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AGRICULTURAL PRODUCTIVITY AND FOOD SECURITY IN THE DEVELOPING WORLD

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Abstract

The study reveals the contribution of increased agricultural productivity in food security in the developing countries. An intensive literature review is conducted in writing the article. It has depicted the different productivity measures in agriculture and their relative uses. It explains several non-conventional production factors influencing agricultural productivity growth along with conventional production factors. It also explains how increased agricultural productivity is linked with food security, rural livelihood as well as rural poverty reduction. Finally it demonstrates why increased agricultural productivity is necessary for developing countries including Sub-Saharan Africa and it also provides a few policy options to increase agricultural productivity in developing countries.

1. INTRODUCTION

Food security as well as ensuring food for all is an important challenge for the world community. Food security refers to the situation "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2010). Many people consider it as a basic human right but approximately one billion people around the world especially in the food deficit and low income developing countries are still living with chronic poverty and undernourishment (IEG, 2011). Among them most of the people live in rural areas and depend on agriculture for meeting their daily necessities as well as for their livelihood. From that sense, to boost up the rural economy, mainly through intensifying agricultural production as well as increasing agricultural productivity and resource use efficiency are the principal instruments for reducing poverty, increasing food security and improving rural livelihoods (Pinstrup-Andersen and Pandya-Lorch, 1998).

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There are three main apparatus or components of food security: (i) availability of food: consist of three elements related to production, allocation and exchange; (ii) access to food: connected with affordability such as income and wealth, provision and preferences and (iii) utilization of food: essential elements associated with dietetic value, social value and food safety (Ingram, *et al*., 2005). A two tiered system of food security has explored by Rosegrant *et al*. (1995) find that well-off and typical fast growing economies typically have reasonably priced food supplies, whereas slow-growing poor countries suffer from food shortage and malnutrition. It means that developing, least developing and slow growing poor countries have to progress agricultural production and increased agricultural productivity is requisite to ensure self-sufficiency in food, which is the first constituent of food security.

Sustainability is another important facet for food security. It means that food productions have to carry on upholding with the demand for future generations. Reality shows that the average yearly growth rate of rice yield around the world has declined from 2.42% in 1974-82 to 1.78% in 1982-90 (Rosegrant *et al*., 1995). In Asia the corresponding figures were 2.62 to 1.66% and in China 4 to 1.6%. It also shows the similar pictures for other crops like maize, wheat, sorghum and other staple food grains (Pinstrup-Andersen, 1994).

Food security as well as sustainable food security depends on a number of physical, social, economic and political factors both countrywide and worldwide (Chang and Zepeda, 2001). Some important socio-economic factors, population growth, demographic changes, rapid urbanization and income growth on the demand side as well as technological development and agricultural productivity growth on the supply side, may encompass a significant role in the progress of world food scenario (Rosegrant *et al*., 1995).

From the ongoing discussion it is clear that agricultural production and productivity growth in agriculture depend on a mixture of factors like agricultural, ecological, micro-economic policies, macro-economic policies and trade at the international level etc., which are also important along with other factors such as land, labour and capital. Therefore, food security is a multidimensional issue. This paper focuses on i) the non-conventional production factors influencing agricultural productivity growth, and ii) the linkage between agricultural productivity and the availability of food, which is considered as the first step towards resolving the problem of food insecurity on the basis of available relevant review literatures.

2. Agricultural productivity and the livelihood of poor people

The livelihood of a major proportion of population in the developing world is directly or indirectly connected with agriculture. World Bank reports that 2.5 billion people depend on agriculture as their main sources of livelihood and among them 1.3 billion people are small farmers and landless workers. About 75% of all world poor people live in rural areas and 86% of them work in agricultural sector for their livelihood (ECG, 2011). Increased agricultural productivity is of great importance for all these people.

