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SELECTION OF MATHEMATICAL MODELLING FOR FORECASTING OF RICE PRODUCTION IN ASSAM, INDIA

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ABSTRACT

The role of rice is vital in the development of economy of Assam as well as India. Forecasting of rice production by using time series analysis techniques may be helpful to find out the best fitted model to forecast the production of rice in Assam. Prediction of rice production in near future will help the authority to adopt appropriate strategy to tackle the management of economy related to rice production.

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INTRODUCTION

India is one of the world's largest producers of white rice and brown rice, accounting for 20% of all world rice production. Rice is India's pre-eminent crop, and is the staple food of the people of the eastern and southern parts of the country (*"India: A Country Study:Crop Output". Library of Congress, Washington D.C. September 1995. Retrieved March 21, 2009.)* The agricultural sector has a multiplier effect on any nation's socio-economic and industrial fabric because of the multifunctional nature of the sector (Ogen 2007). It has the potential to be the industrial and economic springboard from which the country's development can take off (Stewart 2000). Rice is known as the Principal crop of Assam. At present, rice occupies about two-third of the total cropped area in the state of Assam.

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Being the single major source of agricultural GDP, rice plays a significant role in the state economy. Further, its importance in the consumption basket (the average monthly consumption per capita is about 13kg) also speaks volumes on the rice orientation of the state. Another specialty is that the rice is traditionally-grown throughout the year viz. winter, autumn and summer seasons, with winter (kharif) rice as the main crop. Assam occupies a special place in the rainfed rice production system in the eastern India (being a major rainfed rice-growing area) by covering about 9 per cent of the total rice area and contributes 8 per cent to the production. At the national level, the state contributes over 5 per cent of rice area and 4 per cent of rice production. About 26 modern rice varieties are available in Assam for diverse eco-systems such as deep water, shallow water, irrigated and upland. The growth in agricultural production is essential for any economy, particularly in an agrarian economy where the food demand overstrips the supply due to population growth. . The rice has a historical significance and cultural relevance in the state of

Assam, apart from being the staple food. Despite its importance in every sphere of the agrarian economy, the performance of crop in the recent years has been unsatisfactory, which made Assam a net deficit state. In Assam, rice has been the major food in the consumption basket. However, the growth scenario of rice in the state has been quite unsatisfactory. Considering the unparallel population growth in the state, the matter requires greater attention (Barah *et al*., 2001). Rice is the most important crop and it has an important position in the agrarian economy of India. Despite that there is limited research available in case of rice productivity and climate change. From the literature review of earlier studies it is shown that the productivity of major food grain and cash crops decreases with climate change. The climate change directly affected rainfall and temperature, with rise in temperature leading to water deficit and flood in the future, changing soil moisture status, pest and disease incidence (Chinvanno, 2010). But in case of rice crops, it is to be established the relationship of climatic change on rice production. The present study will try to describe the empirical evidence about impact of climate change on rice production. This investigation would be helpful to identify that which climatic factor has negative effect on rice productivity in Assam. How various climatic factors have a seasonal influence on rice productivity in different weather seasons?

Literature Review

Climate change has decreased the agricultural productivity, raised food prices and declined consumer incomes which also reveals that climate change is declined the per capita food consumption in Egypt (Onyeji and Fischer 1993). agriculture is a more vulnerable sector, physically and economically due to climate change compared to other sectors of the economy. Further this study observed that climate change has drastic negative impacts in agricultural production(Gbetibouo and Hassan (2005). Bosello and Zhang (2005) estimated the relationship between climate change and agriculture. This research shows that climate change is complex and higher temperature will influence the production patterns. Deressa *et al*. (2005) applied a Ricardian cross section regression model and found that sugarcane production is highly sensitive to climate change. It has a negative impact on sugar production in South Africa (Deressa *et al*., 2005). Climate change has a significant negative effect on agriculture production that occupies around 40% of the land globally(Masters *et al*., 2010). In various studies it is established that the change in climate have negative affect on the productivity of food grain crop negative effects of temperature on rice productivity is reported by Saseendran *et al*. (2000) . Saseendran *et al*. (2000) also mentioned that change in temperature up to 5^0C can lead to continuous decline in rice yield and every one degree increment of temperature will lead to a 6% decline in rice yield in Kerala (India). The cultivable land of rice is lead to decrease due to the scarcity of inputs and low rainfall in Tamil Nadu (India) (Nandhini *et al*., 2006). Simulation model was employed by Hundal and Prabhjyot (2007) and mentioned that in Punjab the increase in temperature by 1^0C lead to decrease rice and wheat yield by 3% and 10%. Cobb-Douglas production function was employed by Kar and Kar (2008) to assess the rainfall effect on jowar production in Orissa (India) and in their study annual rainfall is included as climatic factors and concluded that low rainfall has negative impact on jowar production as well as income of the poor farmers. A state wise analysis for four states of India, namely Punjab, Haryana, Rajasthan and Uttar Pradesh was performed by Kalra *et al*. (2008) and it is found that the wheat, mustard, barley and chickpea production has decreased due increase in seasonal temperature.

