Irrigation's Impact on Agricultural Development & Land Use Change in India

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Abstract

In a populous developing country like India, developmental initiatives are frequently weaved around land, which is the most important resource in rural populations' livelihood support system. Land has numerous functions in such a socioeconomic setting. Agriculture's performance in terms of area, production, and yield per hectare of food grains and other commercial crops has remained consistent from the First Five Year Plan and during all plan periods. Land SHIFT, an explicit spatial land use model, and two empirical models to examine the effects of land use change on biodiversity and carbon stock changes in soils and vegetation make up the modelling framework. Land use systems are the foundation of the model, which links anthropogenic and natural subsystems. Drivers of land use change are supplied on the country-level, whereas the spatially distributed land use modelling is carried out on a regular grid. The results reveal that in order to fulfill future food production demands, agricultural areas are likely to increase, and existing farmlands need to be intensified. However, both processes will result in biodiversity losses. As a result of both intensification and agricultural conversion, carbon stocks are expected to rise and fall in the coming decades, according to the forecasts. On average, we find that carbon stores rise with the scenarios of future agricultural productivity as projected here.

Keywords: Agricultural, Development, Land, Use, Modeling, etc

1. INTRODUCTION

In a populous developing country like India, developmental initiatives are frequently weaved around land, which is the most important resource in rural populations' livelihood support system. Land has numerous functions in such a socioeconomic setting. For resource-poor farm families, it is the most important source of income, a symbol of social status and prestige, and has extremely high collateral value. The fragmentation of land holdings in these countries is perpetuated by the movement of rural labourers to urban centres in pursuit of job, combined with universal individual inheritance characteristics of land ownership. In the vast majority of these cases, the land has reached the point where it is no longer economically viable to cultivate. Farmers with unprofitable land holdings have three options: sell the land, rent it out, or lease land from others. Land lease and land market policies become critical in such a scenario. According to a review of the literature on the operation of India's agriculture land markets, a great number of research employed national level macro data to investigate changes in land ownership patterns. These studies show that India's land sales sector is modest in comparison to the rental market. They also show that land and labour endowments have a significant role in determining land market outcomes. Surprisingly, few studies have discovered a strong link between farmers' ability to buy land on the open market and their use of contemporary farm technologies. Several studies have discovered evidence that land is valued for a range of noneconomic qualities such as social status in addition to its economic value. Distress sales of land are common in rural India due to the country's often-imperfect credit markets Drought or illness force poor farmers to liquidate their assets in order to deal with these emergencies.

- **Irrigation's Impact on Agricultural Development**

Agriculture has an important role in the Indian economy since it provides food, raw materials, and exports, all of which contribute to total economic growth. Agriculture's performance in terms of area, production, and yield per hectare of food grains and other commercial crops has remained consistent from the First Five Year Plan and during all plan periods. This has been made feasible by an expansion in the area under HYVs and the usage of fertilizers at a faster rate. Aside from infrastructure, other reasons include the expansion of the use of new technology and the incentives offered for the purchase of food grains at reasonable costs. The agricultural sector employs approximately 58 percent of the country's population, while its contribution to GDP has decreased due to strong growth in the manufacturing and service sectors. Agriculture contributed roughly 56 percent of GDP in 1950–1951; by 1970–1971, 1990–1991 and 2009–2010 (at 2004–2005 prices) it had dropped to 44 percent, 31.4 percent, and 14.6 percent, respectively. Agriculture alone accounted for 12.3 percent of the total share of 14.6 percent of GDP from agriculture and allied sectors in 2009–2010, followed by forestry and logging at 1.5 percent and fisheries at 0.8 percent. Almost all aspects of agriculture in the country have changed dramatically since the start of the Green Revolution (1966–1967). To fulfill the growing demand for food among the teeming millions, efforts have been made to

increase agriculture on the one hand, and to bring more and more land under cultivation on the other, resulting in agriculture's vertical and horizontal development. Farmers' attention has turned to the production of more profitable crops as cropping patterns have changed. Crops with a coarse grain have been phased out in favor of more profitable crops. As a result, overall monetary returns per hectare yield have grown significantly.

2. LITERATURE REVIEW

Hamidov, Ahmad & Helming, K. & Balla, Dagmar (2016) Agriculture is a significant part of Central Asia's economy. Economic growth, human well-being, social equity, and ecosystem services all depend on the sustainable use of agricultural land. Salinization, erosion, and desertification, on the other hand, produce significant land degradation, which affects human health and ecosystem services. In 362 articles, we examine the influence of agricultural land usage in the five Central Asian countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan from 2008 to 2013. We examine the types and relative shares of environmental, economic, and social topics related to agricultural land use using the Land Use Functions framework. Our main findings are that (1) land use research in Central Asia drew a lot of international attention, and the number of publications trended higher than the global average. (2) The effects of land use on abiotic environmental resources were the ones that received the greatest attention. (3) There is very little research on how agricultural land usage affects biotic resources. (4) The least investigated were the links between land degradation, such as salinization and dust storms, and human health. (5) Indirect data analysis approaches, such as remote sensing and mathematical modelling, dominate the literature, with in situ data gathering accounting for only a small percentage.

