of integrated soil fertility and nutrient management for sustainable crop production in rural areas of Bangladesh. ISFM and NM are the new techniques or methods for maintaining soil fertility. This study was conducted in eight villages of Mymensingh, Jamalpur, Sherpur and Netrokona in Bangladesh. Major findings of this study are that landless, marginal, and small farmers have either low or very low awareness about ISF and NM for sustainable crop production. Farmer's education and farming experience had significant positive influence on farmer's perception. The major recommendation of this study was that ISF and NM programs should be organized for all categories of farmers. The department of agriculture and other organizations should motivate their field level workers to conduct extension work. The study observed the need to increase the availability of information sources and new programmers to improve knowledge about ISF and NM for sustainable crop production.

Chirwa (2005) addressing Malawi's smallholder farmers, who have been slow to adopt the new technique despite decades of agricultural rules that pushed the adoption of fertilizer and hybrid seed technologies as measures to boost productivity in maize fanning. In empirical literature, a variety of econometric techniques have been used to study smallholder farmers' decisions to adopt new technology. The latent variable for the decision modelling was evaluated using logit regression analysis. Using bivariate probit analysis and controlling for technology acquisition through grants, it was discovered that the adoption of fertilizer was positively associated with higher levels of education, larger plot sizes, and higher non-farm incomes, but negatively associated with households headed by women and distance from input markets. The use of

hybrid seeds was positively connected with fertile soils and market-based land tenure systems but negatively correlated with farmer age and distance from input markets.

Rao and Gulati (1994) said that the current reforms have exposed Indian agriculture to the global market, which is likely to favor agriculture in the terms of trade. To take full advantage of the situation, they identify a few key factors that contribute to agricultural growth, such as infrastructure, institutional reforms, agrarian reforms, women's participation, and technology diffusion. These factors not only help increase the aggregate supply response in the agrarian production system but also speed up the growth of Indian agriculture. In the case of fertilizers, the reforms recommended a wider distribution of the fertilizer production system, meaning that in addition to the progressive elimination of fertilizer subsidies, the local production system should be exposed to foreign competition. Additionally, they recommend using the savings to fund irrigation projects as well as water and soil conservation programs.

Desai (1991) addresses the problems with the increase in fertilizer usage in India with an emphasis on how to maintain the rapid increase in fertilizer consumption with the least amount of environmental harm. In order to examine potential future development in fertilizer usage and its implications for future research and policies, he analyses the reasons underlying the growth of fertilizer consumption in developing countries as well as the elements driving the previous expansion of fertilizer use in India. He makes the point that increasing yield levels per hectare is the only solution in this regard since no other cost-effective alternative measures are available, and that sustained growth in fertilizer consumption is the only alternative for meeting the ever-increasing food grain requirement of the growing population. More importantly, he warns the decision-makers about the potential negative effects on the environment if we merely focus on promoting a high rate of chemical fertilizer usage without addressing the "Flawed Fertilizer Practices". According to India's experience, factors like irrigation, HYVs, and fertilizer prices had less of an impact on demand and supply for fertilizers than government policies targeted at fulfilling the country's goal of self-sufficiency in food production. Since the major crops that dominate fertilizer consumption have reached a plateau and any further increased application could prove to be uneconomical in addition to negatively affecting yield levels and soil systems, any further increase in fertilizer consumption appears remote and is very difficult in Indian agriculture. He asserts that any further growth in fertilizer use is reliant on advances in technology and economic effectiveness of use, and that expanding technology-based growth in agriculture, particularly in non-irrigated areas with an

emphasis on support systems and strict governmental policies, is necessary. In addition to employment-oriented growth and balanced regional development, the author emphasizes guiding concepts such expansion in agricultural production to achieve the core national purpose of self-sufficiency in food production and the eradication of poverty. The author also acknowledges the ever-rising cost of cultivation, which is driving agriculture to unprofitable levels, and that it is urgent to progress towards cost-efficient agriculture with ongoing technological advancement and prudent application of contemporary inputs.

Sarma (1981) the usage of fertilizers depends on the prevailing price of fertilizers and the anticipated prices of crop output, and that a persistent increase in fertilizer prices without a corresponding increase in the prices of agricultural output leads to a decline in fertilizer consumption. The study also shows that the magnitude of the procurement price increase is not comparable to the extremely high fertilizer prices to counteract the effects of an increase in fertilizer prices. This could have a negative effect on how much fertilizer is used. Therefore, the study recommends using bio-fertilizer and green manure, encouraging efforts to cultivate green manure, and promoting biogas units to restore soil nutrients based on cattle shed waste (without sacrificing the need for fuel).

Chadha & Meena (2019) the present investigation was carried out to determine the factors affecting fertilizer consumption in Rajasthan from 1967-68 to 2014-15. The study period had been divided into following three phases: post-green revolution-Phase I (1967-68 to 1980-81), post-green revolution-Phase II (1981-82 to 1990-91) and post-reform period (1991-92 to 2014-15). The regression analysis was done for the three temporal phases as well as for the overall period. High coefficient of multiple determinations (R 2) indicated that 90 per cent of total variation in fertilizer consumption was explained by the variables included in the linear regression model. Gross irrigated area was found to be the most important variable influencing the fertilizer consumption during the three phases as well as for overall period of study. Its coefficient was found positive and statistically significant ($P<0.05$). Area under high yielding varieties appeared to be the second most important variable significantly influencing the fertilizer consumption. Its coefficient was found positive and statistically significant ($P<0.05$) during the overall study period. The regression coefficient of rainfall was found to be statistically non-significant in all the three temporal phases of the study period. Although it was positive in phase I and negative in phase II and III. Highlights m Results clearly indicated that increase in area under irrigation and high yielding varieties will accelerate fertilizer

consumption in the state in future. Rainfall was found to have insignificant impact on fertilizer consumption indicating the erratic behavior of monsoon in the state, on an average, one hectare increases in area under irrigation and area under high yielding varieties resulted in an increase of 150 kg and 43 Kg in fertilizer consumption in the state respectively.

3.3 Issues Pertaining to Subsidies

3.3.1 Studies in favor of subsidy

Justin Joy (2019) Annual time series data for India from 1970–1971 to 2016–2017 is collected from the EPWRF database to determine the effectiveness of fertilizer subsidies in agricultural production considering agricultural credit statistics for India. For the analysis, variables such the agricultural GDP, agricultural credit, and fertilizer subsidy are gathered. Using the Augmented-Dickey-Fuller unit root test and the Phillips & Perron unit root test, the time series properties of the variables were examined. The variables were examined for any long run cointegrating vectors using the Johansen co-integration test. To further describe short-run dynamics among the variables, an impulse response function and vector error correction model were applied. Findings: Unit root tests show that all variables are stationary at the first difference and that unit roots exist among them at the level. The variables were subjected to the Johansen co-integration test, which only found one co-integrating vector at most. Following the normalization of agricultural GDP, the co-integrating relationship suggests that agricultural credit contributes positively to agricultural GDP while fertilizer subsidies contribute negatively, i.e., an increase in agricultural credit will result in an increase in agricultural GDP while an increase in fertilizer subsidies will result in a decrease in agricultural GDP. Due to significant leakage in the fertilizer subsidy delivery system, there is a bad correlation between fertilizer subsidies and agricultural GDP. Agricultural credit corrects the short-run equilibrium more quickly than fertilizer subsidies, according to the speed of adjustment parameter. For four to five years, the effects of the credit shock will be felt in production. Long-term improvements in agricultural production will result from government efforts to eliminate agricultural subsidies, implement monetary transfers, and place more emphasis on agriculture credits.

Tahir & Malik (2019) Over the world, agriculture is a significant driver of economic development. In India, agriculture acts as a vital pillar of economy since approximately 60% of labor force is employed in this industry. The government gets involved by offering subsidies

for inputs to improve the output of the agricultural industry. Since the early 1970s, the Indian government has regularly provided subsidies for finance, energy, irrigation, and fertilizers. The goal of the current study is to determine the frequency and trends of total grants of subsidies made by the Indian government. The author attempted to correlate the agricultural output to the subsidies awarded while also analyzing the percentage rise in the number of subsidies from 1976 to 2017–18. The author conducted an analysis to determine the effect of subsidies on agricultural growth and discovered that fertilizer subsidies have grown more quickly than other types of subsidies. The findings indicate that whereas agricultural output increased by just 18.38% over the same period, fertilizer subsidies have increased by 84.33% between 1991–1992. The analysis is based on secondary data published by the Indian Fertilizer Association, the Indian Government, agricultural statistics, the Indian Government's input survey, and fertilizers statistics (various issues).

Alam (2018) the paper analyzes the effect of 'Subsidy on Fertilizer' on the food price indices of Bangladesh. Fertilizer price indices and food price indices are highly correlated all over the world. The regression analysis shows significant positive relation between fertilizer price indices and food price indices. Using the universal parameters (regression coefficients), simulation has been done using the fertilizer price indices with and without subsidy. Results show that without subsidy, food prices would have increased 2.2 times. Results also show that, without subsidy, food prices would have been volatile. The standard deviation of simulated food prices was higher without subsidy than with subsidy. Data shows that in Bangladesh as percentage of total budget and Budget Deficit, cost of subsidy is decreasing. The paper finally ended with some policy options and recommendations.

