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Agricultural sustainability assessment at provincial level in Pakistan

Farhad Zulfiqar[a,*], Gopal B. Thapa[b]

[a] Department of Economics, COMSATS Institute of Information Technology, Islamabad, Pakistan
[b] Regional and Rural Development Planning, Asian Institute of Technology, Thailand

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ABSTRACT

Agriculture sector of Pakistan has traditionally followed an unsustainable path due to degradation of agricultural resources. Therefore, this study was carried out to find environmental, economic and social sustainability of agriculture in Punjab, Sindh, KPK and Balochistan provinces of Pakistan. Based mainly on secondary data, covering the period of 2005/06–2012/13, each dimension of sustainability was analyzed using selected indicators. Crop diversification, soil salinity, and the use of organic and inorganic fertilizers and pesticides were the indicators considered for environmental sustainability analysis. For economic sustainability analysis, change in overall crop production and stability of crop production were the indicators used. Employment of rural labor force and food security were indicators used for social sustainability analysis. The findings from the analyses revealed a tendency towards unsustainable agricultural production in all provinces. This was caused by overuse of inorganic fertilizer, pesticides and groundwater for irrigation in Sindh and Punjab. The lack of sustainable agricultural production in KPK and Balochistan was due to limited use of fertilizer and pesticides in some areas and altogether no use in other areas. Use of groundwater for irrigation in the coastal areas of Balochistan further reinforced agricultural unsustainability. Thus, it was deduced from the findings of this research that there are regional differences in agricultural sustainability in Pakistan. Therefore, it is recommended to formulate effective regional agricultural policies based on local level research and revise agricultural extension structure in order to incorporate need-based services with better dissemination of information and farm level trainings. In addition, broad policy recommendations are made for sustainable agricultural development in each province under the scope of the study.

1. Introduction

The advent of green revolution in Asia significantly improved agricultural productivity through provision of irrigation water, adoption of improved crop varieties and application of inorganic fertilizers and pesticides (Hazell, 2009). The use of these technologies was boosted by strong public support (Hazell, 2009). As a result, the average cereal yields in Asia increased by a remarkeble 3.57% per year during 1965-82 (Rosegrant and Hazell, 2000). Since the advent of the green revolution, rice yields have increased by 150% and of wheat by 250% in Pakistan, Bagladesh, Indonesia, and northern India (FAO, 2014). Consequently, in Punjab and Haryana provinces of India where green revolution technologies were intensively used, per capita income increased from 1145 and 951 Rs. in 1972/73 to 45,114 and 58,970 in 2008/09, respectively. This led to reduction of poverty in the former province from 28.1% in 1972/73 to 8.4% in 2004/05 and in the latter province from 35.2% to 14.0% during the same period (Chand, 2010). Similarly, in Pakistan, the per capita calorie intake increased from 1748 in 1960–2462 in 2000 (Evenson, 2005). Pakistan was at the forefront of adoption of green revolution technologies. Until 1970, the adoption rate of improved varieties of wheat and rice in Pakistan was 15 and 30%, respectively, as compared to 10 and 10.2% in other South Asian countries, leading to a major jump in crop productivity (Evenson, 2005).

However, not all farmers could equally reap the benefits of green revolution. Large and medium farmers, with access to adequate financial resources required to purchase inputs and equipment, gained the highest benefit in terms of production and income. Despite the green revolution technology being scale neutral (Hazell, 2009), the large farmers benefitted more owing to their easy access to seeds, fertilizers, irrigation water and credit. Small farmers could not enjoy such benefits, resulting in widened socioeconomic inequality in Pakistan (Hussain, 2012). Similarly, the provincial socio-economic disparity widened as the agricultural development policies focused on the promotion of green revolution technology, favoring irrigated areas such as Punjab and Sindh. Similar disparity, arising from the policies promoting

* Corresponding author.
E-mail addresses: farhaduaf@gmail.com, farhad.zulfiqar@comsats.edu.pk (F. Zulfiqar), gopalthapa.ait@gmail.com (G.B. Thapa).

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green revolution technology, was also found in India (Galwani et al., 2007). On the economic front, the decreasing responsiveness of crops to application of high amounts of inputs resulted in decreased marginal returns (Murgai et al., 2001).

Moreover, the green revolution inflicted damage on soil quality due to overuse of inorganic fertilizers (Hussain, 2012). While the excessive application of inorganic fertilizer and pesticide deteriorated water quality (Ali and Byerlee, 2002), intensive use of irrigation water resulted in soil salinization and acidification in many areas (Qureshi et al., 2008). The inevitability of these outcomes was clear, as inorganic inputs were used by millions of farmers coupled with limited extension, absence of water use regulations, and provision of cheap inputs through subsidies subsequently encouraging excessive use (Hazell, 2009).

Overall, agriculture in Pakistan has followed an unsustainable path primarily due to degradation of land and water resources arising from intensive use of inorganic inputs and inefficient use of irrigation water. Degradation of natural resources has jeopardized sustainability of economic and social achievements made through the application of green revolution technology in Pakistan and elsewhere. However, it is not yet known if it is true at the sub-national or provincial level. The four provinces of the country greatly vary in agro-ecological, socio-economic and infrastructure situations, and farming systems. Therefore, it is quite possible that environmental, social and economic sustainability of agriculture vary from one province to another. Any sustainable agriculture development policies have to be attuned to region specific situation and related drivers to ensure that they would achieve intended objectives effectively. In view of such need, this study analyzed agricultural sustainability in four provinces of Pakistan using selected indicators covering environmental, social and economic dimensions. Besides contributing to the studies on sustainable agricultural development, findings of this study would be helpful to devise province specific sustainable agriculture development policies.

