FACTORS DETERMINING AGRICULTURAL OUTPUT IN INDIAN STATES: AN ANALYSIS

[1]Prasant Kumar Panda & [2]Rittu Susan Varkey

[1]Associate Professor, Department of Economics, Central University of Tamil Nadu, Email: prasantkumar@cutn.ac.in
[2]PhD Scholar, Department of Economics, Central University of Tamil Nadu, Email: rittususan92@gmail.com

Abstract: The study examines the factors affecting agricultural output for the fifteen general category states for the time period 1991 to 2013. The special category states have not been included considering their nature of developments and location of the region are different than those of general category states. Panel Fixed Effect Model has been specified to study determinants of agricultural output. Hausman statistic suggests for use of fixed effect within coefficients. The agricultural output of a state has been modelled as a function of gross irrigated area, gross sown area, fertilizer consumption, forest cover as a proxy representing environment performance, agricultural credit and development spending by the government. The variables, such as gross sown area, gross irrigated area, fertilizer consumption, development expenditure and agricultural credit have positive significant relationship on agricultural output of a state. Forest cover emerged to have a negatively significant relationship with agricultural output. Public investment in agriculture and infrastructural development like irrigation facilities will promote agricultural growth in Indian states. In addition to it provision of pro agricultural services like banking and insurance will help in increasing the yield from the farm sector.

Keyword: Agricultural sector, Fixed Effect Model, Determinants of agricultural growth, public investment, India

JEL: O4, C3

INTRODUCTION

Agriculture plays an important role for the Indian economy as it provides livelihood opportunities for its people. Besides, for meeting the increasing needs of food grains requirement and checking imports of food grains, expansion of agricultural output and rise in agricultural productivity are essential.

With the progress of a country and an enlargement in its GDP basket there accompanies a shift in a countries economic activity from agriculturally oriented to industries and services (Lewis ,1954). India has also not been an exception to this, like any other developing country it has transformed itself from an agrarian economy in the 1970s to a rapidly growing service driven economy in the

1990s. The post reform period was largely influenced by the boom in the service sector growth. Figure 1 shows the decline in the contribution of agriculture to total GSDP. Prior to the reform's agriculture was a major component in states GSDP whereas after the reforms the agriculture contribution in the total GSDP has decreased.

In spite of the declining share of agriculture in total GSDP this sector is the bread winner for about 50 percent of the population (Agricultural census ,2012). The importance of agriculture cannot be overlooked as it is closely linked to other sectors. It provides raw materials to the industry like sugar, cotton, jute, rubber products, timber etc. On the other hand, it uses inputs like fertilizers, pesticides, electricity, machines etc. If any surplus is generated from the sector would help in capitalizing

other sectors Saikia (2011). The services on the other hand provides agriculture with facilities like transport, warehousing, communication, agricultural credit and insurance. Therefore, a simultaneous development of all sectors is important in order to achieve rapid economic growth. It should be noted that revolution associated with industry and agriculture should necessarily move simultaneously and those economies in which agriculture stagnates would not show any form of development.

In order to increase agricultural production and cater to the lives of the people dependent on it, becomes

essential to find out the factors that will help in sustaining agricultural growth. Agricultural production depends on a number of fixed as well as variable factors. The fixed factors include access to land, availability of Labour, rainfall on the other hand, the variable factors include agricultural credit, mechanical power, availability of seeds, fertilizers, pesticides, insecticides, natural disaster population as well as the controls exercised on markets.