Chittaranjan (2018) The budgetary subsidy in India has grown significantly over time. Current research tries to evaluate the trend, makeup, and causes of the increase in fertilizer subsidies. According to the report, fertilizer subsidies grew more quickly up until 2008 and then, relatively speaking, started to drop. Yet, it is still amazing and constitutes a sizable portion of India's stated subsidies. The article makes the case for a national policy on subsidy targeting. Based on the study's findings, some policy proposals are made for maintaining fiscal responsibility by streamlining subsidies and directing them primarily to the poor segments of the population, with Direct Benefit Plan payments issued directly to their bank accounts (DBS).

Gulati & Banerjee (2015) Given the importance of agriculture in any sizable country to feed its people, most countries have subsidized agriculture in the past, be they developed countries like the United States of America or countries in the European Union or Japan and Korea, or now emerging economies like China and India. The type of support, of course, varies widely across countries. The Government of India (GoI) has supported agriculture through budgetary provisions as well as through revenues foregone and a sizeable portion of budgetary support goes towards fertilizer subsidy. Fertilizer subsidy in India has succeeded in achieving its objective of increasing fertilizer consumption in agriculture and hence, raising food production, but it has also led to some problems because some fertilizer products have been priced very low. There are three key issues with regard to fertilizer subsidy in India: (1) rising amounts of fertilizer subsidy in the budget and how far they are financially sustainable; (2) extremely low prices of urea leading to imbalanced use of N, P and K, as also misuse of urea (like diversion to neighboring countries and its use for non-agricultural purposes); and (3) lack of investment flows to the sector at home, leading to rising imports in the wake of uncertainty on fertilizer subsidy policy issues and delayed payments to industry. This paper suggests the following alternative policy options: (a) switch to direct cash transfers to farmers on per ha basis (say between Rs 6000- 7500/ha), free up the urea sector with imports at zero duty, and let domestic prices be determined by demand and supply forces in open markets; (b) take up a soil health care program seriously, and if desirable, tag cash transfers to this condition, and communicate that to farmers effectively; and (c) encourage Indian investments in nitrogenous fertilizers in Gulf countries (e.g., Iran, Kuwait, Oman, etc.) where gas prices are typically less than $3 per MMBTU compared to the pooled price of $10.5 per MMBTU in India, with some medium to long-term agreements for imports. This will promote not only efficiency in production but also in consumption and provide a stable policy environment in the fertilizer sector to ensure efficient and sustainable growth and contributing to India's overall food-feed-fiber security.

Dubey (2014) Food, clothing, and shelter are three of humanity's basic requirements. The Indian Constitution addresses all three of these fundamental human requirements. Sadly, despite 68 years of independence, the food crisis has not been resolved. It has produced considerably more future demand for the food Industry. While more efficient agricultural methods and higher crop yields are now achievable, this has come at the expense of the soil's fertility. In this case, using fertilizers has been a workable approach to maintain the soil's nutritional level and boost soil fertility. The fertilizer industry is doing a great job of assisting

farmers in raising overall output. The current paper provides a review of earlier marketing research for fertilizers, both domestically and internationally.

Shrestha (2010) An essential component for agriculture output is fertilizer. The use of fertilizer in Nepal has grown over time as modern agriculture has gained popularity. As Nepal does not produce any fertilizers, formal and unauthorized imports are used to satisfy demand. To meet farmers' demand for high-quality fertilizers, fertilizer policy adjustments have been made repeatedly over the years. While deregulating the fertilizer sector initially had a good impact on the overall supply situation, deregulation policy was mostly unable to guarantee the delivery of high-quality fertilizers in the necessary quantities and at the appropriate times. The government's decision to reinstate the chemical fertilizer subsidy program may be viewed as a step in the right direction towards satisfying farmers' demands for high-quality fertilizer. The supply issue is expected to persist, though, given the allotment of subsidized fertilizer, which is far less than the actual demand. The government should raise the quota by at least 300,000 metric tons to alleviate the current issue of shortages. Moreover, the Ministry of Agriculture and Cooperatives needs to develop a long-term strategy for managing soil fertility in a sustainable way.

Sharma & Thaker (2010) The expense of subsidies and the perception that they are not allocated fairly have led to significant criticism of agricultural subsidies that promote production and productivity. In academic, political, and policy circles, there is a consensus that agricultural subsidies are geographically concentrated, concentrated on a small number of crops and producers, and frequently fail to reach the intended population (s). The distribution of fertilizer subsidies among farmers and the fertilizer business, across regions/states, crops, and various farm sizes, is examined in this article along with changes in fertilizer subsidies.

Parikh et al (2009) Natural Gas is one of the important fossil fuel energy resources in India. Anchor customers of natural gas are the power sector and nitrogenous fertilizer. It is the cleanest form of energy derived from the fossil fuel basket. Because of clean combustion characteristics, natural gas is the fuel choice for many sections of Indian industry. The demand for natural gas will grow with time. Currently natural gas accounts for 7% of the primary energy consumption of India. The Government of India has its commitment to food security and energy security. The policies are directed toward greater allocation of natural gas on a priority basis to fertilizer and the power sector. Natural gas is the main and preferred feedstock for urea manufacture. This paper analyzes and estimates projected demand of natural gas in

the next two decades. The demand projections have been reviewed in the context of changing government policies regarding the fertilizer industry, such as farm gate price regulation and self-sufficiency level of indigenous urea production. The current growth plan of natural gas supply and evolving supply scenario in the future are also considered in the study.

Sharma and Thaker (2009) Fertilizer subsidies increased from 0.85 percent of GDP in 1991 to 1.52 percent in 2008–2009 when trends in subsidies and issues relating to the distribution of subsidies between farmers and the fertilizer industry are examined across regions/states, crops, and other farm types. They also dispel the myth that the fertilizer industry consumes a significant portion of subsidies, noting that subsidies are largely restricted to a small number of states and that small and marginal farmers receive a larger proportion of fertilizer subsidies from crops like paddy, wheat, sugarcane, and cotton. Notwithstanding the fact that fertilizer subsidies are justifiable, this research concludes that a reduction in subsidies will have a negative impact on small and marginal farmers' on-farm output and incomes.

Agricultural subsidies that encourage production and productivity have been widely criticized because of the cost of subsidies and they are perceived to be far from uniformly distributed. There is a general view in academic, policy and political circles that agricultural subsidies are concentrated geographically, they are concentrated on relatively few crops and few producers and in many cases do not reach the targeted group(s). One of the most contentious issues surrounding input subsidies in general and fertilizer in particular in India is how much of what is paid out actually finds its way into the pocket of the farmer, and how much is siphoned away by the input companies. There has also been a debate about the issue of real beneficiaries of fertilizer subsidies like small vs. large farmers, well-developed vs. less developed regions, etc. Therefore, there is need to understand the fertilizer subsidy distribution pattern to assess whether the subsidy benefits the target group(s), an argument often made while giving any farm subsidy. The distribution of fertilizer subsidies among farmers and the fertilizer business, across regions/states, crops, and various farm sizes, is examined in this article along with changes in fertilizer subsidies. According to the study, fertilizer subsidies have dramatically increased from Rs. 4389 crores in 1990–1991 to Rs. 75849 crores in 2008–2009. This shows an increase from 0.85 percent in 1990–1991 to 1.52 percent in 2008–2009 as a percentage of GDP. Because the underlying assumptions I that India's entry into the global market as an importer has no impact on global prices and (ii) that global fertilizer markets are completely competitive do not hold true, the paper demonstrates that the common perception that

approximately one-third of fertilizer subsidies go to the fertilizer industry is false. India's imports have a large impact on global prices because of the more concentrated and volatile global trade flows and markets for fertilizer.

Singh (2004) This paper examines the issue of inter-crop, inter-regional, and inter-class equity in fertilizer subsidy distribution, considering the percentages of various farm classes, crops, and states in total fertilizer use as well as the amount of fertilizer used per hectare on various size categories of farms. The analysis shows that wheat and rice farmers are the main beneficiaries of fertilizer subsidies. The amount of interstate heterogeneity in fertilizer consumption has been declining over time. More significant is the finding that there is a good deal of inter-class fairness in the distribution of fertilizer subsidies, contrary to the widely believed notion. Not all types of subsidies should be cut in the same way. Instead, a properly thought-out, systematically organized, gradualist, and geographically diverse approach to subsidy reduction is required.

Gulati and Sharma (1999) to determine if a farmer is net subsidized or not) looked at issues related to fertilizer pricing and subsidy in the Indian setting from an economic standpoint. According to the study's findings, farmers receive 60% of all fertilizer subsidies, with the remaining 40% going to the fertilizer business. Indian farmers would have fared better in a free trade environment than in a restricted trade one. In light of relative crop fertilizer price ratios for wheat, rice, and cotton, the analysis suggests that Indian farmers are not subject to taxation and are not net recipients of subsidies. The potential yield of paddy with an optimal dose of NPK for the eastern region works out to 407 percent as opposed to 155 percent in respect of the north region and 152 percent for the southern region. However, the fertilizer subsidies shared by wealthy regions and better-off farmers tend to deprive other regions of their legitimate share of resources for infrastructure development (1981-82). Hence, in order to maximize societal benefits, significant amounts of fertilizer should be sent to areas with untapped potential. This involves non-price-related action, such as strengthening the distribution network. He continues by saying that irrigation, rather than price changes, has a more significant impact on the pattern of fertilizer consumption.