It is well mentioned by Kapur *et al*. (2009), that rainfall may decrease crops yields by 30% by the mid 21st century and this particular study also justified that there would be reduction in arable land that could be results in more pressures on agriculture production In India. The projected large-scale changes in the climate would lead to significant reductions in rice and wheat crop yields by 2060 (Kumar and Parikh ,2001) . It may affect the food security of more than one billion people in India. By using a simulation model Haris *et al*. (2010) mentioned that rice production may lead to decrease by 31% in 2080 due to climate change in the state of Bihar in India. The climatic effects on paddy and corn crops was analysed by Hari *et al*. (2010) and observed that climate change adversely affect the paddy and corn crop since last decade in most of the districts of Uttar Pradesh of India. The climate change has shifted the weather condition which affected the seasonal crops and reduced the available growing time of rice and sugarcane crops in Uttarakhand and Uttar Pradesh, India (Kumar *et al*., 2011a). Geetha lakshmi *et al*. (2011) reported that the productivity of rice has declined by 41% with 4^0C increase in temperature in Tamil Nadu (India). Kumar *et al*. (2011b) argued that irrigated area for the production of maize, wheat and mustard in northeastern and coastal regions; rice, sorghum, and maize production in Western Ghats may decline due to climate change. The climatic impact on crop productivity of rice, sorghum and millet at macro level was studied by Gupta *et al*. (2012) where they included average temperature and actual rainfall in growing time of these crops and it is found that climate change is likely to reduce the yields of rice, sorghum and millet crop in 16 major agriculture intensive states of India. Ricardian cross sectional regression model was employed by Kumar (2009) to investigate the effect of climate sensitivity on farm net revenue in India. Kumar (2009) in his study undertaken maximum temperature and actual rainfall in three weather seasons like autumn, summer, rainfall and winter where he found that climate change is results in 9% reduction in agricultural farm net revenues in India. The impact of climatic and non-climatic factors on productivity of major food grain crops in India using a Cobb-Douglas production at state level panel data in India was investigated by Kumar *et al*. in 2014 where the authors included average minimum temperature, average maximum temperature and actual rainfall as climatic factors in growing time of each crops (sowing time to harvesting time). The most empirical result of the study reveals that productivity of wheat, barley, gram and rice crops are declined due to increase in actual average minimum temperature and also the productivity of rice, maize, sorghum, and ragi crops are lead to decrease with increase in actual average maximum temperature in growing time of corresponding crops.

MATERIALS AND METHODS

The sudy will be carried with the help of following secondary data.

- Rice production of last 50 years
- Rainfall of last 50 years
- Temperature of last 50 years

- Relative Humidity of last 50 years
- Arable land under rice cultivation

Importance of the Study

Climate change is very harmful for agricultural sector as many more studies give the clear picture that the agriculture productivity is decreased due to climate change in different regions of India and other countries of the world. In India the productivity of major food grains like wheat, rice, maize may also be affected due to climate change and hence any suitable model of forecasting system will be required to face the challenges in mitigation of rice production in Assam, India.

Selection of Mathematical Model For Forecasting of Rice Production: As per the report of United Nations(2011), the following models among others of Time Series Analysis are employed to testify the forecasting of various agricultural products.

- Production function model
- Ricardian cross sectional regression model(non-linear regression model and RP Model):
- Agronomic-economic model
- Agro-ecological zone model
- Integrated assessment model
- Simple linear regression model (LR Model):
- Cobb-Douglas production function model (C-D Model)
- ARIMA mpdel

To assess the impact of climatic factor on rice productivity, one of the following model may be employed in the present study.

- Simple linear regression model (LR Model):
- Ricardian productivity regression (non-linear regression model and RP Model):
- Cobb-Douglas production function model (C-D Model):

Hypothesis Testing and Selection of Appropriate Model*:* In this study several regressions models will be done for each proposed models to select an appropriate model. Random effects model will be applied to assuming that the variation across the state of Assam, India is to be random and uncorrelated with jute productivity. After that to capture the unobserved heterogeneity in district and to control annual difference in jute productivity, fixed effects and time fixed models will be used (Kumar *et al*., 2014).

Testing for random effects: To decide either random effects or an ordinary least square regression model is appropriate or not. Breusch-Pagan Lagrange multiplier (LM) test will used for all three proposed model (Kumar *et al*., 2014). Null hypothesis is that variance across district is zero and it means that there is no significant difference among all districts and there is no panel effect.

Testing for fixed or random effect: Hausman specification test will be used to check the quandary of fixedand random effects model (Kumar *et al*., 2014).

Testing for cross-sectional dependence/contemporaneous correlation: Cross sectional dependenceis the major problem of macro level panel (over 20 years) data. If outcomes will be correlated with across state then there is presence of cross sectional dependence in fixed effects model. To identify the cross sectional dependence, Breusch-Pagan Lagrange multiplier (LM) and Pesaran's (CD) test will be applied for three proposed models (Kumar *et al*., 2014).

Testing for heteroskedasticity: Modified Wald test will be applied to identify that whetherheteroskedasticity exist or not (Kumar *et al*., 2014)

Testing for serial correlation: If serial auto-correlation exists in fixed effects model then outcomeswill becorrelated across years for a given district.

Final Estimation: Finally Prais Winsten models with panels corrected standard errors (PCSEs)estimation may be useful for all the proposed regression models to avoid the problems of heteroskedasticity, serial correlation, auto -correlation and serial auto-correlation in fixed effects regression model (Gupta *et al*. (2012), Kumar *et al*. (2014).

Anticipated Outcome

- Selection of best fitted model to forecast the rice production in Assam
- Dependence of rice production on climatic variables like temperature, rainfall and humidity.

Conclusion

Rice is very important from the view point of economy. Rice is not only important from the view point of revenue generation but also important from the view point of consumption as a food grain. A well defined forecasting model will help the management authority to adopt requisite policies to meet the mitigation process if any required in connection with the production of rice in Assam, India.

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