Ahluwalia (2000) suggests that the performance of states in its economic front after the policy reforms of 1990s has not received enough attention by policy makers as there has

Figure 1: Contribution of Agriculture in total GSDP (State level)
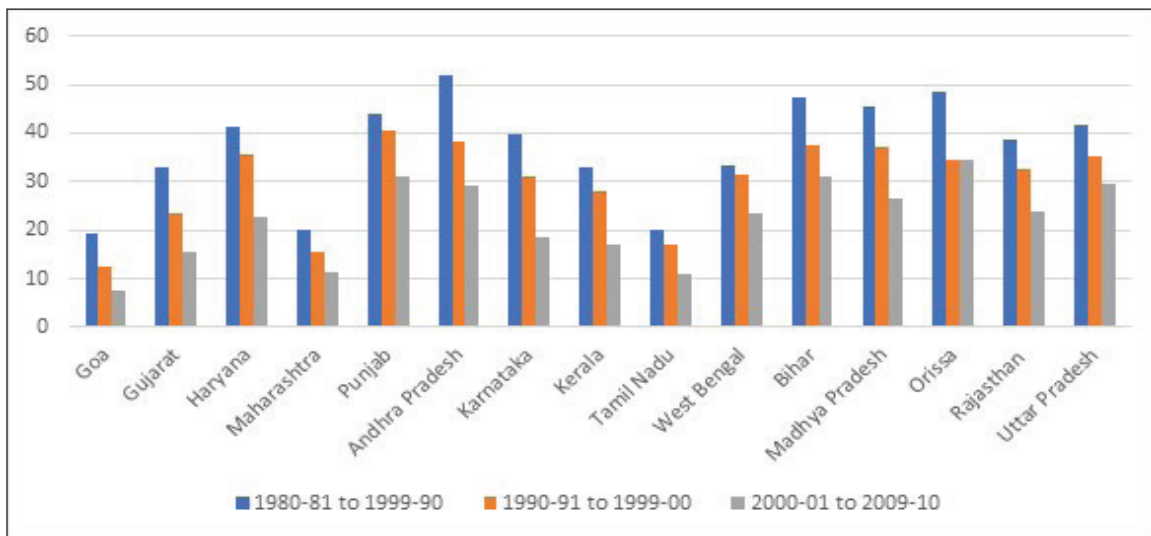
Source: Varkey and Panda (2018)

not been any state specific targets for the country as a whole. A careful analysis of the plans also reveals that it lays down targets for the national aggregate but state specific targets have been ignored. This topic deserves widespread attention firstly due to the countries federal structure where states have to play a key role in many areas like roads, agriculture, irrigation, water supply, power education as well as health. Secondly decentralization of decision making and lastly to study the rapid inequalities across states. Thirdly past performance can help in formulating future policies.

In this backdrop, the study tries to determine the important factors contributing to the agricultural development of a state in a panel frame work. Agricultural output has been modelled as a function of gross

sown area, gross irrigated area, fertilizer, forest cover, development expenditure and agricultural credit on agricultural development of a state.

The remainder of the paper is arranged as follows: Review of literature is given section 2. Empirical frame work of the study is given in section 3. Empirical results and discussion are given in section four and section five provides conclusion and suggestions pertaining to the study

LITERATURE REVIEW

Barnes and Binswanger (1986) have studied the impact of rural electrification on agriculture. The study found more impact on well irrigation rather than total irrigation on agriculture. It was through the investment in pump

set that the villages had an indirect effect on well irrigation. On the other hand, the growth of grain mills is directly related to number of years that a village has been electrified. With the passage of time the impact of electricity has increased but in terms of innovation the increase has not been that much as found in the study. The finding of multiple cropping on agriculture has not been as robust as the well irrigation, due to a number of factors like soil rainfall water and other factors

Binswanger and Khandker (1995) have found that the impact of rural finance on the farm sector is smaller than that which is observed in the non-farm sector. The rural finance has on the other hand positively impacted the inputs like fertilizer and investment in machines.