1.1. Sustainable agriculture: theoretical context

Sustainable agriculture is defined as the use of natural resources for agricultural production while maintaining or enhancing the quality of these resources (Firebaugh, 1990). The broad emphasis of sustainable agriculture is to satisfy human needs for food, the improvement of natural environment (environmental sustainability), promotion of social welfare (social sustainability), and economic capability (economic sustainability). The production cost and feasibility of agriculture in the ever-changing socioeconomic conditions are the basic concerns of *economic sustainability* (Smith and McDonald, 1998); it is also the ability of the agricultural production system to give stable yields in the long run without degrading the soil (Kang et al., 1990 cited by Poudel et al., 1998). *Social sustainability* requires meeting the food and fiber requirements of the society (Smith and McDonald, 1998) and provision of employment opportunities (Bowers, 1995). Lastly, the conservation of natural resources required for sustainable production is the focus of *environmental sustainability* (Yunlong and Smit, 1994).

The *conventional agriculture* is highly mechanized and capital intensive. Moreover, monoculture is widely practiced in this type of agriculture with extensive agrochemical use (Hansen, 1996). Such agriculture has high dependence on external inputs, including seed, pesticides, fertilizers and irrigation water (Rasul and Thapa, 2003). Overuse or imbalanced use of agro-chemicals leads to natural resource degradation, and production decline (Ikerd, 1993). It also pushes production cost up, and adversely affects human and animal health (Zia et al., 2009).

Analyzing agricultural sustainability entails determination of scientifically meaningful criteria. Moreover, the criteria should be location specific based on socioeconomic and ecological conditions (Hayati et al., 2011). While it is impossible to precisely measure the sustainability of any system because of its dynamic and location specific nature (Ikerd, 1993), selected indicators/criteria can point to the trend toward sustainable or unsustainable agriculture (Pretty, 1995).

The researchers have used various indicators to measure agricultural sustainability at aggregate and disaggregate levels. Lynam and Herdt (1989) analyzed econmic sustainability of agriculture by considering yield change and total factor productivity as indicators. Others have used indicators such as average crop production (Hayati et al., 2011; Nambiar et al., 2001 and Rasul and Thapa, 2003), input expenses, profitability and economic efficiency (Herzog and Gotsch, 1998). Regarding social sustainability, Rasul and Thapa (2003), used social equity, while Van Cauwenbergh et al. (2007) used improved quality of rural life as indicators. Some researchers have used nutritional/health status as an indicator of social sustainability (Herzog and Gotsch, 1998; Rasul and Thapa, 2003 and Van Cauwenbergh et al., 2007). The common indicators used by researchers to analyze environmental sustainability included crop diversification (Nambiar et al., 2001), use of pesticides and herbicides (Hayati et al., 2011 and Rasul and Thapa, 2004), use of organic manure (Bosshard, 2000), chemical fertilizer use (Hayati et al., 2011) and soil erosion (Van Cauwenbergh et al., 2007).

2. Materials and methods

This study considered four provinces of Pakistan, namely Punjab, Sindh, Khyber Pakhtunkhwa (KPK) and Balochistan (Fig. 1). Federally Administrated Tribal Areas, Gilgit Baltistan and Azad Jummu Kashmir were excluded due to lack of data.

Each province in Pakistan has distinct socioeconomic and environmental features. The variations in agricultural infrastructure and biophysical conditions have resulted in the development of different agricultural systems in each province. Punjab is the agricultural heartland of Pakistan, accounting for 73% of the total cropped area of the country from which 39 percent was covered by wheat, 13 percent by cotton and 10 percent by rice in 2010–11 (GOP, 2011a). The majority of chemical fertilizer used was also in Punjab, in fact 71 percent of fertilizer was used here (GOP, 2011a). A majority of labor force, 60 percent, lived in Punjab out of which 71 percent was in rural areas (GOP, 2010c).

Sindh province accounted for the second largest cropped area (14%) of the country followed by KPK (7%) and Balochistan (5%). Out of the total cropped area in Sindh 33 percent was covered by wheat, 13 percent by cotton, 10 percent by rice and six percent by sugarcane in 2010–11 (GOP, 2011a). About 20 percent of the chemical fertilizer used was in Sindh (GOP, 2011a). A significant proportion of labor force, 24 percent, lived in Sindh out of which 57 percent was in rural areas (GOP, 2010c).

KPK province is a mountainous region with difficult terrain. The cropped area of this province stood at seven percent of the country from which 45 percent was covered by wheat, 26 percent by maize and five percent by sugarcane in 2010–11 (GOP, 2011a). The use of chemical fertilizer was low, with only six percent used in this province (GOP, 2011a). The labor force in this province stood at 11 percent out of which 83 percent was in rural areas (GOP, 2010c).

Balochistan is the largest province, covering 43% of the total area of Pakistan. However, its share of farmland was only 5%, because most of the land was not suitable for crop cultivation due to mountainous topography and dry conditions. Out of the total farmland 30 percent was covered by wheat, 17 percent by rice and nine percent by apple in 2010–11 (GOP, 2011a). The chemical fertilizer used was only three percent of total fertilizer use in Pakistan (GOP, 2011a). Balochistan had the smallest population base with only five percent of population of Pakistan living in this province in 2009–10 (GOP, 2010c). Only four percent of the labor force lives in Balochistan out of which 80 percent was in rural areas (GOP, 2010c).

This study relied heavily on secondary data based on government reports, surveys and periodic development plans. The Economic Survey of Pakistan, Agricultural Statistics of Pakistan, Agricultural Census,