Agricultural productivity growth has mired in recent era. The growth of the yield of major food grains throughout the world is about 1% per year (FAO, 2009a), whereas the recent world population growth rate is about 1.2%. Land is a scarce resource; expansion of the cultivated area is not possible in many developing countries (ECG, 2011). Accordingly, the only solution may be to increase agricultural productivity to meet the future demand for food for the growing population. Due to the limitation of cultivable fertile land and related inputs, new approach to increase future productivity growth in agriculture in most parts of the world may be intensive agricultural growth rather than extensive growth. Therefore, intensification of production and upgrading the inputs or resources use efficiency are significant key strategies along with diversification (Dixon *et al.*, 2001).

The deviation between exactly possible and actual yields for most crops indicates an immense potential for increasing food as well as agricultural production by improving productivity (Zepeda, 2001). FAO expects that in the developing world about 80% increase in food production will need to come from the increase in yields as well as cropping intensity and only 20% will be obtained from the extension of arable land (FAO, 2009c). Hence, Intensification is fundamental not only to meet up the ever-increasing demand for food grains but also to condense deforestation, ecological destruction, and global warming.

Agricultural productivity can play a vital role in economic growth by linking the supply and demand side (Johnston and Mellor, 1961). For example, the agricultural sector supplies raw materials for industrial or other non-agricultural sectors and demands inputs from the modern sectors like science and information technology. In the demand side, increased agricultural productivity can raise the earnings of the rural population and thereby it may create more demand for local industrial products (Dethier and Effenberger, 2011). In this way, a link can be created between agriculture and modern sectors and that may create new

employment opportunities and thereby it may improve rural income and livelihood.

3. Productivity measures in agriculture

Agricultural productivity is the measurement of the quantity of agricultural output produced for a given quantity of input or a set of inputs. There are different ways of defining and measuring productivity. For instances, the amount of output per unit of input (such as tons of wheat per acre of land), or an index of numerous outputs divided by an index of numerous inputs (Wiebe, 2003). The quantities of output relative to the quantity of inputs are the conventional measures of productivity. If output increases at the same rate as inputs, then productivity is unchanged. On the other hand if the output growth rate exceeds the growth rate in the use of inputs, then productivity is positive.

Two measures are often used. First, partial factor productivity measure, state the amount of output per unit of a particular input like land or labour, and the second total factor productivity measure. Most commonly used partial measures are land productivity, i.e., yield or output per unit of land, and labour productivity i.e., output per economically active person (EAP) or per agricultural person-hour (Zepeda, 2001). Sometimes the indication from partial measures of productivity is not clear enough to show why production is changing. This is because different factors are responsible for changing the productivity, for example, land or labour productivity can increase due to better and more use of fertilizer, power tillers, the use of high yielding variety (HYV) and etc. To avoid such kinds of problems it is better to measure total factor productivity (TFP) to account for the accurate agricultural productivity. Hence, the measure of multifactor or total factor productivity indicates total output relative to a more comprehensive metric of all measurable inputs including land, labour, capital, livestock, chemical fertilizers, pesticides and other purchased inputs (Alston *et al*., 2009).

It is worthwhile to note that different productivity measures are used for different purposes. For example, yield or land productivity is usually used to evaluate the success of new technology. It is also useful to determine what amount of land is required to meet the future demands of world food (Wiebe, 2003). Labour productivity is usually used for comparing productivity among sectors within or across economies (Block, 1994). It also facilitates to determine the incomes and wellbeing of people engaged in agriculture (Wiebe, 2003). The growth in TFP is usually a measure of technological advancement that can be ascribed by the development of scientific agricultural research, enhancing extension services,

human capital development such as education and the development of infrastructure and government policies (Ahearn *et al*., 1998).

