Agricultural resilience-sustainability and food security in South Asia in the context of changes in global climate

Tavseef Mairaj Shah (tavseef.mairaj.shah@tuhh.de), Ralf Otterpohl

Abstract:

One of the areas that is directly affected by the changes in global climate and involves the poorest of the world is agriculture and hence by association food security. Unsustainable farming practices like the excessive use of mineral fertilizers and plowing have further aggravated the situation, having led to an irreversible destruction of cultivable soils worldwide. In this regard, certain areas of South Asia have been described as among the regions most vulnerable to climate change.

In South Asia, more than 65 % of the 1.7 billion people rely on agriculture for their livelihood and rice is the staple for the majority of the population. With 68 % of the total population based at or near rice ecosystems and nearly 30 % living on less than USD1.25 a day, the resilience of rice based small-holder farms assumes great importance in the present scenario. South Asia would be the worst affected in terms of absolute change in rice production with the production in 2050 being projected at 40 % lower than in the no-climate-change scenario. In this context, it is imperative to focus on agriculture in the context of a changing climate when framing future policies for South Asia.

From the perspective of high water productivity and better yields, the rice production system known as System of Rice Intensification (SRI) is among the well-recognized systems in application in various agro-ecological regions of the world. SRI is a methodology for increasing the productivity of irrigated rice by better management of plants, water, soil and nutrients. It is as a climate-smart rice production system having improved resistance to drought, floods, storms, and pests and results in increased yields. The water consumption with SRI—rice being a water-intensive crop—is also lower than in the conventional rice production system, a factor that assumes great importance in the current scenario of receding water tables in South Asian countries. This paper will examine the case for SRI in South Asia in the context of climate change and related factors.

Keywords: Food security; Agriculture; Rice cultivation; Climate change; Water scarcity; Resilience

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Introduction

South Asia is a power-house of rice production powered by rice itself and has been described as the 'food bowl' of Asia (Gumma et al. 2011). Rice is the staple food of around 70 % of the South Asian population Despite being the world's most densely populated region it houses the largest population of undernourished people with more than 500 million people living under US$ 1.25 a day (Bishwajit et al. 2013). The population of the region is expected to grow to 2 billion by 2030 and the increase in population is expected to be faster than the increase in rice production in the coming decades (Papademetriou 2000). Agriculture is the largest consumer of the available freshwater on earth and if the current water management practices are continued with, it will lead to acute water crises in many parts of the world (Foundation on Future Farming, 2016).

Further complicating this situation is the increased frequency of extreme weather events as seen in the last decade that lead to huge losses in agricultural production (Camou and Rahmstorf 2012). Cases in point from South Asia being the Pakistan floods of 2010 and the Kashmir floods of 2014, which led to crops losses in agriculture to the tune of 13.3 million metric tonnes and 875 million US$ respectively (WFP 2010, Indian Express 2014).

Considering these factors and keeping resource conservation in focus there is a need to go for sustainable intensification of crops in general and rice in particular in South Asia. This should also ensure resilience in the face of weather extremes of the million families in South Asia that depend on agriculture for livelihood. System of Rice Intensification (SRI) reverses the Green Revolution thinking that intensification is matter of increasing material inputs (Uphoff 2014). The following sections examine the need for such a farming strategy in the context of South Asia based on ongoing research and interactions with farmers and scientists working in this field from India, Pakistan, and Kashmir.

The Case for System of Rice Intensification

The importance of rice to the sustenance and development in South Asian countries and the current productivity-ecology-population dynamics call for a resource efficient and sustainable intensification of the rice production in the region. The following three sections build a case for the implementation of SRI in the South Asia regions in the light of existing research in the field of agriculture, ecology, and sustainability.

Rice and Yield Situation in South Asia

In addition to being the major source of calories for half the world's population, rice is the single largest source of employment and income in rural areas around the world (WWF-ICRISAT 2010). It is expected that the global rice consumption will increase to 555 million tonnes in 2035 from 439 million tonnes in 2010. The contribution to this increase from Asia alone will account for 67 % (GriSP 2013). In South Asia, more than 65% of the population depends on agriculture for their livelihood and rice is the staple for the majority of the population. Globally, rice is grown on some 144 million farms, most of which are less than 1 hectare in size. Hence most of the rice farmers worldwide are small-holder farmers. In South Asia, with 68 % of the total population based at or near rice ecosystems and nearly 30 % living on less than US$1.25 a day, the resilience of rice based small-holder farms assumes great importance (GRiSP 2013).

Although since the Green Revolution South Asia witnessed impressive production growth and gained status as one of the largest rice-exporting regions in the world, it was still home to 295 million undernourished and hungry people in 2011-13. This is nearly 35% of the 842 million hungry people in the world while as the total population of South Asia is 24% of the world population. This translates to 16.8% of the South Asian population that were hungry in this period (Mohanty 2014). On a global level more than 70 % of the under-nourished population lives in rural areas, the majority of which consists of small scale and subsistence farmers who have direct dependence on local land and water use for their survival. It can hence be argued that hunger is primarily a rural problem that can be overcome locally in the long run by building resilience in small-holder farming systems. Hence, regional food sufficiency or food sovereignty has been described as the backbone of any rural development initiative (FFF 2016).

In the Green Revolution period, a remarkable increase in the global rice production was witnessed, which has been attributed largely to the widespread adoption of high-yielding varieties and increased inputs of seeds, mineral fertilizers, and agrochemicals in Asia. Recently however it has been reported that farmers have experienced a decrease in productivity growth. This has been attributed partly to loss of soil fertility (loss of biomass and soil nutrients), salinization of the soil, and other forms of land degradation (Noltze 2012). Other forms of land degradation may include loss of soil biodiversity, soil pollution, loss of soil carbon—often a result of poor farming practices.