Desai and Namboodiri (1997) have analyzed total factor productivity in agriculture is a function of barter terms of trade, government expenditure in agricultural research and education as well as crop development programmes, fertilizer ratio measured by the ratio of phosphorous tri oxide to nitrogen, percentage of land irrigated by canal irrigation, percent of rural literacy, marketing and banking infrastructure density, density of rural roads, Gini ratio of owned land distribution, Gini ratio of operational land distribution and the average rainfall received. The barter terms of trade is negatively contributing towards total factor productivity. Whereas government expenditure has also been positively contributing towards total factor productivity. Canal irrigation has also been negative due to reasons like inefficiency in its management. Literacy rate is negative but not significant. Average rainfall, density of rural roads, density of banking infrastructure and fertilizers are all positively contributing towards the total factor productivity. Out of the two-land distribution variable owned land distribution is negative, whereas the distribution of operational land is positive. As inequalities in the owned land distribution increases it reduces total factor productivity.

Fan et al. (2000) have used state level data of India in a simultaneous linear framework. The results show that there needs more investment in agricultural research, irrigation, infrastructure like roads and electricity supply and rural poor oriented development programmes has helped in reducing poverty as well as the productivity

in agriculture. Irrigation on the other hand has modest impact on rural poverty as well as agricultural productivity. Governments investment on health affected rural poverty to a smaller extent whereas it did not impact the agricultural productivity.

Bhattarai and Narayanamoorthy (2003) have found that irrigation has played an important role in reducing the gravity of inequalities across states. They have observed that gross cropped area under irrigation has contributed negatively to the poverty incidence and positively to the consumption model. HYV and literacy has been negatively contributing to the poverty incidence. On the other hand, the HYV adoption rate and literacy has been positively contributing in the consumption model.

Bhattacharya et al. (2004) have found that the net sown area has a positively significant relationship on agricultural output. Rainfall has a positively significant relationship for all the three states. Irrigation and fertilizer have been used as a determinant for Uttar Pradesh and they have positive significant relationship.

Odhiambo et al. (2004) have observed that the key determinants of agriculture total factor productivity growth are trade ratio, import penetration, real exchange rate, rainfall, and government expenditure in agriculture, access to credit, roads and school enrollment for Kenya. Trade ratio and import penetration are negatively significant whereas rainfall and government expenditure in agriculture are positively significant.

Narayanamoorthy et al. (2006) have used a multi variate analysis for 256 districts of India for three years 1970-71,1980-81,1990-91. Agricultural output has been defined as a function of cropping intensity, fertilizer, electricity, irrigation, literacy, road. Two models have been estimated one with lagged values of infrastructure and other without the lagged values. Except rural electrification variable, all the other infrastructure variables show a positive significant relationship on agricultural output. Fertilizer has been significant for the period 1980-81 and 1990-91 in the two models.

In the work of Badar et al. (2007) have modelled agricultural production with cropped area, agricultural labour, fertilizer consumption, distribution of improved seeds, the governments expenditure on agricultural

research, land reclamation and food trading services, the minimum support price for wheat. Agricultural labour and seed distribution have positive and significant impact on agricultural production, whereas the fertilizer consumption has a negative impact.

Chand et al. (2007) have observed that rainfall, institutional credit and fertilizer are key determinants of agricultural output. Dasgupta and Singh (2005) have used the Dynamic panel model, Arellano Bond regression for the districts of Maharashtra, West Bengal, Punjab and Andhra Pradesh. Agricultural credit obtained directly contributes positively to the agricultural output. Whereas agricultural credit obtained indirectly is positively significant with the lag.

Tripathi and Prasad (2010) have analysed the impact of the production inputs on agricultural growth. The gross value added of agriculture has been modelled as a function of agricultural land, agricultural labour and capital used in agriculture. In addition to it an intercept and slope dummy has been used. The results show that during the period 1950-51 to 1964-65 land has been significant. Whereas in the latter half it was labour and capital that had a significant relationship with agricultural gross value added.

Aggarwal et al. (2009) the key determinants affecting crop growth and yield has been given as the interactions between crop and climate, availability of water, suitability of soil, the interactions between crop and pest and lastly socio-economic factors. Kannan et al. (2012) has found that capital formation, rainfall, improved irrigation and fertilizer use will help in improving the crop output for India.

