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Short Communication

Improving crop productivity through sustainable intensification

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Abstract: To meet current and future demand of food, feed, fibers and fuel for a rapidly growing population, agricultural systems should intensify the use of land and water resources through more sustainable methods and by changing existing production systems and diversifying them into newer and more efficient enterprises. Sustainable agricultural growth is critical to ensure food and nutrition security .The more efficient use of agricultural inputs with improved management techniques are the key consideration for the sustainable intensification. Modern clever technologies regarding agronomic management and improved farm mechanizations may increase resource use efficiency in crop production. The reduction of high input use with relative increase in crop yield is the major concern. The objective of this study is to view the role of the sustainable agriculture intensification in relation to crop production and achievement of food security. In this paper, we will explore the ways in which sustainable intensification interventions can be carried out. Sustainable intensification could be the better means to minimize the crop yield gap without environmental burdens, a major challenge of agriculture for this era It has a positive implication on livelihood security in terms of better economic and social conditions.

Keywords: Agriculture, food security and intensification

INTRODUCTION

Agricultural production should be increased to meet the challenge of food security for a growing population in the world. The world will need 60% more food than is available today if global population and food consumption trends continue, by 2050. Because arable land is limited, most of this additional production will have to come from sustainable agricultural intensification [1]. Agricultural intensification is an increase in agricultural production per unit of inputs that improves per-hectare yields rather than expanding land under cultivation Agricultural intensification has been defined in three ways: (1) increasing yields per hectare; (2) increasing cropping intensity (i.e. two or more crops) per unit of land or other inputs (water), or livestock intensity (e.g. faster maturing breeds); and (3) changing land use from low value crops or commodities to those that receive higher market prices or have better nutritional content [3]. Agricultural intensification has greatly increased soil nutrient demand from crop production; meeting this demand through synthetic fertilizers is associated with a high energetic, environmental and public health cost [4]. Sustainable intensification (SI) is a process or system where yields are increased without adverse environmental impact and without the cultivation of more land [2]. Sustainable intensification is a technological means to closing the yield gap. The difference between actual yields in a region and agro-climatically achievable yields in the same region is termed the 'yield gap'. Sustainable intensification allows for increasing the availability of biomass without increasing the burden on the environment, which is key to producing more bioenergy (and food, feed, fuel and fibre). . Sustainable production systems should exhibit a number of key attributes at the production end of food systems [5, 2]. They should: (1) utilize crop varieties and livestock breeds with a high ratio of productivity to use of externally and internally derived inputs; (2) avoid the unnecessary use of external inputs; (3) harness agroecological processes such as nutrient cycling, biological nitrogen fixation, allelopathy, predation and parasitism; (4) minimize use of technologies or practices that have adverse impacts on the environment and human health; (5) make productive use of human capital in the form of knowledge and capacity to adapt and innovate and of social capital to resolve common landscape-scale or system-wide problems (such as water, pest or soil management); and (6) minimize the impacts of system management on externalities such as green house gas (GHG) emissions, clean water, carbon sequestration, biodiversity, and dispersal of pests, pathogens and weeds. Because of increased road links and market access, Nepalese agriculture is now transforming into intensified cropping, especially in peri- and semi- urban areas in Nepal. A shift from cultivating cereal crops towards vegetables and other cash crops has evolved through the process of agricultural intensification in the hills [6]. In Nepalese

mid hill semi-urban context, intensification has replaced the conventional practice of farming of two crops in a year into the plantation of three and more crops including vegetables in a year [21]. The agricultural intensification in mid hills of Nepal is characterized by the extensive use of chemical fertilizers and pesticides [22].