Chandhran (1993) In his study titled "Pricing of Feed Stocks in India," the author discovers that in addition to higher railway freights, a 99 percent net increase in fertilizer subsidies is being offset by a sharp rise in the price of domestic feedstock and inputs. He also points out that the majority of the fertilizer subsidy is an intra-economy transfer and is not a financial

burden on the government.

Khatkar, Kaushik and Chamola (1992) Analyze the extent and impact of input subsidies on Indian agriculture using secondary data. The findings show that input subsidies have increased over time, primarily to offset growing input prices and encourage the use of modern inputs. The study notes that agriculturally developed states receive a larger subsidy, which makes up around 60% of the total fertilizer subsidy. The proportion of fertilizer subsidies going to cultivators is found to have decreased from 93% in the triennium ending in 1982–83 to about 55% in the triennium ending in 1986–87, while the proportion going to the fertilizer industry is found to have increased from 7% to 45% over the corresponding periods. This finding raises concerns about the withdrawal of input subsidies. The research recommends keeping input subsidies in place to boost agricultural output by stopping leaks.

3.3.2 Studies against the subsidy

Velayudhan, et al (2023) discuss that conflict between the nitrogen (N) fertilizer use and the actual N requirement in Indian agriculture is of enormous concern. When N is overused, it appears as a threat to the environment, and crop yields are affected when it is underused. Budgeting of Nutrient is a useful tool in assessing the inflows and outflows of nutrients to the agricultural system and formulating future strategies. Since the policies and socio-economic factors are the frequently studied drivers of N fertilizer use, crop production factors have not received due attention. They have examined the contribution of these factors to N fertilizer use. The Fertilizer application Rate (FAR) is the most important among the major crop production factors that drive N fertilizer use. Their findings propose that the surplus N in Indian agriculture, hastened by higher FAR, may pose serious sustainability issues if not addressed.

Salunkhe (2015) In India from last several years government provides subsidies to agriculture sector in direct & indirect form. But how much they are beneficial to the agriculture sector is question. To find out the answer to this question authors study about factors measure & contributing to growth of agriculture sector. e.g., Finance, Production, Infrastructure, Irrigation & Technology etc. It is difficult to determine the precise impact of subsidies on the agricultural

sector. The subsidies are highly helpful for the agricultural industry, but because of poor distribution system management, they do not reach the final customers, which are the farmers in India. This analysis is based on secondary data that has been released by academics and the government.

Chand & Pandey (2008) Role of fertilizer in increasing agricultural productivity and production during the last five and half decades has been well documented. A very close association is observed between growth of fertilizer and crop productivity in almost all the states of the country. No input in agriculture has seen as much growth as witnessed in the use of fertilizer in the recent history of agriculture. Fertilizer consumption was around 67 thousand tons in the early 1950s and it picked up very fast during the mid-1950s. By the early 1960s consumption of NPK crossed 400 thousand tons and at the time of onset of green revolution consumption of fertilizer approached 1 million tons. On per hectare basis, fertilizer consumption in India increased from 0.5 kg in early 1950s to 7 kg at the time of onset of green revolution in 1966-67. It is worth mentioning that in the pre green revolution post-Independence period fertilizer consumption remained quite low, but its growth rate was higher than that of crop production. The average growth rate in crop production (index) during 1950-51 to 1966-67 was 2.48 percent whereas average growth rate in fertilizer consumption in the same period was 19.41 percent. This shows that even in the pre green revolution period fertilizer was used as an important input for raising agricultural production.

Vidhyasagar (1996) observes that an increase in the price of fertilizers is the only available alternative for reducing fertilizer subsidies. He supports a dual pricing policy of fertilizers to save the interests of small and marginal farmers.

Tyagi (1993) The author of the paper "Pricing of Fertilizer" contends that all consumer groups gain from subsidies. According to him, all groups of consumers of agricultural products must shoulder a sizable portion of the farmers' increased burden.

Desai (1993) In his work on fertilizer policies, addresses the issue of how to maintain the growth of fertilizer usage with the least number of negative effects on the environment and fiscal resources. He makes the point that it is possible to do so by managing the supply and demand for fertilizers more effectively.

Roy's (1992) It argues that since the price of urea (N), which small and marginal farmers mostly use, is still restricted, the government's decision to decontrol fertilizer prices will not have an impact on urea use. Given that commercial crops primarily use decontrolled kinds of fertilizers P and K, any increase in fertilizer prices can be compensated for by rising procurement costs. By adding certain controls, it is possible to restore balanced use of NPK, and at the very least, cutting subsidies would assist the government relieve some of its financial burden. According to a partial equilibrium analysis, the removal of fertilizer subsidies results in a drop in retention price, which would only slightly lower domestic producers' revenues and have no negative effects on job growth in the fertilizer sector. As contrast to depending on short-term solutions like fertilizer subsidies, a general equilibrium study reveals that importing food grains is a better choice for improving per capita cereal consumption. Additionally, it recommends irrigation as a superior alternative because it increases GDP, fertilizer use, food grain output, and the welfare of the lower socioeconomic groups in both rural and urban areas. Retail prices still need to be evaluated to allow for more competition and efficiency. Any fall in retention price will only slightly 56 diminish the industry's profits without having an impact on them through fertilizer use. In the end, fertilizer costs only play a little role in encouraging consumption because anytime fertilizer prices have dropped, there has also been a noticeable rise in fertilizer use. As a result, efforts should be concentrated on eliminating structural obstacles in fertilizer use through the improvement of distribution networks and marketing initiatives through extension programs.

Nanjegowda (1992) finds that continuing to subsidize agricultural products such as food grains and fertilizer has more drawbacks than benefits, as it depletes government coffers and amplifies inflation while failing to produce the desired results. So, it is important to consider both the economic impact and the agricultural sector's production while evaluating the continuation of subsidies.

Gulati and Sharma (1992) Measure the degree of distortions on a country and commodity-specific basis, estimate in terms of "Producers subsidy equivalent," and present the position of various countries on subsidy reduction as they relate to the extent of distortions in subsidies in the agricultural sector across several countries during the 1980s. They also trace the origin of distortions in terms of policies followed by major countries. Macro-level findings show that Japan is emerging as the top protector of its agricultural sector, followed by the European Union. It is demonstrated that India would benefit from lowering its protection of the agricultural

industry. Furthermore, if protection is lifted, highly protected commodities like rice, wheat, and cotton may find a sizable export market. The study recommends shifting resources from heavily protected crops to those that are not protected; however, the potential for export markets is very low, but these crops are very important for supplying domestic food needs because products like wheat, rice, fruits, and vegetables have the potential to become significant foreign exchange earners. Overall, if global reforms are successfully implemented, the very demand pattern in the country would alter, which would benefit agriculture tremendously and bring in better profits.

Gulati (1990) examines the issue of whether Indian farmers are subsidized or not and examines the relationship between Crop- fertilizer prices. He finds fertilizer subsidy to cultivators amounting to only 48 percent with the remaining 52 percent assumed to be going to the fertilizer industry in the form of intra economy transfers within the government agencies such as from ONGC to CIL and state Electricity Boards and as such cannot be called a subsidy. It is discovered that Indian farmers stand to gain more in a free trade scenario than under a restricted trade regime with regard to crop fertilizer ratio (In respect of important crops such as wheat, rice, and cotton which account for a substantial share of fertilizer use). When compared to ratios prevalent in the majority of Asian and Pacific countries, Indian producers confront unfavourable crop fertilizer price situations under a regulated trade situation. So, despite a substantial number of subsidies given to fertilizers with no economic significance, it can be concluded that Indian farmers are net taxed rather than net subsidized.

3.4 Studies About Nutrient Based Subsidy (NBS) Policy

Praveen (2019) Fertilizers are a crucial component of agriculture because they directly affect the production of food grains, along with other elements like High Yielding Varieties (HYVs), irrigation, loan availability, etc. The crop response, fertilizer cost, the price farmers receive for their produce, and the availability of fertilizers all have a direct impact on how much fertilizer is used by farmers. The fertilizers are responsible for between 50 and 60 percent of the increase in food grain yield during the green revolution. Hence, during the green revolution era and for several years later, the rising fertilizer use, and rising crop yield mutually supported one another. Yet, recent times have seen a decreasing trend in how crops respond to fertilizers, which is worrying for the agriculture industry. This decreasing trend in crop response is allegedly caused by an imbalance in fertilizer application. In an effort to solve this issue, the government has developed a complicated web of regulations to take action at several points in

the production and transportation chain for fertilizer. The majority of current initiatives are focused on more general goals including promoting the sustainability of the agricultural system, effective fertilizer distribution, and benefit transfer without leakage. Any fertilizer policy will significantly affect many farmers, especially small and marginal farmers, as well as industry. As a result, institutions developing the regulations must be cautious enough to ensure that all stakeholders benefit as much as possible.