Narayanamoorthy et al. (2015) have modelled agricultural output with cropping intensity, fertilizer, electricity, road, rural literacy, irrigation. The multivariate regression has been performed with and without the use of irrigation dummy for five data points (1970-73,1980-83,1990-93,2003-06,2005-08) for 2035 districts of 13 Indian states. Crop intensity has been positively significant for the initial three periods using irrigation as a dummy. Whereas fertilizers in both the model are significant for all the years except the initial years. Electricity has been significant only in the initial years for the two models.

Irrigation has played a dominant role but the value of the coefficient has been decreasing. Rural literacy has been significant for all the years in both the model. The availability of roads has also played an important role for the initial three years for the two models.

Patra et al. (2016) have found that the use of modern inputs of agriculture like fertilizer has not helped in sustainable agricultural growth for the Hooghly district of West Bengal. The use of these fertilizers has led to loss of soil fertility as well as environmental degradation.

McArthur and McCord (2017) have used fixed effect and instrument variable approach to study the link between agricultural inputs like water, high yielding seeds, fertilizer with the yields per hectare. All these three variables contributed positively towards cereal yield. The study also finds that there is stronger yield as well as growth if the inputs adopted by the green revolution is emphasized.

India is the largest contributor towards global food market. For the agriculture sector to progress its growth strategy should focus on innovation as well as towards catering towards the market demand that is dynamic. The use of digital technologies will help in lower cost as well as customized sale. It will also aid in scale operations. In addition to it the present growth strategy for agriculture has to focus on new markets, better roads as well as transport, storage and availability of electricity supply. Technology led agricultural growth has been accepted as a public regime in India and has helped in easy access and affordability of technology (Seth and Ganguly ,2017).

Huang et al. (2018) have found that adequate nourishment is necessary to ensure higher crop production and growth. A logit regression analysis has been performed in order to find the important determinants of soil testing and fertilizer determinants for rural Bangladesh. Among the coefficient's farmers age, education, farmers income, secondary income and knowledge of soil testing and fertilizer recommendation was positively significant. Whereas the variables the experience in farming and farm size was negatively significant.

The following reviews are on the sectoral linkages across agriculture. The paper Gemmell et al. (2000)

have studied the inter sectoral linkages of agriculture, industry and services for the Malaysian economy. Each sector is modelled with the labor and capital used in the sector along with the externalities generated from other sectors. the development of manufacturing has positive impact on Malaysia agriculture in the long run. For the Malaysian economy the policies that aim to bring progress in manufacturing will have a positive impact on the agriculture sector. On the other hand, policies strengthening agriculture will have a negative impact on agriculture. Lastly policies targeted towards service sector expansion will have negative impacts for agriculture. Sastry et al. (2003) have used the Leontief input output model and has found agriculture that despite the sudden spurt in service led growth the role of agriculture in the other sectors of the economy was highly inevitable. Kaur et al. (2009) have used the Leontief input output model found that although form the production side the industry and services had a greater degree of association from the demand side the industry agriculture association was more. Saikia (2011) has used the Leontief input output model using the input output table given by Central statistical organization to estimate the intersectoral linkages. It has been found that there has been a decrease in the agriculture industry linkage after the reforms. Prior to the reforms both the production and demand linkages were from agriculture to industry. The reforms on the other hand has helped in changing the direction of both production and demand linkages from industry to agriculture.

Varkey and Panda (2018) have used Panel cointegration and Fully Modified Ordinary least squares to study the determinants of agricultural growth in an open economy framework. Industry was an important determinant contributing to agricultural growth rate. The impact of rest of the state's industry and services was not significant. The services on the other hand was negatively significant. A time series analysis showed that the rest of the states has been significant for the states of Bihar, Madhya Pradesh, Orissa and Rajasthan.

