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Soil Properties, Crop Yield, and Economics Under Integrated Crop Management Practices in Karnataka, Southern India

SUHAS P. WANI, K.H. ANANTHA and KAUSHAL K. GARG *

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India

Summary. — Considering the importance of sustainable production practices with greater resource use efficiency, a study was conducted during 2009–12 to understand the soil properties, crop yield, and economics as affected by the integrated crop management (ICM) practices under the *Bhoochetana* (soil rejuvenation) program in Karnataka, India. Results from 3776 crop-cutting studies on different crops (cereals, pulses, and oilseeds) revealed that there is a vast spatial variability in case of various soil nutrients across different taluks of Karnataka. Balanced fertilizer application, both in rainfed and irrigated areas, directly influenced crop yields. Yields of cereals, legumes, and oilseeds were 3590, 1400, and 2230 kg ha^{-1} with improved management practices as compared to 2650, 1030, and 1650 kg ha^{-1} with conventional farming practices, respectively. Average net income estimated from conventional farming was Rs. 26,290 ha^{-1}, while it was Rs. 35,540 ha^{-1} from improved management practices, which indicated that ICM practices resulted in an additional 35% income. The oilseeds performed better in terms of achieving higher net income and benefit–cost ratio while the cereals and legumes also have shown significant improvement in yield compared to the yields from conventional farming practices. The detailed findings on soil properties, yields of crops, and economics suggested that there is a vast potential for crop productivity improvement through ICM practices across different soil types and rainfall zones of Karnataka, India.

Key words — soil nutrients, crop productivity, water balance, smallholder farmers, *Bhoochetana*

1. INTRODUCTION

Globally, agriculture has to produce more food from less area of land through more efficient use of natural resources in order to meet the growing demands of increasing population (Hobbs, Sayre, & Gupta, 2008). India has 141 million ha of agricultural land with a low cropping intensity of 135% (NAAS, 2009). About 54% of the agricultural land is rainfed and characterized by water scarcity, land degradation, low inputs use, and low productivity. Crop productivity of these areas oscillates between 0.5 and 2.0 ton ha^{-1} with an average of 1 ton ha^{-1} (Rockström *et al.*, 2010; Wani, Rockstrom, Venkateswarlu, & Singh, 2011b; Wani, Rockström, & Sahrawat, 2011a). Irrigated land that covers 46% of the total agricultural area contributes significantly in satisfying 55% of total food requirement of the country (GoI., 2012), but on the other hand, it consumes almost 70% of the freshwater resources and has left limited scope for further expansion of the irrigated area (CWC & Handbook of water resources statistics, 2005). Thus, the current and future food security of the country is only feasible by harnessing the huge untapped potential of rainfed agriculture through improved management of land, water, nutrients, and other natural resources (Rockström *et al.*, 2007; Wani, Sarvesh, Krishnappa, Dharmarajan, & Deepaja, 2012b; Wani, Sreedevi, Rockström, & Ramakrishna, 2009).

However, recent data show a general increase in the global food production. This can be attributed to both the expansion of cultivated area and technological progress, leading to increased crop yields (FAO, 2010). This yield gain has been achieved largely due to heavy reliance on fertilizers and pesticides, thereby putting pressure on the environment. Thus, it is clear that the current approaches to agriculture and agricultural technology are not adequate for addressing the food security issues. It is estimated that by 2025, India's population is expected to reach 1.45 billion (United Nations., 2006) and the cereal requirement will be between 257 and 296 million tons (Bhalla, Hazell, & Err, 1999; Kumar, 1998). The future food production must increase by about 5 million tons annually to ensure food and nutritional security to the increasing population (Kanwar, 2000). Therefore, there is a need recognized for further examination of the contextual factors associated with the development of new and environmentally sustainable agricultural technology (Sahrawat, Wani, Pardhasaradhi, & Murthy, 2010; Wani *et al.*, 2012b). This requires multidisciplinary approach involving farmers, researchers, and policy makers to deal with knowledge integration.

It calls for sustainable soil management for achieving food and environmental security. Investing in soil management provides opportunities for agricultural intensification and diversification of livelihood options that minimizes resource degradation (Shiferaw, Bantilan, & Wani, 2006). There is now emerging evidence that regenerative and resource-conserving technologies and practices can bring both environmental and economic benefits for farmers, communities, and nations. The best evidence comes from the countries of Asia and Africa where the concern is to increase food production despite fragmentation of land and limited use of technologies. In these complex landscapes, some farming communities adopted regenerative technologies and substantially improved their agricultural yields (Rockström *et al.*, 2007, 2010; Wani, Pathak, Jangawad, Eswaran, & Singh, 2003). These evidences have common elements, i.e., farmers have made use of resource-conserving technologies, such as soil and water conservation, integrated nutrient management, crop diversification, water harvesting, and integrated pest management. There has been action by groups and communities at the local level, with farmers becoming experts in collectively managing their farms and watersheds as ecosystems. Moreover, there

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have been supportive external government and/or non-governmental institutions, often working in new partnerships with new participatory approaches, which have reoriented their activities focusing on the local needs and capabilities (Wani, Garg, Singh, & Rockstrom, 2012a).