The Nitrogen Based Subsidy (NBS) Policy, which was adopted in India in 2010 with the goal of encouraging the balanced use of fertilizers and raising agricultural output, is covered in the article by *Rao (2015)*. The programme substituted a subsidy based on the nutrients given by the fertilizers for the prior system of subsidy based on the quantity of fertilizers. The paper examines the NBS policy's success in attaining its goals and emphasizes its benefit for the wise use of fertilizers. It also highlights the difficulties the Indian fertilizer business has, such as low production, a lack of nutrient supply, and excessive fertilizer costs. The essay offers a number of solutions to these problems, such as promoting organic farming, forming public-private partnerships, and enhancing fertilizer availability and quality. The essay offers insights into the prospects and problems facing the Indian fertilizer sector as well as the part played by government regulations in advancing sustainable agriculture.

Sengottaiyan and Ambika (2013) The fertilizer situation in India was underlined in the paper they presented. India ranks among the world's top producers and consumers of fertilizer. The major goal of the fertilizer sector is to guarantee the availability of primary and secondary nutrients in the necessary quantities at the appropriate times. They recommended embracing cutting-edge production techniques and cutting-edge new items.

Sachdeva (2011) examined the Nutrient Based Subsidy (NBS) impact on Indian agriculture. This study analyzed the positive and negative impacts. NBS is applicable only for N, P, K, Sulphur, Zinc, and Boron. According to this study, industries raised the prices of DAP, MOP by Rs 600 per ton after the introduction of the NBS scheme. Nutrient Based Subsidy scheme has promoted balanced and integrated use of plant nutrients and addresses the problem of multi-nutrient deficiency in Indian soils. The study observed that the subsidy helps to promote the efficient use of fertilizer and increase agricultural production.

Sharma and Thaker (2011) analyzed that by the introduction of nutrient-based pricing scheme and programs like the national project on Management of Soil and Fertilizer Health to promote balanced use of fertilizer nutrients, the demand for SSP and complex fertilizer might increase at a faster rate in the coming years. The country had achieved near self-sufficiency in N and P, with the result that India could manage its requirement of these fertilizers from the indigenous industry and imports of all fertilizers except K were nominal.

Singh (2011) stated that in the mad rush to balance the chemical fertilizer kitty with global prices, policymakers are forgetting a huge problem that is staring us in the face — the deteriorating soil in the country and the resultant threat to food security. However, farmers are aware of the crisis but are helpless in the absence of support systems from the government.

Pelliciardi (2011) The aim of this paper is to compute the macronutrients mining by crops (output of nitrogen N, phosphorus P, and potassium K) and the addition through organic manure (input of N, P, K), in the barley (Hordeum vulgare L.) and wheat (Triticum aestivum L.) cultivation in a small, family managed farm, located in Hemis Shupkachan village, central Leh district. Moreover, a static balance is computed by measuring the difference between macronutrients contained in the manure spread on the fields, and in the crops harvested, without quantifying soil nutrient stock or the contributions from the rotation of crops. The evaluation is done at small farm level, < 1 hectare, because the majority of the district's farmers, 62%, belong in this category. However, results could lead to wider considerations regarding the importance of the traditional soil fertility practices in Ladakh.

Mukherjee (2010) the new nutrient-based fertilizer subsidy policy provides implicit incentives to farmers to test soil samples regularly and get crop-wise recommended doses of nutrients and offers prospective benefits from the agro-environmental management point of view. A study of six villages in the lower Bhavani Basin in Tamil Nadu reveals that despite a strong willingness on the part of farmers to adopt agricultural best management practices, inadequate infrastructure and the high transaction costs involved in accessing such services make them reluctant to test soil samples regularly. This paper looks at the institutional, infrastructural, and agronomic factors influencing farmers' willingness, and concludes that the new policy needs to be supplemented with basic agricultural extension services through public-private partnerships.

Chandrashekhar (2006) explained that subsidies given by Organization for Economic Co-operation and Development (OECD) countries, especially the United State and the European Union are huge. Every ton of commodity produced is subsidized to the extent of between 25 per cent and 50 per cent of the market price. These subsidies encourage more production, augment global supplies, depress would prices and di-start the discovery of free market prices. Therefore, a strong move to pressure the developed economies to phase out farm support. The foregoing simple analysis shows that in none of the four major commodities would India stand to benefit substantially if the subsidies were eliminated. It may be politically correct and perhaps expedient for India to make appropriate noises against farm subsidies at global forms such as the World Trade Organization. While reduction or elimination of subsidies would impact world commodity prices, consuming and importing nations would be the worst hit. Unlike several countries, there are dependent on farm goods export, India is a large consuming country, so subsidy induced low prices would be in Indian Consumer's interest. The author explained the agriculture situation in India that, a lot of attention is now being showered on the farm sector but given the neglect of this sector for decades, entrenched problems and serious changes in raising production and productivity, self-sufficiency itself would be a distant dream, leave alone generating export surplus of major commodities. Developed economies can afford huge payments as subsidies. India cannot concert efforts are required to strengthen agriculture, improve agro-produce marketing, and enhance quality. The author suggested that huge investments are necessary for this national effort. The government will have to find adequate financial resources for 31 strengthening input delivery system, expanding irrigation, building rural infrastructure, and delivering price/market information to farmers.

Modi (2006) observed that there is no denying the fact that the expenditure incurred on irrigation soil conservation and agricultural research will be more productive than expenditure of the same amount being doled out as subsidies. The author found that public investment is agriculture and allied sectors in 1985-86 at constant prices were of the order of Rs. 6213 crores. In 1993-94, it amounted to Rs. 4918 crores on the other hand, total agriculture subsidies were Rs. 14069 crores. There was an increase in public investment during 1994-95. Since then, they have again fallen from Rs. 5369 crores to Rs. 4658 crores in 2001-02 amounted to Rs. 36224 crores. These figures clearly indicated that a part of the enormous increase in the subsidies paid to the agricultural sector was at the cost of public investment in agriculture. The author argued that if the government did not withdraw the subsidies, it will obviously try to reduce the fiscal deficit by cutting down its expenditure on 30 some other count, a cut which may be more

harmful for the economy than the withdrawal of subsidies.

John (2006) argued that on the one hand there is a need to get rid of the subsidies, on the other if they were all withdrawn at once thousands of farmers would go out of business and food prices would really go through the roof. Farm subsidies came in with Roosevelt's New Delhi Policies, the same thing that gave us welfare payments to the poor. Today, both systems have grown completely out of control. Agricultural subsidies are geared to help farmers keep their production cost low and Governments cannot cut all welfare because hundreds of thousands of people would starve. Both systems are going to have to be drawn down gradually until hopefully they can be done away with altogether without harm to people and our country. The author suggested that there should be a shift in the way subsidies are handed out, that would help small size category farmers using sustainable farming practices to make a decent living off the land. This would tend to encourage more diversity of crops, "better" (in the sense of more sustainable) use of farmland and higher quality of production available to the consumer.

Moris, L. and Mary, B. (2005) stated that subsidy on irrigation has caused considerable distortion on the cropping pattern in Punjab. The majority of the cultivable land has become mono-crop culture and has favored water– intensive crops like paddy, subsidy on canal water and electricity has led to excessive irrigation causing salinity adapter logging in some areas. Subsidies on fertilizers have led to excessive application with adverse environmental effects. The subsidies on the production of fertilizer have not been even on all fertilizers. The main prominent feature was the excessive consumption of Nitrogen based fertilizers in both seasons. This is so because of the lower cost of nitrogen-based fertilizers as they were more subsidized than the other fertilizers based on potash and phosphorus. There are also wide regional variations in the consumption of fertilizers. In 1999-2000, the preparation of NPK consumption in Mansa district of Punjab was 378:122:1 as compared to that of Jalandhar district which recorded 9:35:1. Intensive cultivation of paddy and wheat is causing nitrate pollution and excessive chemicalization of soils and rising deficiency of micronutrients. Application of chemicals to the soils can cause irreversible damage to the content of the soil, killing its microorganisms that are essential or maintaining the soil structure and basic fertility. The water pricing policy was only aggravating the problem. The policy of providing free electricity for agricultural 29 purposes was causing indiscriminate use of electric motors and excessive water use. This is one of the reasons for depletion of the ground water table. The author suggested that the government start the farmers for balance use of subsidies.

Singh (2005) investigated the issue of equality in the allocation of fertilizer subsidies in India, considering the proportion of various farm classes, crops, and states in overall fertilizer consumption as well as the amount of fertilizer used per hectare on various size categories of farms. The primary source of data is the Agricultural Input Survey, which was conducted in conjunction with the Agricultural Census in 1991–1992. The survey revealed that the main recipients of fertilizer subsidies were farmers of paddy and wheat. Despite decreasing over time, interstate variation in fertilizer consumption is still substantial. According to the analysis, it is not justified to reduce all sorts of subsidies in the same way. Instead, a carefully considered, regionally diversified strategy for subsidy reduction must be used.