Studies so far have looked at the concept of determinants of agricultural output for the national as well as sub national aggregates. In these lines, the present study looks at the determinants of agricultural output in a Panel framework for all the fifteen general category states.

DATA AND METHODOLOGY

Data have been collected from the Central Statistical Organization, Reserve Bank of India, Forest survey of India category states [1] for the period 1991 to 2013. The states that are under the special category have not been included considering their nature of developments and location of the region are different than those of general category states. The variables used in the study are agricultural output (AGSDP) as dependent variable. The explanatory variables include gross sown area (GSA), gross irrigated area (GIA), fertilizer consumption (FCN), forest cover (FC) and development expenditure (DE) of states. Forest cover has been used as a proxy for measuring environment performance. The data on agricultural output has been spliced to the 2004-05 base year.

All the variables have been transformed into their natural logs. Fixed Effect Model and Random effect model coefficients have been estimated. Hausman test supports the use of Fixed Effect coefficients. The model in its general form has been given below

$$AGSDP_{it} = \beta_0 + \beta_1 GSA_{it} + \beta_2 GIA_{it} + \beta_3 FCN_{it} + \beta_4 FC_{it} + \beta_5 DE_{it} + e_{it} \quad (1)$$

EMPIRICAL RESULTS AND DISCUSSION

The regression coefficients of agricultural output obtained through Fixed Effect estimation has been shown in Table 2.

Table 2: Agricultural Output as the Dependent Variable

Variable	Coefficient	Prob
GSA	0.4594*	0.0000
GIA	0.0008***	0.0962
FCN	0.5201*	0.0000
FC	-0.08050**	0.0122
DE	0.0436*	0.0002
AC	0.02791**	0.0115
C	8.61414*	0.0000
R Square (over all)	0.8437	
F-Stat (P Value)	134.6	0.000

Note: *, ** ,and *** indicate significance at 1%, 5% and 10% level of significance.

Source: Authors calculation from basic data.

Gross sown area is the aggregate sum of area cultivated more than once in a year. It depends on various factors like the availability of water, fertility of the soil and the pattern of cropping employed. Gross sown area if increased will have a positive association with the agricultural production. The results in Table 2 shows that the gross sown area has positively and significantly contributed to the agricultural output of a state. For a percentage increase in the net sown area agricultural output increases by 0.45 percentage.

An important determinant that will facilitate a stable agricultural economy is irrigation. The timely supply of water to the farms will reduce the chances of crop failures and facilitates a higher yield from the crops. Irrigation is also essential for regions with rainfall as it helps in reducing the shocks due to short dry spells that these regions can experience in the future. Gross irrigated area also has positively significant relationship on agricultural output of a state. A percentage increase in gross irrigated area by one unit leads to a percentage increase in the agricultural output by 0.0008.

Agricultural production faces a lot of threats associated with the pests, secondly loss of fertility of the soil, as well as depletion in the nutrients. All these factors will lead to a decrease in the agricultural production. The fertilizers used include nitrogen, Potassium and Phosphorous. Nitrogen is essential for any living organism as it helps building cellular components, nucleic acids and proteins. This will facilitate the growth of plants. Potassium on the other hand will help in the photosynthesis and other bio chemical process in plants. Lastly Phosphorous also aids in photosynthesis and respiratory functions. The results show that fertilizer has a positive significant relationship with the agricultural output. For a percentage increase in the fertilizer consumed agricultural output increases by 0.52 percentage.

The highly intensive agricultural activities through the use of rapid fertilization is contributing to the depletion of the natural resources. Intensive cultivation with chemicals and uses of energy will help increase the agricultural yield. On the other hand, it also helps in generating externalities like loss of biodiversity. It has also led to increase in soil erosion, as well as changes in climate.