Lokesh Meena, Shoji Lal Bairwa, Kerobim Lakra, and Chandra Sen (2013) India is a densely populated and mostly rural country with a long history of non-governmental organisations and volunteerism. The phrase "non-governmental organisation" was coined in 1945 in order for the United Nations to distinguish between participation rights for intergovernmental specialised agencies and participation rights for international private groups in its charter. The current research focuses on the state of non-governmental organisations (NGOs) in India and their role in agriculture and rural development. The origins of NGOs, their basic purposes, varied roles of NGOs, functions in agricultural and rural development in India, and the top 10 NGOs working in India were all examined in this study. The fundamental purpose of NGOs in agriculture and rural development is to catalyse rural population, construct models, augment government efforts, and organise rural poor.

Maya, Awasthi (2009) In a populous developing country like India, developmental initiatives are frequently weaved around land, which is the most important resource in rural populations' livelihood support system. Land has numerous functions in such a socioeconomic setting. For resource-poor farm families, it is the most important source of income, a symbol of social status and prestige, and has extremely high collateral value. The fragmentation of land holdings in these countries is perpetuated by the movement of rural labourers to urban centres in pursuit of job, combined with universal individual inheritance characteristics of land ownership. In the vast majority of these cases, the land has reached the point where it is no longer economically viable to cultivate. Farmers with unprofitable land holdings have three options: sell the land, rent it out, or lease land from others. In such circumstances, land lease and market rules become crucial.

Maitreesh Ghatak and Sanchari Roy (2007) we evaluate and add to the empirical literature on the impact of land reform on agricultural productivity in India in this research. We discovered that land-reform legislation had a negative and considerable impact on agricultural productivity across all states. However, this masks significant variance across land reform types as well as across states. Land-ceiling legislation appears to be the main driver of this negative effect when broken down by kind of land reform. Tenancy reform, on the other hand, has a negligible effect when averaged across all states. There appears to be a wide variety of state-specific effects, implying that concentrating on average treatment effects can obscure a lot of variation. We find that land reform had a somewhat favourable effect relative to the rest of India when we allow a separate slope for West Bengal, one of the few states that strictly enforced tenancy regulations.

3. OBJECTIVES

- To study Irrigation's Impact on Agricultural Development.
- To analyze Advancement of Agriculture till the year 2030.

4. RESEARCH METHODOLOGY

4.1 Modeling structure

Land SHIFT, an explicit spatial land use model, and two empirical models to examine the effects of land use change on biodiversity and carbon stock changes in soils and vegetation make up the modelling framework (Figure 1). This type of IMPACT-LandSHIFT model coupling was already

effectively implemented and deployed for other scenario studies in Southeast Asia and East Africa. Exogenous data on climate and socioeconomic scenarios drive both models. The IMPACT model is used for estimating changes in agricultural productivity and crop yields in India due to changing socioeconomic and climate conditions. Impact is a worldwide agricultural market and trade balance model that takes into account changes in agricultural product demand, output, and net trade in India and other nations. Internally crop yield variations due to climate and technological development are determined by the DSSAT suite of crop models applied in MINK, a global gridded crop modelling technique. LandSHIFT receives the model's output, which includes country-level data on agricultural and livestock production as well as changes in crop yield. In the following, LandSHIFT transforms this information into land use patterns, which then serve as input to the environmental impact assessment models. In this work, land use change is simulated on a raster with a cell size of 5 arc minutes (~9 × 9 km) at the equator.