4. Measurements of total factor productivity

Different types of economic models such as index number or growth accounting technique, econometric estimation of production relationships and nonparametric approaches are generally used to measure TFP or aggregate agricultural output. The growth accounting model assembles detailed financial records of inputs and outputs by combining them into input and output indices to calculate TFP index (Diewert, 1980). The econometric approach is based on an econometric estimation of the production technology (Antle and Capalbo, 1988). It quantifies the marginal contribution of each type of inputs to the aggregate production (Chavas, 2001). For example, it can find out the effect of one-percent changes in fertilizer use on overall agricultural output, with all other inputs remaining constant. Linear programming techniques are used to calculate TFP in non-parametric methods (Chavas and Cox, 1992). It doesn't impose assumptions on the technology that generates agricultural output; therefore it has the advantage of flexibility (Capalbo and Vo, 1988). Among the three methods, every method is appropriate in addressing different questions and requires different datasets and has some strengths and weaknesses.

5. Factors influencing agricultural productivity growth

A majority of the researchers has given attention to the function of conventional inputs like land, labour, water, chemical fertilizers and physical capital etc. in explaining the productivity growth (Lachaal, 1994). Along with the above factors, the role of human capital, research and technological development or technology transfer, public investment in agricultural research, extension services and infrastructural development, sustainable natural resources management, policy reform and political stability etc. are also important strategies and closely linked to agricultural productivity (Auraujo *et al*., 1997).

There are several factors that can contribute to increasing agricultural productivity. Research on different factors influencing global agricultural productivity is conducted by various researchers (Hayami, 1969; Hayami and Ruttan, 1970; Nguyen, 1979; Kawagoe and Hayami, 1983; Kawagoe, Hayami and Ruttan, 1985; and Bhattaccharjee, 1995). They emphasize the significance of education, training and human capital on productivity growth. Evenson and Kislev (1975) study the role of research in explaining the cross-country deviation in agricultural productivity, whereas, Antle (1983) concentrates on infrastructural development.

Chavas (2001) finds a weak connection between technological change and agricultural productivity growth across countries over time, which is a quite surprising finding, because there is a good deal of evidence for technological progress to contribute to strong productivity growth in agriculture over the last few decades. Green revolution in Asia is the example of that, though it has some negative aspects like environmental degradation. In addition to human capital and infrastructural development, differences in agro-climatic conditions can also assist to increase agricultural productivity across the countries. Some of these important factors influencing agricultural productivity growth are highlighted:

i. Human capital and agricultural productivity

Human capital plays a crucial role in accelerating agricultural productivity by learning, applying and disseminating technical knowledge. It also influences a farmer's capability to adjust new technology in particular circumstances as a changing demand. Romer (1986) and Lucas (1988) utter theoretical settings for human capital, being worked as a dynamic force for economic growth. Jamison and Lau (1982) find that farmer's education and extension services have enhanced the production of Korean, Thai and Malaysian farms. Some studies find a reasonably weak relationship between growth and physical capital as compared to investment in technology and human capital (Zepeda, 2001).

Lopez and Valdes (2000) argue that the return of education in farming in majority of the cases is unexpectedly small. They conclude that the important contribution of education in rural areas is to set up a young generation to migrate in urban areas. However, Nehru and Dhareshwar (1994) illustrate that human capital development is three to four times more significant than unskilled labour. There are different opinions about human capital and agricultural productivity growth but I would like to argue strongly that education, training and extension services are necessary elements for developing and increasing the knowledge of farmers and thereby creating human capital. This is because knowledge can help them to adopt proper technology as well as efficient use of scarce resources or inputs like land and water and that can increase productivity.

ii. Agricultural research, extension and technology transfer

Technological improvement is one of the key sources of productivity growth. It can change the production process by applying innovation, newly achieved scientific and practical knowledge and through management skills. The reason is that new technological knowledge is considered as the outcome of research (Antle and Capalbo, 1988). Therefore, investment in research and development is most essential for increasing productivity. But it may take some times to realize the productivity gains. For instance, Chavas and Cox (1992) find a 15 year lag between the investment in research and its effect on productivity. The contribution of research investment in agricultural productivity is more in Sub-Saharan Africa, which is about one third of the TFP growth (Block, 1994). The returns of research may be high but the technology adoption rate is not always equal in different regions. For example, high yielding variety (HYV) is about 36% in Asia and the Middle East, 22% in Latin America and 1% in Africa of their total grain area (Wolf, 1987). The reason behind it is that technological progress may lead to use the superior quality inputs or to the combination of inputs, which can assist in better productivity. But, potential users of new technology are often different in different regions or even in the same agro-ecological settings. Hence, careful planning and provision for supporting infrastructures are necessary to increase adoption of new technology and to obtain the complete benefits from it.