Acharaya, S. S., & Jogi, R. L. (2004) explained that the genesis of input subsidies in Indian agriculture can be traced to the philosophy and objectives of agricultural development strategy launched during the mid-1960s. Input subsidies help in balancing the conflicting interests of farmers and consumers and in achieving macro food security. The majority of subsidies, which include those for power, canal water, and fertilizers, have been examined. In 1999–2000, the subsidies for energy, fertilizers, and canal irrigation made up 53%, 28%, and 19%, respectively. Over the past 20 years, an increase in the per-unit subsidy rate has accounted for 81% of the incremental subsidy. Contrary to popular belief, Punjab has only received 7.4% of all agricultural subsidies in India. The allocation of subsidies has generally followed the pattern of the percentage share of operated areas across different farm size groups. Crop-wise analysis has revealed that the input subsidies are mainly going to the food crops. The author suggested that should be handled cautiously the issue of subsidies in Indian agriculture because the economic conditions of farmers have not improved to a desirable level. Subsidies on farm inputs cannot be seen in isolation of the subsidies in other sectors of the economy, which were many times more, and consequences of their withdrawal were less painful.

Razzaq et al (2004) In their study, they explained the importance of using the appropriate fertilizer in the suggested amount and at the recommended time in order to obtain the greatest benefits and identified the challenges Pakistani farmers experience when trying to obtain fertilizer. The authors proposed legislative changes to increase farmer production through farmer education, price reductions, better storage and transit infrastructure, better administrative infrastructure, etc.

Sengupta (2004) stated that India is the third largest producer and consumer of fertilizer in the world. The world fertilizer consumption is approximately 142 million tones and growing at 2

per cent per annum. International trade in fertilizer accounts for approximately 62 million tons out of current world consumption of 142 million tons i.e., approximately 43 per cent of the total consumption. To provide fertilizers at an affordable price to farmers, the major thrust of Indian Fertilizer Policy is based on subsidy. The author discovered that the developed states received a bigger share of fertilizer subsidies, which accounted for roughly 60% of all fertilizer subsidies, as well as a similar pattern for irrigation and electricity subsidies. According to this analysis, the overall input subsidies represented on average 16% of the country's GDP. The author opined that maintaining the current rate of agricultural production growth would require maintaining input subsidies while reducing leakages.

Bala et al (2004) They looked at the effects of several variables, including price, the area under high yielding varieties, the gross cropped area, the cross-irrigated area, and subsidies, on its consumption in their study as they attempted to investigate the trends in fertilizer production and consumption in India. For this analysis, the time series data from 1975–1976 to 1999–2000 were considered. According to the findings, fertilizer consumption grew at a pace of 11% over the study period. While the production of fertilizer grew at a rate of 10.6%. Subsidies appeared as the most significant factor influencing fertilizer consumption, followed by the area under high yielding cultivars and total irrigated area. According to the author, farmers should be encouraged to use fertilizers in a balanced way, plant more land with high-yielding crops, and make better use of their limited irrigation capacity.

Nair (2003) outlined that fertilizer industry are helping the country for their agriculture development and became backbone of Indian economy. But it is also responsible for environmental pollution like soil pollution, air pollution, water pollution, acid rain, greenhouse effect, technological hazards etc. This is very harmful for the human race and society. Researchers analyze various national and international environmental policy, norms, rules regulation, and recognized the important factor involved in environmental protection in fertilizer production also identify reason for noncompliance those norms and also suggested to take appropriate action to control pollution and protect environment as well increase fertilizer production in India.

Orden (2003) stated that since the early 1990s, India has undergone substantial economic policy reforms and economic growth. In this study, author evaluated the protection and support versus dis-protection of agriculture in India. His methodology involved examining market price support for eleven crops, the expenditure on input subsidies benefiting farmers (for

fertilizer, electricity, and irrigation) and product specific and total producer support estimates over the period 1985-2002. The author drew extensive price-comparison and subsidy measurement data sets. Overall, results indicate that support for agriculture in India has been counter cyclical. Support for agriculture has been rising when world prices are low 25 (as in the mid-1980s and 1998-2002) and falling when world prices are high (as in the early and mid-1990s) Results demonstrate the increased importance of budgetary payments for input subsidies in agriculture in recent years. Yet, in the aggregate for both price support and budgetary expenditures over the period 1985-2002 in the counter-cyclical dimension of agricultural policy dominates a clear trend of movement from dis-protection towards protection. The magnitudes of estimated support for agriculture obtained in this study are important for several reasons. The estimates confirm that high levels of subsidies were required for India to export wheat or rice in recent years.

Chakraborty (n.d) stated that the rising demand for fertilizers, it is imperative for the Indian government to construct subsidy policies that encourage sustainable and environment-friendly agricultural growth. His study tried to estimate a demand function for fertilizers and explore the impact of various non-price factors on demand. Unlike past studies, his study used data entirely from the post-reform era (after 1991) and captured the impact of recent government subsidy policies and other non- price factors on the rising demand for fertilizer.

3.5 Studies about Fertilizers Use Efficiency

Kumar, et al (2022), concludes in their paper that in recent times, deterred by the unpleasant impact of over or under application of fertilizers or even unbalanced application of fertilizers without considering the crop needs and soil health, the researchers are working hard on making a pattern shift to demand driven precise application of nutrients with an overall goal of enhancing the efficient application of nutrients.

Panhwar et al (2019) Mineral fertilizer application is not a sole tool for wheat, but an integrated mineral nutrient strategy could be incorporated for sustainable wheat crop production. Efficient and effective modern technologies should be taken up to ensure food security. The increase in world population and the potential of the food system to meet future demand for food has brought into focus the use of cereals to boost crop yield. Integrated nutrient management could be the way to sustain the wheat crop and secure the world food demand.

Panwar & Mohammad et al (2019) Rice-Wheat Cropping System (RWCS), a lifeline for most of the population in South Asia is under stress, due to the imbalanced and indiscriminate use of fertilizers. Therefore, we conducted an on-farm study at eight locations (Amritsar, Katni, Nainital, Samba, Pakur, Kanpur, Ambedkar Nagar, and Dindori) covering five agro climatic zones of six Indian states (Jammu and Kashmir, Punjab, Uttarakhand, Uttar Pradesh, Madhya Pradesh, and Jharkhand) to (i) calculate the Partial Factor Productivity (PFP) and Agronomic Use Efficiency (AUE) to judge the response of NPK and Zn on grain yield of rice and wheat in RWCS and (ii) to work out the economic feasibility of different combinations of NPK in rice and wheat. Seven fertilizer treatments: Control (0-0-0), N alone (N-0-0), NP (N-P-0), NK (N-0-K), NPK (N-P-K), NPK+Zn (N-P-K-Zn), and FFMP (Farmers Fertilizer Management Practice) were assigned to all the locations. The amounts of applied nutrients were employed in accordance with the location's typical recommendation. The grain yield of rice and wheat is increased by 105% and 97%, respectively, when NP is used as opposed to control, according to the average of all the locations. RWCS system productivity was measured in terms of Mg ha 1 of rice grain equivalent yield (RGEY). Samba had the lowest RWCS productivity with fertilizer treatments of all the locations. In contrast, the best yield of RWCS with fertilizer treatments was obtained at Amritsar, except with NPK and NPK+Zn fertilisation, where Katni topped Amritsar. With the joint usage of NP over control throughout the locations, RWCS production increased by around three times (Sustainability 2019, 11, 122 2 of 26). Overall, our study's findings demonstrated that the balanced application of NPK boosted RWCS output above control by 245%. Between Pakur and Amritsar, the partial factor productivity of Nitrogen (PFP n) N alone in rice ranged from 19 kg grain kg 1 N to 41 kg grain kg 1 N. At Ambedkar Nagar, PFP n of N alone in wheat ranged from 15.5 kilograms grain kg 1 of N to 28 kg grain kg 1 N. However, the average PFP n of N alone across all locations was 21 kg grain kg 1 N for wheat and 29 kg grain kg 1 N for rice. When N and P were applied together and sorted in both rice and wheat across the locations, PFP n rose. The partial factor productivity of applied phosphorus (PFP p) in both crops rose when NPK was applied in combination at all locations. The PFP k for applied K at all locations increased because of the simultaneous application of NPK. When K treatment was paired with the application of N and P, the response was, on average, 114% for rice and 93% for wheat. In our investigation, rice consistently outperformed wheat in terms of agronomic use efficiency of applied N (AUE n) and agronomic use efficiency of applied P (AUE p), regardless of fertilizer treatments. In terms of economics, the application of N alone yielded the lowest mean net financial returns (INR

29.5 10 3 ha 1) and the application of NPK+Zn yielded the highest (INR 8.65 10 3 ha 1). The locations' average marginal returns were as follows: N alone > NK > FFM > NPK > NP > NPK+Zn.