This study was conducted in the state of Karnataka in India (**Figure 1**), which has a large rainfed area (7.5 million ha) in the country, after Rajasthan, with diverse agroecological characteristics. Quantitative distribution of rainfall determines the growth of the agriculture sector in Karnataka as 70% of the total agricultural area comes under rainfed lands. The state's average rainfall is 1139 mm, which varies from 3085 mm in the coastal region to 593 mm in the northern dry region. Nearly half the total rainfall is received during the monsoon season (GoK, 2011). Large variability is also found in its distribution between years. In 2009, the state experienced a surplus in rainfall as most of the taluks received rainfall above the normal (taluk is an administrative sub unit of a district typically comprising number of villages). Rainfall was normal in 2010 but in 2011 and 2012 there was a deficit in rainfall. Out of 176 taluks, only seven taluks received lesser than 500-mm rainfall in 2009 whereas 101 and 127 taluks received rainfall less than 500 mm during 2011 and 2012, respectively. The rainfall analysis also shows the occurrence and severity of drought situations in the state (**Figure 2**).

Maize (*Zea mays*), rice (O*ryza sativa*), sorghum (*Sorghum bicolor*), finger millet (*Eleusine coracana*), and pearl millet (*Pennisetum glaucum*) are the major staple crops occupying more than 50% of the land area and accounting for more than 60% of the population's calorie intake (GoK, 2011). Until recently, farmers were facing four major constraints (GoK, 2011). Firstly, over the last two decades, the average productivity of the major rainfed crops was two to three times lower than the potential productivity of the state. Secondly, soil

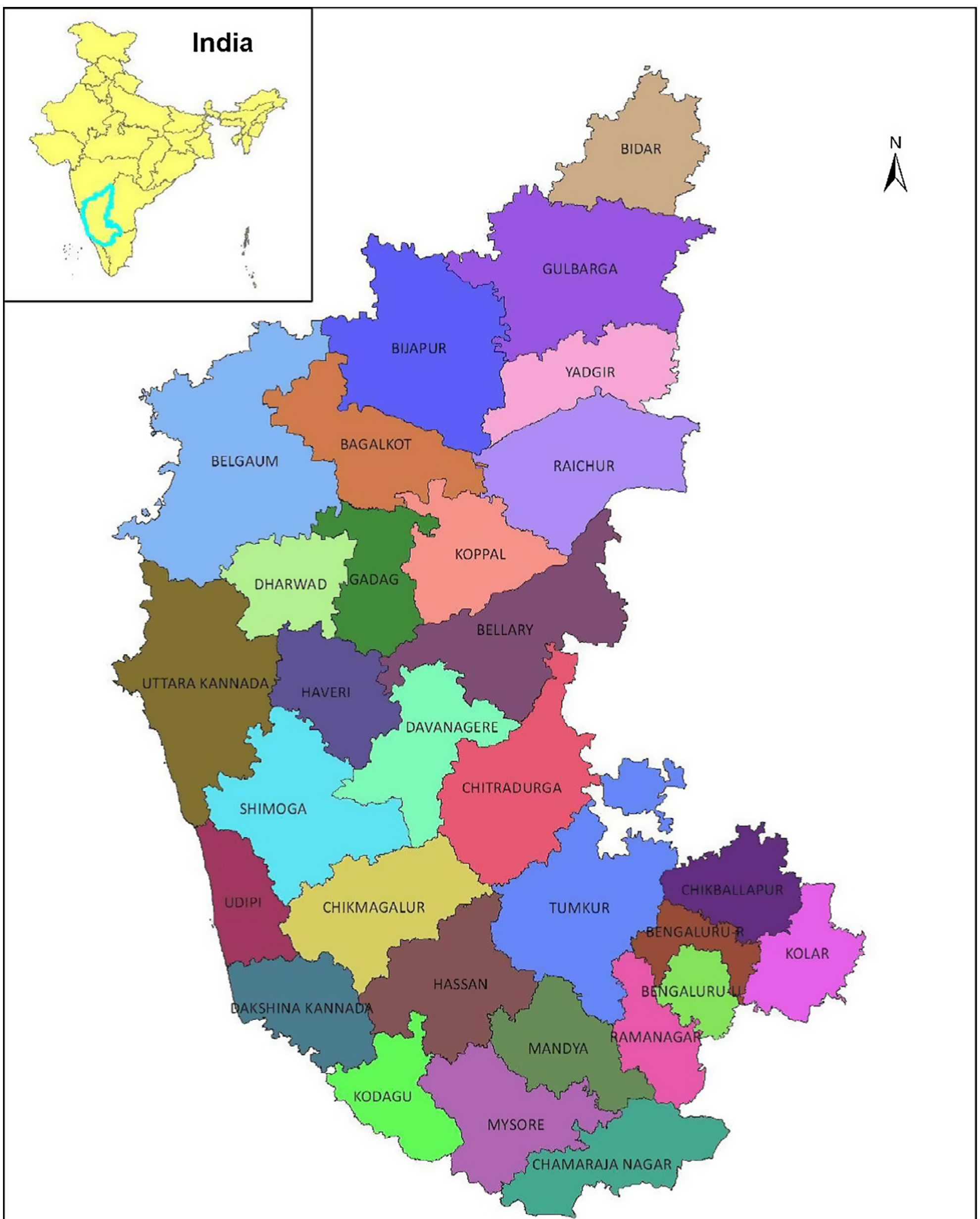

Figure 1. *Map showing all the districts in the state of Karnataka.*

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