The scenario has also depleted the natural resources which are necessity for the sustenance of the human race. As our study focusses on state level analysis, we have used forest cover as a proxy for environment performance. It was the14[th] Finance commission that include forest cover as a proxy for environment performance in determining the center state transfers across states. Environment performance has a negative association with agricultural growth. In recent days forest cover has been depleting and agricultural output is expanding through modern means of use of large fertilizer consumption. One percent increase in fertilizer consumption in the state increases agricultural output by 0.52 percentages.

In order to take into account government spending on agricultural research, infrastructure etc. development expenditure has been used. The development expenditure of the government also has a positive significant impact on agricultural development of state. For a percentage change in the development expenditure agricultural output increases by 0.04 percentage.

Lastly availability of agricultural credit is an important component for sustaining production across states. Over the years it has been found that credit is essential for the small and marginal farmers for their survival (Das and Senapati,2009). It is also necessary for the large farmers so that they can improve their earning probability. Credit for agricultural sector significantly and positively influences agricultural productivity across states. For a percentage change in the availability of credit for agricultural purposes agricultural output increases by 0.02 percentage. Therefore, pro agricultural services like banking play an important role for the development of agricultural output across states.

CONCLUSION AND SUGGESTIONS

The study examines the factors determining agricultural output for the fifteen general category states for the time period 1991 to 2013. Fixed Effect Model has been used to study the impact of various factors on the agricultural output of a state. The variables like gross sown area, gross irrigated area, fertilizer consumption, government expenditure, agricultural credit is found to influence agricultural output positively. On the other hand, variable like Forest cover was found to be negative and significant.

Therefore, facilitating agricultural inputs, increasing facilities for irrigation by utilizing water resources, and increased government spending will help in promoting agricultural output. It is necessary to keep a check on our forest cover in order to ensure environmental sustainability so that we can cater to the needs of the future generation. Government's intervention in pro agricultural services like banking through provision of agricultural credit will also help in reaping larger benefits to the farm sector.

NOTE

Tamil Nadu, Kerala, Andhra Pradesh, Karnataka, Goa, Orissa, Maharashtra, West Bengal, Madhya Pradesh, Bihar, Gujarat, Punjab, Rajasthan, Uttar Pradesh

REFERENCES

Aggarwal, P. et al. (2009). Determinants of Crop Growth and Yield in a Changing Climate. *Rainfed Agriculture: Unlocking the Potential.*

Ahluwalia, M. S. (2000). Economic Performance of States in Post-Reforms period.

Economic and Political Weekly, Vol. 35(19):

Badar, H., Ghafoor, A., and Adil, S. A. (2007). Factors Affecting Agricultural Production of Punjab (Pakistan). *Pakisthan Journal of Agricultural Sciences*, 44(3):506-510

Barnes, D. F. and Binswanger, H. P. (1986). Impact of Rural Electrification and Infrastructure on Agricultural Changes, 1966-1980. *Economic and Political Weekly*,21(1): 26–34.

Bhattacharya, B., Bhanumurthy, N., Kar, S., and Sakthivel, S. (2004). Forecasting State Domestic Product and Inflation: Macroeconometric Model for AP, Karnataka and UP. *Economic and Political Weekly*, 39(31):3541–3550.

Bhattarai, M. and Narayanamoorthy, A. (2003). Irrigation Impact on Agricultural

Growth and Poverty Alleviation: Macro Level Impact Analyses in India. IWMATata Workshop, January.

Binswanger, H. P. and Khandker, S. R. (1995). The Impact of Formal Finance on the Rural Economy of India. *The Journal of Development Studies*, 32(2):234–262.

Chand, R., Raju, S., and Pandey, L. (2007). Growth Crisis in Agriculture: Severity and Options at National and State levels. *Economic and Political Weekly*, 42(26): 2528–2533.

Dasgupta, S. and Singh, A. (2005). Will Services be the New Engine of Indian Economic Growth? *Development and Change*, 36(6):1035–1057.