iii. Public investment and policy

Public investment in research contributes more than half and extension provides one third of the total output growth in India (Evenson and McKinsey, 1991). One fifth of total production growth in Chinese agriculture during 1965 to 1994 is achieved by public research expenditure and the rapid growth of Chinese economy from 1980 to 1990 is resulted from the government investment in research and development (Fan, 1996). Similarly public infrastructure as well as infrastructural development may increase the productivity by promoting the exchange of goods and services. Pardey and Alston (2010) reveal that investment in agricultural research and development increase the agricultural productivity through technological progress. Therefore, enhancement of agricultural productivity is robustly coupled with Research and Development spending (Alston *et al*., 2000).

Suitable government policies are obligatory for an efficient and proper use of resources which eventually can promote productivity (North, 1994). For instance, China's "responsibility system (RS)" policy in 1980-81 and it shows that policy

reform augments the crop yields for each major crop (Wiens, 1983). Due to China's "RS" and price reform policies, outputs of agricultural sector in China have increased by more than 61% during 1978 to 1984 (McMillan *et al*., 1989). Production of rice in Egypt has increased by 62% from 1987 to 1993 whereas total yields have increased 42% due to the implementation of price reform policy of 1986 (Khedr *et al*., 1996). Lachaal (1994) shows that protectionist policies are not always good because TFP growth in the dairy industry has reduced due to the direct subsidies in the agricultural sector in the USA. On the basis of the above facts and figures it is clear that public policy is gradually more essential element for agricultural productivity gains.

iv. Political situation and productivity

Political situation is also important for agricultural production. In the war time including the civil war, the economies work as the worst and most of the countries are at prices distorting policies (Nehru and Dhareshwar, 1994). This is confirmed by Velazco (2001) who argues that the political violence has negative effects on investment, technology, market infrastructure as well as on productivity. Recently Zerfu (2007) investigates the significance of governance on agricultural productivity by using household survey data from the rural Ethiopia and his result shows that the progress in governance may shrink the technical inefficiencies significantly and therefore may considerably increase the productivity in agriculture.

v. Natural resources and environment

Natural resources may also influence the agricultural productivity. Pinstrup-Andersen and Pandya-Lorch (1998) find that production capacity is seriously hampered by the degradation of natural resources like land and water. Excess use and abuse of irrigation water is one of the causal factors in land degradation (Anderson, 1994). Groundwater depletion, groundwater quality contamination, deforestation, soil salinity, soil erosion etc. are somehow linked to agricultural practices. Inappropriate agricultural practices, overgrazing and deforestation are also found responsible to world land degradation (Oldeman, 1992). Among the natural resources, quality land plays an important role in determining the agricultural productivity due to the constraints of area expansion and rising costs in agricultural production. Similarly there are serious agricultural productivity losses due to environmental degradation. Significant agricultural productivity losses have been accounted to soil erosion. For example, In Europe and Central Asia up to

40% productivity losses are attributed due to soil erosion, 25% in the United States, 25% in Nigeria, and 30% in Haiti (Wolman, 1985). Moreover, agricultural productivity may decline from 20 to 40% if temperature rises by more than 2° C in developing countries (FAO, 2009b). Therefore, government policy should be taken in response to sustainable use of natural resources for proper agricultural practices that can maintain sustainable quality land and enhance the agricultural productivity.