Usama & Khalid (2018) Plants require macronutrients and micronutrients for their growth and fertilizers are the source of these nutrients which not only enhance the plant growth but also maintain the soil fertility. The purpose of this study is to evaluate the pattern of fertilizer consumption, production trends in India and suggest the sustainable use of fertilizers based on requirements of various crops, agro-climatic zones, soil, and climate. The data for major fertilizer consuming zones and states helps us to understand consumption patterns in our country. During the period 2007-11, it was observed that west zone was consuming 31,116.73 kilo tons of fertilizers which was the highest among the four zones and was also having highest total annual compound growth rate percentage of 9.68. Uttar Pradesh was discovered to be the state in India that consumes the most fertilizer overall, at 16,621.29 kilo tons. The two most important crops, rice, and wheat, use 37% and 24%, respectively, of all the fertilizers used in India for all crops. The usage of fertilizers is greatly influenced by climatic factors, such as rainfall patterns, as their need rises along with the expansion of irrigated regions. Agro-ecological zone no.7 was consuming 177.1 kg/ha of fertilizer which was the highest among the different agro ecological zones of India. The paper also aims to recommend that fertilizers should be used in a balanced manner through integrated management of nutrients involving the use of chemical fertilizers, bio-fertilizers, compost and vermicompost. Balanced use of fertilizers will reduce harmful effects of chemical fertilizers on the environment and will help in making our agriculture sustainable. It also increases water and nutrients use efficiency, improves grain quality, soil health, and gives better economic returns to farmers and helps in sustainability. So, for sustainable growth in the agriculture sector, it is imperative to reduce demand of chemical fertilizers without hampering food production. This can be achieved by having a better understanding of climate of India, its soil, agro-ecological zones, and crop specific fertilizer requirements. The demand of fertilizer for consumption can also be fulfilled by bringing efficiency in the fertilizer application techniques, distribution system and extension services, increasing credit facilities and redesigning fertilizer subsidy policy.

Singh (2017) The total annual nitrogen (N) input into cropping systems increased by 62%, but N in harvestable output ($kgNha^{-1}year^{-1}$) increased only by 42% in India during 1990-2009. The relationship between input and output of N in cropping systems translates into a regularly decreasing trend of N use efficiency and the need to substantially improve the fertilizer management practices. Around 70% of the total fertilizer N applied in India is used for production of food grains. There is an evolutionary trend in the way fertilizer N has been managed in cereals. Since the 1960s, fertilizer N has generally been managed by following blanket recommendations consisting of two or three preset split applications of the total amount of N. However, in recent decades emphasis is shifting toward achieving high agronomic efficiency by following strategies revolving around feeding the crop N needs. Technological developments have made it possible to quantify spectral characteristics of leaves quickly and nondestructively, which can then be used to diagnose plant N deficiency and, indirectly, to correct N fertilization in real time and site-specific manner leading to improved N use efficiency. Nitrogen status assessment tools, however, must be affordable.

Fixen et al (2015) A crucially essential topic in the assessment of crop production systems is nutrient use efficiency (NUE). The management of soil, plant, and water resources can all have a significant impact on it. Using nutrients is meant to maximize crop nutrition while reducing nutrient losses from the pitch, with the goal of improving cropping systems' overall performance. NUE addresses some facets of that performance, but not all of them. As a result, goals for system optimization must incorporate both NUE and total productivity. The issue being posed frequently is the spatial or temporal scale of interest for which trustworthy data are available decide the most appropriate formulation of NUE. Plant water status is one of many managerial and environmental variables that interact to affect NUE. Like this, plant nutritional status can have a significant impact on how efficiently water is used. Several chapters of this book go into greater information about these connections.

Aulakh & Benbi (2008) there is no doubt about the prominent role of fertilizers in raising crop productivity, however, concerns are increasingly expressed on their declining efficiency. Any inefficient use of fertilizers is liable to make fertilizer consumption uneconomical, produce adverse effects on atmospheric environmental pollution and groundwater contamination causing health hazards and global climate change. Fertilizer Use Efficiency (FUE) traditionally centers on fertilizer, soil, water, and crop management, as these along with location and climate are the controlling factors. The key measures needed for optimizing FUE for sustainable crop

productivity and reducing environmental risks are (i) timely prediction of nutrients' deficiency, (ii) timely sowing of crops, (iii) selection of proper method and right time of application of fertilizers from suitable sources, (iv) interrelationships of nutrients and balanced fertilization, (v) greater need for nutrients recycling through organic manures and crop residues leading to integrated nutrient management, (vi) harnessing the benefits of nutrient interaction by avoiding the excessive use of one or the other fertilizer nutrient, and (vii) minimizing leaching and gaseous losses by utilizing residual fertilizers. There is an urgent need to delineate unexplored and potentially Sulphur and micronutrient-deficient areas; educate the farmers about the benefits of soil testing, and how to take soil samples for this purpose; develop reliable, efficient soil testing laboratories across the country and monitor their quality performances; frame effective policies addressing the availability and distribution of balanced/fortified fertilizers especially in S and micronutrients-deficient area; expand extension services to reach the actual fertilizer consumers; and to undertake systematic studies on malnourishment that is emerging as a consequence of wide spread S and micronutrients deficiency in animal and human beings. Maintenance of pollution free soil health, optimum crop productivity and environmental protection for posterity is of utmost importance.

Terry (2008) Although the public is quite aware of the need to improve nutrient use efficiency, not everyone always understands it. It shows how the same set of data can be used to calculate a fertilizer's N efficiency of 21% or 100% using an overview of four nutrient consumption efficiency indices and an example of how the terminology may be utilized in various circumstances. Fertilizer N recovery efficiencies from researcher-managed studies for major grain crops range from 46% to 65%, in contrast to on-farm N recovery efficiencies of 20% to 40%. Fertilizer use efficiency can be increased by implementing fertilizer best management practices that provide nutrients at the ideal rate, moment, and place. The most efficient use of nutrients always occurs in the lower regions of the yield response curve, where fertilizer inputs are lowest. However, the effectiveness of fertilizers in increasing crop yields and enhancing farmer profitability should not be sacrificed for efficiency's sake. Crop productivity and nutrient use efficiency must coexist peacefully for there to be optimal results.

Hegde et al (2007) The nutrient-use efficiency of all the major, secondary and micronutrients continuous to be low despite increasing consumption of fertilizers in India Improvement in nutrient-use efficiency is necessary to reduce the cost of production as well as to prevent environmental pollution. Adoption of best management practices is essential to get higher

input-use efficiency and profitability. Among all the major nutrients, nitrogen is most vulnerable, and increasing its use efficiency through physical manipulation of the size of granules, coating of granules with films, amendments, or chemicals to prevent their fast dissolution or prevent bacterial-mediated denitrification did not prove economically viable. Split application is effective but costly. Reliance on biological N2 fixation through inclusion of legumes in cropping system and maintenance of higher soil organic matter will help to build-up soil fertility and better soil physical and microbial environment with good buffering capacity. The recent developments in the field of biological nitrification inhibition offer good opportunities in effective nitrate management. Identification of efficient genotypes for low nutrient situations or higher response to applied nutrients through better acquisition and assimilation are encouraging. Phosphorus management should consider proper source and the cumulative effects that can be exploited through biological processes for nutrient availability and root acquisition. Adoption of conservation tillage, site-specific nutrient management and best fertilizer management practices will go a long way in increasing nutrient-use efficiency. Adoption of new technology through gadgets such as leaf color charts, sensor-based technology, laser land leveling etc. can reduce the dependence on laboratory assistance and manual labor.

Sendhil (2003) The present study entitled "A study on fertilizer use efficiency in paddy production in Pondicherry region" was undertaken to examine the fertilizer consumption pattern, costs and returns, factors influencing fertilizer consumption and technical efficiency of fertilizer use in paddy production. A multi-stage stratified random sampling technique was adopted for the selection of communes, villages, and the farmers. A sample of 90 farmers was selected at random from the selected 4 villages. The primary data for the year 2001-02 were collected through a pre-tested schedule by survey method. Besides DEA, both conventional and functional analyses were used to analyze the data and to arrive at valid conclusions. The average level of consumption of N+P+K was 286.24 kg ha-1 in the study area. It was highest in the case of small farmers, followed by medium and large farmers. Among the seasons, Rabi I (Samba) had the lowest consumption, followed by Rabi II (Navarai) and Kharif (Kuruvai). The per hectare cost of cultivation of paddy for the whole sample farmers was Rs.30,055.90. It was highest in the case of large farmers, followed by small and medium farmers. Human labor, tractor services and fertilizers were the major cost components among the variable costs. The share of fertilizer cost to the total cost of cultivation was 11.08 per cent for the whole sample farmers in the study area. It was highest in the case of small farmers (11.44 per cent),

followed by medium (10.74 per cent) and large farmers (10.25per cent). The net income for the whole sample was Rs. 6,151.57 per hectare. It was highest in the case of large farmers, followed by medium and small farmers. The adjusted multiple coefficients of determination for the regression analysis were found to be 0.997 which indicated that 99.70 per cent of variation in the fertilizer consumption was explained by the independent variables included in model. All the variables included in the model except cost of procurement of fertilizer input contributed positively to the mean level of fertilizer consumption in paddy production in the study area. DEA was used to measure the technical efficiency of fertilizer input in combination with other inputs. The study results showed that only 4 farmers were the most efficient among the selected sample farmers in the study area.