APPROACHES OF SUSTAINABLE AGRICULTURE INTENSIFICATION

Sustainable intensification includes many approaches, such as participatory breeding, biodiversification, Integrated Pest Management, Integrated Pest Management (IPM), conservation agriculture, cultivation of climate resilient and high yielding crop varieties and legume intercropping in cereals [6]. The IPM is a system of farming designed to be sustainable, it involves using a combination of cultural, biological and chemical measures, including plant biotechnology. The aim of Integrated Nutrient Management (INM) is to integrate the use of natural and man-made soil nutrients to increase crop productivity and preserve soil productivity for future generations [9]. Jha [7] found that IPM-FFS (integrated pest management-farmer's field school) trained farmers used 36% lesser amount (1.82 kg/ha) of active ingredients of pesticides than the non-trained farmers (2.85 kg/ha). Similarly, another report GC [8] stated that the pesticide application reduced up to 40% in FFS implemented areas as compared with non-FFS areas. In Nepal, Soil Management Directorate (SMD) has launched many programs that include soil analysis, fertilizer analysis, micronutrient analysis, Integrated Plant Nutrient Management System (IPNS), Nutrient deficiencies study, Soil fertility maps of different districts, training related to soil management and laboratory procedures, FYM and Compost Management programs etc. Chapagain and Gurung [10] reported that maize yields under Improved and Farmers' management systems were found to be very similar to the research station yield, and were higher than the average productivity in the average farmers' field. Average maize yield using the Local cultivar under Farmers' management was 3.5 t/ha which was nearly 2.3 tons lower than the yield obtained with IPNS management and Improved cultivar. Efficient use of all nutrient sources, including organic sources, recyclable wastes, mineral fertilizers and bio-fertilizers should therefore be promoted through Integrated Nutrient Management [11].Conservation agriculture is considered as a resource saving agriculture production system that encourages to increase production and profitability through rejuvenating fertility of the soil. Conservation agriculture is a system approach which is characterized by three interlinked principles namely minimum soil disturbance, permanent soil cover and crop rotation [12]. Ghosh et al. [13] reported 79% higher grain yield of wheat (1700 kg/ha) in conservation agriculture than conventional (950 kg/ha). Bashour et al. [14] reported increase in wheat and lentil yield by 27 and 27.7% under the experimental plots of conservation agriculture than conventional. Conservation agriculture aims to produce crop yields by reducing production costs, maintaining the soil fertility and conserving water [15]. Increased productive potential has resulted in yield differences ranging from 20 to 120 % for CA compared with conventional tillage systems [16]. The incorporation of legumes into cropping system is beneficial. It is reported that legumes at about a yield of 1 t/ha can provide a residual 20-40 kg N/ha to succeeding crops depending on the quantity of biomass returned to the soil. Cultivation of legumes between rice-wheat crops short period e.g. vetch, clover etc. can increase grain yields of main crops. Crop rotation with Sesbania (Dhaincha) can increase 10-13% rice grain yield i.e. 450-750 kg/ha [17]. Some of the legume based cropping pattern recommended by Regmi [18] are; Rice-Vegetable-Legume, Rice-Legume-Vegetable, and Leguminous vegetable-Wheat-Vegetable (Cucumber). Varietal improvements, particularly focused on increased yield and pest resistance, have long been at the forefront of agricultural intensification. Yield improvements in key agricultural staples – wheat (208 %), paddy rice (109 %), maize (157 %), potato (78 %) and cassava (36 %) – between 1960 and 2000 [26] were key to reducing protein-energy malnutrition (undernourishment) in the developing world [27] by increasing output and reducing food prices. System of Rice Intensification (SRI) involves cultivating rice with as much organic manure as possible, starting with young seedlings planted singly at wider spacing in a square pattern; and with intermittent irrigation that keeps the soil moist but not inundated, and frequent inter cultivation with weeder that actively aerates the soil. The SRI have been adapted and applied to a variety of other crops, including wheat, sugarcane, finger millet, various pulses and turmeric [19]. The study compared SRI and conventional cultivation across 13 rice-growing states and showed between 12 and 54 % higher yields in the former, combined with improved water-use efficiency [20].

MERITS AND DEMERITS OF SUSTAINABLE AGRICULTURE INTENSIFICATION

Since intensification has provided increased income opportunities through the better linkages with the urban markets, farmers with relatively smaller landholdings and limited off farm income have also adopted intensification practices in the watershed [22]. The prevailing school of thoughts to grow more food to feed the growing population are; 1) Commercialization of agriculture-adopting high input-high output i.e., Western model of agriculture production system. 2). Sustainable intensification in agriculture-producing more food from the same area of land to feed humans without damaging the biodiversity and ecosystem services [6]. Agricultural intensification in Nepal is believed to have important socio-economic implications. Studies from Katwal and Sah [23] showed that agricultural intensification offered important socio-economic benefits to the Nepalese farmers. Agricultural intensification has increased employment opportunities for local people in mid- hills. It opens new opportunity of employment in the markets of agricultural products, fertilizers and pesticidesAlso, it has the merits of food security, increased employment, increased decision making, improved local institutions and local economy of the farmers [22]. Since intensification increases the annual harvests through the cultivation of more number crops in a plot, it thus provides higher production and income opportunities to the farmers.. Farmers with large landholdings hire local farmers who have small landholdings, for cultivation and transport of farm production up to the market [24]. Furthermore, labor wages has also been increased which benefited the poor and disadvantaged groups. In mid-hills the economy of the farmers involved in agricultural intensification, has been reported to be improved [23]. Agricultural intensification enhanced the quantity of food produced; improvements in food security [23, 25] and farmers are also able to consume more nutritious

food in terms of more green vegetables in their diet [24]. Agricultural intensification is considered to have some negative effects as well. Agricultural intensification has serious implication on environmental degradation. Agricultural intensification raises concerns about soil erosion, nutrient depletion, water quality and soil organic matter depletion [28].Increased tillage activities in farms because of cultivation of more crops in intensified farming makes soil susceptible to erosion and degradation [29]. Since intensification practices in Nepal have relied extensively on the excessive use of chemical fertilizers and pesticides in recent years, farm sustainability has been largely challenged. Further, unsustainable agriculture practices pose the risks of natural resources over usage in form of inputs which has detrimental environmental effects [30].

CONCLUSION

Agricultural intensification has a positive implication on livelihood security in terms of better economic and social conditions, like food security, employment opportunity and improved division of labor; and improved institution. With the application of clever and modern agronomic management and mechanization techniques, crop production can be increased without any problems regarding environment and climate issues. The closeness to the huge yield gap and increase productivity to feed the number of populations in this world, sustainable intensification play a crucial role. Therefore adoption of agricultural intensification leads to the increased agricultural production. It has been found to be a viable option to improve livelihoods context of farmers.

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