If I synthesize the reviews on factors then it is clear that several factors (such as climatic changes, shifting location of production to less favorable environments, land degradation, farmers' responses to resource paucity or higher prices of inputs, changes in public institutions, and political conflicts (related to physical, social, economic, political and environmental) etc.) may influence the agricultural productivity growth. I would like to divide the factors into two main different branches such as conventional (like land, labour, fertilizer etc) and nonconventional production factors (like investment in research, human capital development, sustainable use of natural resources etc). Moreover, I would like to add that government and policy makers of developing countries must focus on non-conventional production factors along with conventional one to increase agricultural productivity in developing countries.

6. Agricultural productivity, rural poverty and food security

Agricultural productivity growth can be a significant instrument for reducing poverty in developing countries (Dethier and Effenberger, 2011). In this case the fact is that the linkage between traditional (agricultural) and modern (industrial) sectors is more important for tumbling poverty in developing countries. It is also essential to prioritize small and medium sized farmers, who prefer to use domestically produced goods and services rather than large scale farmers (Adelman, 1984). Moreover, the development strategy of developing countries should be agriculture driven rather than export oriented and that increased productivity in agriculture may be the initiator of industrialization (Singer, 1979). However, the extent of these effects in reducing poverty depends on the specific situation of an economy (*Irz et al*., 2001).

There is a positive correlation between agricultural GDP growth and non-agricultural GDP growth in developing countries. Bravo-Ortega and Lederman (2005) also agree about the positive relationship between them but they argue that this relation is reverse for developed and industrialized countries and there are also regional differences. Other factors such as openness of the economy may change

the relation between agriculture and non-agricultural growth. This is because global markets interfere in agricultural growth by providing international capital flows and through food imports (Timmer, 2002). Hence, it is clear that the significance of linkages between the agricultural sector and the rest of the economy differs across the countries.

Agricultural productivity growth is positively correlated with lower food prices, better nutritional intake and increased capital flows from agriculture (Timmer, 2002). Self and Grabowksi (2007) confirm the Timmer's findings and find a positive relation between different agricultural productivity measures and average real GDP growth. Therefore, it may increase the employers' productivity as well as may improve the rural household's food security.

Absolute and relative poverty have reduced with higher farm productivity in India (Datt and Ravallion, 1998). The direct and indirect effects of agricultural productivity growth reduce poverty in developing countries (Mellor, 2001). Afterwards, Christiansen and Demery (2007) estimate that 1% per capita agricultural growth may reduce the poverty 1.6 times more than the similar growth in industry and 3 times in the service sector. Therefore, it can be thought that agricultural growth in developing countries is a vital mechanism for helping the very poor. From that sense, increased agricultural productivity may not only contribute in poverty alleviation but also may improve the country's economy.

7. Agricultural productivity and availability of food: A critical discussion

From the above reviews, it can be argued that agricultural productivity growth can facilitate in reducing poverty. Besides, I would like to argue that it may help to meet the food demand as it may eventually ensure the availability of food for the rural poor people in the developing countries. It may work through three channels: i) it can increase the incomes of agricultural labourers, who are in majority poor, ii) it improves food supplies that can reduce the food prices, which in turn increases the real income and facilitates in declining poverty in rural and urban areas, and iii) it helps the development of the whole economy by the combination of backward and forward linkages. These linkage effects can boost up the employment both in the farm and non-farm sectors in rural areas as well as indirectly may improve the rural income and may have better access to food. In addition, it can give potential to earn more foreign exchange by exporting surplus agricultural goods and services and can ensure better rural livelihood. From that sense, sustained growth in

agricultural productivity is crucial in reducing poverty and to improve the food security. This is because increasing income resulting from GDP growth can enhance the ability to purchase food and other basic necessities for many food-insecure people (Wiebe, 2001). Additionally, GDP growth emerging from agriculture is approximately four times more effective and valuable for growing incomes of the extremely poor than the GDP growth from outside the sector (World Bank, 2007). Consequently, the continued growth in agricultural productivity can assist to meet the survival requirements, fight against hunger, decrease the dependency on imported foods, uplift the balance of trade, achieve the sustainable growth and increase the national food security.