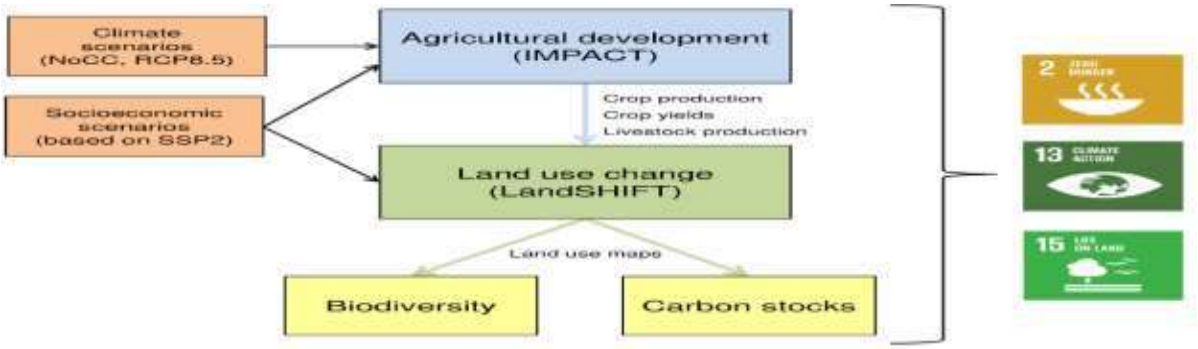

Figure 1: Modeling framework used for the scenario analysis

4.2 Land Use Modeling

Agricultural, grazing, and urban land use changes are all modelled using LandSHIFT software. In the area of biofuel assessments, it has been verified and evaluated for use in India. Land use systems are the foundation of the model, which links anthropogenic and natural subsystems. Drivers of land use change are supplied on the country-level, whereas the spatially distributed land use modelling is carried out on a regular grid. Cell-level information encompasses land use type, human population density, landscape characteristics (e.g., terrain slope, potenial yields, road infrastructure), and land use constraints (e.g. protected areas) (e.g. protected areas). LandSHIFT converts the input from the country-level model into spatial land use patterns during the simulation. At the beginning of every time step, the suitability of each raster cell for the different land use types is calculated based on the cell-level information. After that, the model makes use of data collected at the country level to identify and distribute the appropriate amount of land to various crops, pastures, and settlements. The model findings are raster maps that represent the regional and temporal patterns of land use change till 2030 in 5-yeartime increments.

5. RESULT AND DISCUSSION

5.1 The Advancement of Agriculture till the year 2030

Changes in agricultural productivity and crop yields are simulated using the IMPACT model. Crop yields are expected to rise in all scenarios due to agricultural R&D investments and climate change, as well as crop output due to rising populations and shifting global and regional demand. The comparison of the reference scenarios (REF HGEM and REF NoCC) indicates that, looking at India as a whole, climate change has a detrimental effect on the yields of practically all modelled crops. Exceptions are temperate roots and tubers, which benefit from the shifting climate. Spatially aggregated yields of all crops show a lower growth rate from 2010 to 2030 for the climate change scenario (+41 percent) compared to the no climate change scenario (+48 percent). A similar tendency can be noticed when looking at the growth rates of overall crop production. Climate change reduces production by 43% compared to a route without climate change, which increases production by 50%. Some crops will see an increase in importance, while others will see a decrease in cultivation as a result of both scenarios. Increases in yields and production are greatest for cash crops, such as vegetables and cotton, as well as for wheat. When compared to the NoCC reference scenario, the investment scenarios that adhere to the climatic assumptions of REF HGEM while investing more quickly in agricultural R&D produce bigger yield increases. Out to 2030, the yields of crops in aggregate for the MED and HIGH+RE scenarios grow by 43 percent and 54 percent, respectively. In comparison to the base year of 2010, total production is expected to rise by 46% for MED and by 55% for HIGH+RE.

5.2 Land Use Change's Effects on Carbon Storage

Similar to the biodiversity losses, carbon stock changes are caused both by processes of land conversion, such as conversion from forest to agriculture, and by the intensification of agricultural management. The annual CO2 emissions are negative in all scenarios because the atmosphere is absorbing CO2. As a result, soil carbon reserves are growing. REF HGEM has the lowest yearly uptake of CO2 (35.42 MtCO2/a), followed by REF NoCC (46.35 MtCO2/a). REF HGEM There are disparities in CO2uptake that can be traced back to varying rates of agricultural land development, because the assumptions about increasing agricultural management and livestock grazing were the same in both scenarios Due to lower yields under climate change conditions, more set-aside land with relatively high plant and soil carbon stores is converted to cropland and pasture in the REF HGEM scenario. Under the investment scenarios, the extra improvements of agricultural management, including reduced tillage techniques, have a considerable good effect on the rates of CO2uptake. Under the MED scenario, the yearly uptake is 92.93 MtCO2/a whereas the HIGH+RE boosts this to 246.76 MtCO2/a. In summary, under our scenario assumptions regarding the improvements in agricultural management methods on cropland, we calculate a substantial pickup of carbon from the atmosphere. As this intake is higher than carbon losses owing to the conversion of set-aside and natural land, we discover a net carbon sink in agricultural soils.

6. CONCLUSION

The results reveal that in order to fulfill future food production demands, agricultural areas are likely to increase, and existing farmlands need to be intensified. However, both processes will result in biodiversity losses. As a result of both intensification and agricultural conversion, carbon stocks are expected to rise and fall in the coming decades, according to the forecasts. On average, we find that carbon stores rise with the scenarios of future agricultural productivity as projected here. Finally, we believe that additional agricultural intensification is essential for ensuring food security while also slowing down the expansion of cropland and pasture. Policies are needed to achieve this intensification in a way that minimises biodiversity losses, though. Due to the importance of soil carbon sequestration and biodiversity conservation, Indian agricultural and environmental policies should support farmers in their efforts to implement sustainable intensification measures that reduce biodiversity loss while also increasing soil fertility and lowering agriculture's contribution to global warming emissions.

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