Desai, B. M. and Namboodiri, N. (1997). Determinants of Total Factor Productivity in Indian Agriculture. *Economic and Political Weekly*, 32(52).A165–A171.

Fan, S., Hazell, P., and Thorat, S. (2000). Government Spending, Growth and Poverty in Rural India. *American Journal of Agricultural Economics*, 82(4):1038–1051.

Forest Survey of India (2018). Ministry of Environment, Climate and Forest Change.

Gemmell, N., Lloyd, T., and Mathew, M. (2000). Agricultural Growth and Intersectoral Linkages in a Developing economy. *Journal of Agricultural Economics*, 51(3):353–370.

Huang, Z., Karimanzira, T., et al. (2018). Investigating Key Factors Influencing

Farming Decisions Based on Soil Testing and Fertilizer Recommendation Facilities (STFRF)A Case Study on Rural Bangladesh. *Sustainability*, 10(11):4331.

Kannan, E. et al. (2012). Trends in India's Agricultural Growth and its Determinants. *Asian Journal of Agriculture and Development*, 8(2):79.

Kaur, G., Bordoloi, S., and Rajesh, R. (2009). An Empirical Investigation on the Inter-Sectoral Linkages in India. *Reserve Bank of India Occasional Papers*, 30(1):29–72.

Lewis, W. A. (1954). Economic Development with Unlimited Supplies of Labour.

The Manchester School, 22(2):139–191.

McArthur, J. W. and McCord, G. C. (2017). Fertilizing Growth: Agricultural Inputs and their Effects in Economic Development. *Journal of Development Economics*, 127:133–152.

Narayanamoorthy, A., Alli, P., Suresh, R., et al. (2015). Is the Role of Irrigation in Agricultural Output Declining in India? A District-Wise Study at Six Time Points. *Indian Journal of Agricultural Economics*, 70(3):333.

Narayanamoorthy, A., Hanjra, M. A., et al. (2006). Rural Infrastructure and Agricultural Output Linkages: A Study of 256 Indian Districts. *Indian Journal of Agricultural*

Economics, 61(3):444.

Nayak, D. K. (2017). Changing Cropping Pattern, Agricultural Diversification and

Productivity in Odisha A District-Wise Study. *Agricultural Economics Research Review*, 29(1):93–104.

Odhiambo, W., Nyangito, H. O., and Nzuma, J. (2004). *Sources and Determinants of Agricultural Growth and Productivity in Kenya*. KIPRA Discussion Paper No:34.

Patra, S., Mishra, P., and Mahapatra, S. C.and Mithun, S. K. (2016). Modelling Impacts of Chemical Fertilizer on Agricultural Production: A Case Study on Hooghly District, West Bengal, India. *Modeling Earth Systems and Environment*, 2(4):1–11.

Saikia, D. (2011). Analyzing Inter-Sectoral Linkages in India. *African Journal of Agricultural Research*, 6(33):6766–6775.

Sastry, D., Singh, B., Bhattacharya, K., and Unnikrishnan, N. (2003). Sectoral Linkages and Growth prospects: Reflections on the Indian Economy. *Economic and Political Weekly*, 38(24):2390–2397.

Seth, A. and Ganguly, K. (2017). Digital Technologies Transforming Indian Agriculture. *The Global Innovation Index*, pages 105–111.

Shah, T. and Singh, O. (2002). Irrigation Development and Rural Poverty in Gujarat:

A Disaggregated Analysis. In *Annual Review Meeting, November, International Water Management Institute, Colombo, Sri Lanka*.

Tripathi, A. and Prasad, A. (2010). Agricultural Development in India since Independence: A Study on Progress, Performance, and Determinants. *Journal of Emerging Knowledge on Emerging Markets*, 1(1):8.

Varkey, R. S. and Panda, P. K. (2018). Inter-sectoral Growth Linkages and their Implications for Agriculture: Evidence from Indian States. *Millennial Asia*, 9(3):262–277.