8.Need for increased agricultural productivity

Increased agricultural productivity is essential around the world to feed the global hungry people. Agricultural productivity is low in Sub-Saharan Africa in compared to other developing regions like South Asia and Lain America (ECG, 2011). For example, an average farmer in Sub-Saharan Africa gets a maximum of 2 metric tons grain per hectare whereas an Indian farmer receives double, a Chinese farmer gets four times more, and an American farmer gets five times more of what an average farmer of Sub-Saharan Africa gets (AfDB-IFAD, 2010). Hence, productivity should be increased in Sub-Saharan Africa.

To increase agricultural productivity in Sub-Saharan Africa, it is necessary to know about the obstacles of agricultural production as well as productivity growth in agriculture in that region. Limited land rights, inadequate access to water, insufficient access to credit, underdeveloped rural roads and transport infrastructures, narrow market support, underprivileged agribusiness activities, and underinvestment in research and extension etc. are some of the major constraints in agricultural productivity in that region (IEG 2010). In addition, institutions like coordination within organizations and among the donor agencies are also most difficult task and are related to market failures and property rights. Six action areas namely i) access to land and formation of land rights, ii) access to water, iii) access to credit, iv) improve transport and marketing facilities, v) market opportunities, agribusiness activities and policy reforms, and vi) investment in research and extension have to be prioritized to improve agricultural productivity in Sub-Saharan Africa (ECG, 2011). Moreover, weakness in institutions and in any of these action areas can slow down the agricultural productivity in these regions. Hence, appropriate institutional framework is also necessary for that region. Interventions in these areas can create different scenarios in agricultural production

in Sub-Saharan Africa. For example, investment in agribusiness, which can help in increasing productivity, improving market opportunities for smallholders, delivering reasonably priced, nutritious and healthy foods to growing urban and semi-urban populations, increasing employment opportunities, and eventually improving food security and may contribute in rural and regional economic growth in Sub-Saharan Africa.

9. CONCLUSION

Food security is a major concern in global agriculture that needs a significant increase in order to be able to feed the expected growing world population. One way to feed an ever increasing world population is to increase the local and regional food supply of each and every country through improving agricultural productivity and that may confirm the first element of food security namely the availability of food in achieving sustainable food security. Moreover, increasing productivity among small and marginal farmers can be an important instrument to guarantee food security in low income developing countries in the long-run.

Different conventional production factors like land, labour, chemicals, fertilizers, water, and physical capital etc. influence the productivity in agriculture. Improvement in non-conventional production factors like human capital development, agricultural research and proper technology transfer, public and private investment in education, research, extension and infrastructural development, policy reform, political stability, and sustainable natural resources management etc. are also significant strategies to enhance agricultural productivity in many developing countries. It is observed from the intensive literature review and the case of Sub-Saharan Africa that most of the government and donor agencies provide more emphasis on increasing in conventional inputs, but sufficient investment in non-conventional inputs like investment in agricultural research and development is equally important. The returns of investment in research and development are higher than support to any other inputs (Evenson and McKinsey, 1991; Pardey and Alston, 2010) and it can provide appropriate technology for each specific region.

Finally, it can be concluded that increased agricultural productivity growth may contribute in overall economic growth by improving the availability of food which is the first and foremost step of food security. Hence, the government of food deficit developing countries should reform the traditional agricultural policies and formulate new appropriate policies emphasizing the non-conventional production factors that can promote them to increase the production capacity of agriculture

through productivity growth and thereby improving the food security. This is because agriculture provides a livelihood to a significant portion of population in developing countries more especially in the rural and agrarian areas where poverty is more prominent. However, intensive agricultural production systems may also have some environmental and equity problems and further research can review the agricultural productivity along with environmental degradation.

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