Duxbury (2000) uses a composite index to measure the imbalance in fertilizer consumption, with Punjab and Haryana topping the list, followed by Bihar, Kerala, and Rajasthan. The primary cause of the uneven use of synthetic fertilizers is their misuse, particularly N fertilizers. Furthermore, inconsistent application and excessive fertilizer use are serious issues, especially given the considerable soil deterioration and yield losses they result in. The study discovers that there has been a considerable drop or stagnation in yield level, particularly with respect to rice, after reviewing the data from various long-term studies on intensive rice-wheat systems. For instance, in eight out of 11 long-term (over eight years) rice-wheat studies in India and Nepal, rice yields in relation to the highest yielding treatments have decreased, while wheat yields have decreased in three cases.

Bundyopadhya (1992) examines the effectiveness of chemical fertilizers (NPK use) in terms of yield per unit of plant nutrients applied for paddy cultivation in the states of Assam, Orissa, and West Bengal with two sets of villages. One set of the villages received crucial production inputs, training, improved production techniques, and free-soil testing, while the second set of the villages served as the control group and received no such inputs. Contrary to expectations, there was a surprising lack of variation between the two groups of villages in terms of the output achieved and the efficiency of fertilizer use; fertilizer usage efficiency was found to be noticeably high in both villages. These surprise findings clearly demonstrate that farmers utilize their own reasoning when selecting their production technology; in other words, given the suitability of any technology, farmers would accept it even without the assistance of any extension support or subsidized inputs. This places the responsibility for creating regionally specialized industrial technologies on researchers and decision-makers.

Frank Notes (1985), enhance the effectiveness of fertilizer application to boost agricultural output. He says it is imperative to boost production per unit area through heavy use of external plant nutrients, notably chemical fertilizers, given the restriction on further extension of the cultivable land. Yet, using expensive chemical fertilizers frequently results in higher crop costs. Hence, optimizing fertilizer use would boost profit through greater yield. He adds that adequate agronomical methods are required, and depending on the soil and climate, an optimal combination of different nutrients is required. He notes that in this regard, the use of micronutrients, appropriate soil conservation measures, watershed management, etc. need to be encouraged for increasing fertilizer use efficiency. Under an intensive cropping system, balanced use of all essential nutrients, including secondary nutrients, assumes greater significance.

3.6 Farmers Preference for Different Fertilizers

Magen, Imas & Bansal (2020) The International Potash Institute (IPI) has initiated the distribution of a questionnaire to several hundred farmers in villages and locations across India and in two locations in East China, and to approximately a hundred fertilizer dealers in India. The results were compiled and compared between the two countries and, in some cases, between villages of the same country. The results show that Chinese farmers rarely avoid the annual application of nitrogen (N), phosphate (P), potash (K) and Organic Matter (OM), when compared with farmers in India. About 40% of farmers asked in India add K 'sometimes' or 'never', while 10% only apply 'sometimes' in China. The use of a soil test was highly varied between the various locations in India but was very low in the two locations surveyed in China. Dependence on precipitation and the socio-economic level of farmers strongly affects the use of nutrients and consumption of services such as soil testing. Regular contacts with extension services also varied greatly between locations in India and were quite high in China. Indian farmers appear to appreciate less the knowledge of the fertilizer dealers, mostly ranking their knowledge as poor to medium, but Chinese farmers tend to rank the dealers' knowledge as "good" and "very good". Most farmers in the survey appreciate workshops and meetings as the best channels for receiving agronomic information, followed by TV and information sheets. It is concluded that, in order to make the most efficient dissemination of agricultural knowledge, a site-specific knowledge transfer policy has to be tailored according to the local agronomic, social, economic, and societal parameters and the needs of the region.

Ramappa & Kannan (2016) there are concerns about the indiscriminate use of chemical fertilizers by farmers with a view to increase the crop yield. This has led to deterioration of soil structure, wastage of nutrients, and destruction of soil microorganisms and scorching of plants in the extreme cases. Soil test based nutrient management is important for maintaining soil productivity. The Integrated Nutrient Management (INM) Division of the Ministry of Agriculture, Government of India entrusted this study to Agro-Economic Research Centers/Units to analyze the constraints in the adoption of soil testing and application of recommended doses of fertilizers through farmers' survey. The present report discusses issues related to adoption of soil testing and recommended doses of fertilizers for paddy and maize in Karnataka.

Garima et al (2014) This study was undertaken to assess farmers' preferences and willingness to pay (WTP) for various climate-smart interventions in the Indo-Gangetic Plain. The research outputs will be helpful in integrating farmers' choices with government programs in the selected regions. The Indo-Gangetic Plain (IGP) was selected because it is highly vulnerable to climate change, which may adversely affect the sustainability of the rice-wheat production system and the food security of the region. Climate-Smart Agriculture (CSA) can mitigate the negative impacts of climate change and improve the efficiency of the rice-wheat-based production system. CSA requires a complete package of practices to achieve the desired objectives, but adoption is largely dependent on farmers' preferences and their capacity and WTP. To assess farmers' choices and their WTP for the potential climate-smart technologies and other interventions, we used scoring and bidding protocols implemented through focus group meetings in two distinct regions of Eastern and Western IGP. We find that Laser Land Leveling (LLL), crop insurance, and weather advisory services were the preferred interventions in Eastern IGP. Farmers preferred LLL, direct seeding, zero tillage, irrigation scheduling, and crop insurance in Western IGP. Through the bidding approach, farmers implicitly express their WTP for new technologies that could transform current agricultural practices into relatively low-carbon and more productive farming methods. But actual large-scale adoption of the preferred climate-smart technologies and other interventions would require access to funding as well as capacity building among technology promoters and users.

Mall et al (2013) Future agricultural growth that is dependent on chemical fertilizers will result in increased soil quality degradation, the potential for water contamination, and an unsustainable weight on the fiscal system. Bio-fertilizers could help meet the growing need for

fertilizers, which would certainly save farmers money. This is crucial for developing nations like India in particular. This article aims to educate readers on the bio-fertilizer market, available types, potential demand, and production in India, as well as the advantages and benefits of using them.

Kumar & Nain (2013) ever increasing population poses production needs of 140 million tons of rice per year by 2025 requiring higher management practices. This demands increased emphasis on need-based training of farmers in rice production technology. The present study was undertaken in Jammu district of J&K state to delineate the farmers' training need in rice production. The study was conducted on 80 randomly selected farmers of R.S. Pura block with a pre-structured interview schedule. The findings revealed that the farmers were requiring training in almost all the subject matter areas of rice production, especially use of insecticides, pesticides, use of manures and fertilizers, seed and seed technology and water management.

Hansson & Lagerkvist (2012) A behavioral framework and psychometric theory were used to develop a domain-specific scale to measure farmers' preferences (attitudes) for risk, when the expected benefits and perceived risks of each domain were explicitly modeled. Exploratory factor analyses based on a sample of 237 Swedish farmers highlighted three risk domains, which we termed 'Up-to-date and in deliberate control of production,' 'Carefulness and planning in general' and 'Progressive farming.' The results suggested that farmers are risk-averse in all domains. External validation of the domain-specific measurement scale suggested that it could significantly predict the observed five-year volatility in farm income. The suggested domain-specific measurement scale is of practical importance for the farmers themselves, the agribusiness, and for policymakers.

Bari et al., (2007) There findings of a study on the impact of urea fertilizer on food grains, plants, and soil are presented in the paper. The study was conducted in Bangladesh, where urea fertilizer is frequently used in agricultural production. The application of urea fertilizer boosted soil pH and electrical conductivity, as well as plant height, stem girth, and yield, according to the researchers. The study did discover, however, that the protein content of the cereal grain decreased because of the use of urea fertilizer. Preserve the health of the soil and achieve sustainable crop production, the experts advise farmers in Bangladesh to follow a balanced fertilisation strategy.

Ghosh (2004) The long-promoted fertilizer-intensive agricultural method brought forth a green revolution but also long-term harm to the soil's quality. The technology currently appears unsustainable for India's future agricultural development due to both its ecological effects and the financial strain. It is now necessary to review the conventional techniques traditionally employed in farming and to search for a thoughtful blending of chemical fertilizer-based technology and organic manure. There is concern that a change in technology from chemical fertilizer to organic manure may mean a compromise in productivity or may harm farmers' profits because manures are relatively less productive in the short term. This essay highlights the environmental advantages of a potential change in agricultural technology while also emphasizing how crucial it is to maintain crop output levels and safeguard farmers' earnings. The research examines two important crops in India in particular areas and finds that throughout time, manure use in agriculture either stagnated or decreased while fertilizer use increased significantly. In contrast to the structured and state-supported fertilizer industry, the manure market remained regional, constrained, and unorganized, and its price was much higher than fertilizer in terms of nutrients. In most circumstances, there won't be any financial loss because of a slight shift in technology towards organic manure, according to the paper's estimates of quadratic yield functions based on cross-section household level data and utilizing prices faced by farmers as stated by official survey. Yet, if the homes that lose out are paid and the price of manure is kept in check by encouraging a more active dung market, such a change may be regarded feasible.

3.7 Problems Encountered by Fertilizer Distributors and Farmers

Chandini et al (2019) However, plants grown in this manner do not develop good plant characteristics such as good root systems, shoot systems, nutritional characters, and will not have enough time to grow and mature properly. This is true even though chemical fertilizers increase plant growth and vigor, thereby meeting global food security needs. Toxic compounds from chemically generated plants will build up in the human body and are extremely harmful. The manufacture of these chemicals, whose byproducts include some poisonous chemicals or gases like NH4, CO2, and CH4 etc. that will create air pollution, is where the harmful effects of chemical fertilizers will begin. Moreover, water pollution results from the untreated disposal of industrial pollutants into surrounding bodies of water. Also, it contains the most harmful consequence of chemical waste buildup in aquatic bodies, known as water eutrophication.

Moreover, when applied to soil, its continued use impairs the health and quality of the soil, resulting in soil pollution. It is therefore imperative that we acknowledge how this crop production input is harming our ecology and environment. So, continued use of it without any reduction or wise use measures will eventually exhaust all natural resources and endanger all forms of life on earth. Only by adopting new agricultural technological practices, such as switching from chemical intensive agriculture to organic inputs like manure, biofertilizers, biopesticides, slow-release fertilizers, and nano fertilizers, which would improve the application efficiency as well as use efficiency of the fertilizers, can the negative effects of these synthetic chemicals on human health and the environment be reduced or eliminated. A healthy natural environment and ecology will result from choosing organic farming for both the present and the coming generations.

Aarthi & Rajandran (2017) Direct marketing is the strategy of one-to-one relationship between farmers and consumers. This paper discusses some basic components and challenges in direct selling. The analysis of challenges faced by the farmer's direct marketing will be convenient to take measures for the improvement of direct marketing. This study determines to ascertain the farmers constraints and analyze the factors which make direct marketing more complicated. Based on the literature review several challenging factors that affect direct marketing are measured. The study was conducted among various vegetable marketers of 61 farmers who were involved in direct marketing. The challenging factors were statistically evaluated. The research findings revealed that farmers lack cold storage and are facing heavy competition in direct selling.

Makal et al (2017) this study has identified that West Bengal farmers prefer to cultivate staple food crops, followed by accompanying food crops and lastly pure profitable crops. On average, farmers produce three different crops per year such as staples i.e., paddy: accompanying i.e., potato and various green vegetables and pure profitable crops i.e., flower, betel-leaf, potato, groundnut, sesame, and guava. These crops are dominant, profitable, and have market demand in several regions of the State. Therefore, farmers of the state prefer to cultivate these lucrative crops. Conversely, they cultivate paddy only for consumption. As a result, paddy cultivation is decreasing all over the State. Then again, there are some other reasons behind the decrease of paddy cultivation. For example, the occurrence of floods in some paddy growing areas affect paddy every year. Khanakul and Palashpai regions are the most flood affected regions of the Hooghly District. In every year a disastrous flood occurs in these areas which affect all the

villages and destroy agricultural land, livestock, farming constitution and life of the farmers. In addition, farmers of some regions fail to cultivate paddy due to lack of irrigation like Mahatpur village of Purba Medinipur. On the other hand, fragmentation of paddy land has made some holdings no longer viable for sustained production. Finally, on top of all that, the increasing cost of production on one hand, and decreasing farm gate prices on the other, have caused many farmers to stop paddy farming due to marginalization of net farm returns.

Goyal et al (2016) the critical issues that plague Indian agriculture at present are the knowledge deficit and infrastructure deficit, especially in the rural areas. Problems related to irrigation infrastructure, market infrastructure and transport infrastructure add significant cost to farmers' operations. Another issue is the lack of delivery mechanisms. There are several schemes aimed at bringing development in agriculture. We do not have effective delivery mechanisms that can translate into effective facilitation in terms of increasing productivity or decreasing cost or increasing price realization at the ground level. Moreover, inadequate government support exacerbates these issues. Thus, corporate farming could be a solution to Indian agrarian sector, but it needs a deep thinking and innovating better policies so that neither the corporate nor the farmers be at loss. Also, the role of central government and state governments needs to be defined clearly as because of being a joint subject, it creates a lot of confusion. Eminent experts should do research in this aspect and governments must take proactive action. Indian agrarian sector in fact requires very innovative ideas for uplifting of this sector. Also, without mechanization, farming is hard and back-breaking work. This has resulted in most farmers' children quitting farming and going for other vocations. Farmers get more money from selling their land to builders, malls, and factories. This has put more pressure on farmland, thereby requiring technologies to increase the productivity so that shrinking farmland can feed billion plus people of India in the future. India, though one of the biggest producers of agricultural products, has very low farm productivity, with the average only 33 percent of the best farms world over. This needs to be increased so that farmers can get more remuneration from the same piece of land with less labor.

Kumar & Sinha (2015) IP protection to agricultural biotechnology has remained a contentious issue in India having serious implications for stakeholders and agricultural innovation. Farmers and plant breeders made strong resistance against the extension of IP monopoly to agriculture sector and were skeptical that their rights could be compromised against the interest of giant agro-based companies. However, the growing need to enhance food production, improve the

quality of seeds, experiment the nutritional content of food crops and attract investment in agricultural field necessitated the conjunction of IPR and agricultural biotechnology. India has adopted a dual form of IP protection for agricultural biotechnology; plant varieties are protected through the Protection of Plant Variety and Farmers' Rights Act 2001, while the genetic traits of plants are protected through the Patents Act 1970. Though the line of demarcation as to the application of both the laws is theoretically drawn, enormous confusion persists on practical level. The IP protection to agricultural biotechnology has not produced desired results in India due to asymmetrical innovation model, complex regulatory structure, and confusing regulatory approach. The exclusive licensing practices with exorbitant licensing fee on uneven licensing terms place licensor, licensee and end user in a conflicting position and raise the issues of accessibility and affordability of technology.

Kumar & Nain (2013) ever increasing population poses production needs of 140 million tons of rice per year by 2025 requiring higher management practices. This demands increased emphasis on need-based training of farmers in rice production technology. The present study was undertaken in Jammu district of J&K state to delineate the farmers' training need in rice production. The study was conducted on 80 randomly selected farmers of R.S. Pura block with a pre-structured interview schedule. The findings revealed that the farmers were requiring training in almost all the subject matter areas of rice production, especially use of insecticides, pesticides, use of manures and fertilizers, seed and seed technology and water management.

Arndt, et al (2013) Program evaluations often overlook economywide spillovers and constraints. We estimate the impact of Malawi's Farm Input Subsidy Program using a computable general equilibrium model informed by household-level studies. We find that indirect benefits account for about two-fifths of total benefits, underscoring the complementary difference between economy wide and survey-based program evaluations. Benefit-cost ratios fall when domestic taxes finance the program or when real fertilizer prices rise. Abstracting from very strong weather events, we find that Malawi's program potentially generates double-dividends in the form of higher and more drought-resilient yields. Overall, using parameters like survey-based evaluations, we identify mostly positive economy wide returns over a range of program designs and risks. However, like earlier evaluations, benefit-cost ratios depend strongly on assumptions about fertilizer dose-response rates; and the dose-response rates from ex post survey-based studies generate benefit-cost ratios less than one even when indirect program benefits are included.

Ferroni & Zhou (2012) the purpose of extension is to disseminate advice to farmers. Knowledge gaps contribute to yield gaps. Services and quality inputs are essential productivity-enhancing tools. However, their optimum use requires knowledge. Farmers also need information on prices and markets, post-harvest management, produce quality determinants, and safety standards. Some farmers marshal knowledge themselves. The "resource-poor" majority, growers of much of India's food, need external, science-based, extension to complement local knowledge. Much debate focuses on how best to achieve the desired outcomes that extension can convey. Many countries have neglected extension and indeed agriculture. But interest appears to be returning globally, and India is no exception. In 2009, a National Seminar on Agriculture Extension discussed knowledge management, convergence of extension systems, the role of information and communication technology and mass media, private sector initiatives including public–private partnerships, and farmer- and market-led extension systems. This article builds on that discussion. It looks at extension in relation to both primary production and market links, and acknowledges the contributions of all providers of extension, public and private.

Charyulu (2010) Availability of quality organic inputs is critical for success of organic farming in the country. Development of an efficient input marketing system is the need of the hour for strengthening the organic food production in India. This paper made a humble attempt to understand the economics of production and marketing of organic inputs in four states of India sanctioned under NPOF scheme. The results concluded that the average capacity utilization of sample units was 76.2 TPA which is nearly half (50.8%) of its full potential. Overall, the average cost of production of vermi-compost was Rs.286 per quintal. The mean price realization and net margins were Rs.506 and 220 per quintal respectively. Most of the sample units follow a direct method of marketing organic inputs. In general, the demand for these products was very low. The major reasons are lack of awareness, absence of existing marketing channels, adulteration of products and low-price realization etc.

3.8 Research Gap

The prior research discussed the factors affecting fertilizer use and fertilizer use efficiency, including fertilizer subsidies, their removal, nutrient-based subsidies, and others. On the other hand, the consumption of fertilizer is the study and there is no pertinent study. Specifically, there hasn't been any research on India's nutrient-based fertilizer subsidy policy and how it

affects the factors that influence farmers' purchasing decisions. The goal of the current study is to evaluate the effectiveness and impact of the fertilizer subsidy policy.

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