Food Insecurity in South Asian Countries

The food security situation in Afghanistan is very grim and is also intricately linked to other problems that the country faces. In Afghanistan, it has been reported that, approximately 61 percent of the population consumes poor to very poor food, while as 30 percent of the population does not have sufficient food to sustain daily life. And, approximately 20 percent of the Afghan population suffers from chronic food insecurity. A decrease in crop productivity due to changes in weather patterns compels farmers to switch to drought hardy cultivation, including opium poppy. With the frequency of dry seasons expected to increase in the coming years, with the prevalent resource-intensive systems of cropping are going to suffer (Khadka 2011). This highlights the relevance of climate change resilience in agriculture or climate-smart agriculture in the context of challenges faced by a country like Afghanistan on the socio-political front and with regards to self-sufficiency. In Bangladesh, agriculture is the principal occupation of nearly two-thirds of the population and contributes to 20 percent of nation's GDP. With 10 million hectares under cultivation, rice is the major crop and also the staple food. Bangladesh is, however, even after achieving agricultural self-sufficiency, still near the bottom in Global Hunger Index (GHI). One of the key reasons affecting its food security is the inflation in food prices (Khadka 2011). The fact that inflation is a factor behind food insecurity points to the importance that needs to given to local food production, which will result in less transportation costs and will decrease the number of middlemen involved right from the farm to the consumer. With periodic droughts and cyclonic storms having become more frequent in many parts of India and Bangladesh, climate change is expected to adversely affect agricultural prodcutivity in future.

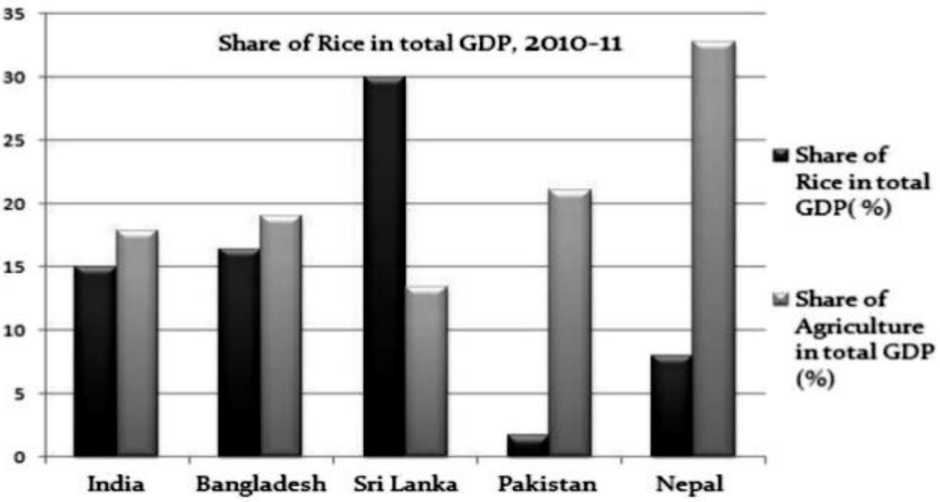
Table 1. Agricultural GDP and Poverty in South Asia (Khadka 2011)

Country	Contribution of Agriculture to GDP	Poverty headcount ratio at US$2 a day	Percentage undernourished population
Afghanistan	40	No data	No data
Bangladesh	19.1	81.33	27
Bhutan	21.9	49.49	-
India	19.0	75.59	21
Maldives	6	-	-
Nepal	32.9	77.57	16
Pakistan	20.4	60.31	26
Sri Lanka	13.2	39.74	19

Agriculture is the principal occupation of approximately 52 percent of India's total labour force and its contribution to nation’s GDP is 17.5%. With rainfall patterns expected to become shorter and more erratic, farmers become more vulnerable to many risks, including droughts, diseases and unpredictable market irregularities. Pakistan, like other South Asian countries, has an agro-based economy. Agriculture is the main occupation of approximately 45 percent of the total labour force and accounts for 21.8 percent of the country’s GDP. In Pakistan as well, the net agricultural productivity is expected to decrease with increasing environmental degradation in the coming years (Khadka 2011).

Rice has been described as the cheapest and the most effective means available in South Asia that is likely to eradicate acute undernutrition. Many studies have revealed that there is a great potential to increase the rice production in South Asia. India, Bangladesh and Sri Lanka are among the most disaster-prone countries in the world. Recurrent floods, cyclones, earthquakes, landslides and droughts hugely affect the production in these countries (Bishwajit 2013). The aforementioned potential to increase the rice production in South Asia cannot be divorced from measures taken to adopt farming systems resilient to such weather extremes.

Table 2. Rice and Agricultural GDP in South Asia (Bishwajit 2013)



Although an increasing trend in the average yield of rice can be found in Pakistan, Nepal and Sri Lanka, the demand for food is only rising and the increase in yields is achieved at the cost of rapidly diminishing resources—like water. Increasing amounts of fertilizer and pesticide are being used to boost the production, hence aggravating environmental and ecological problems. Thus the need for a sustainable intervention to these urgencies necessitates innovation in rice technology to produce rice in more ecofriendly ways (Bishwajit 2013).

Bishwajit et al. (2013) conclude that sustained production of rice is central to food security in South Asia. The land resources in South Asia are quite capable of being self-sufficient in rice production. Poverty is another direct cause of food insecurity, which can be alleviated if people can be employed in agricultural activities and facilitated to grow their own food in resource-efficient ways. Gaining self-sufficiency in rice production has been projected as the easiest way to promote food sovereignty in South Asia, agriculture being the mainstay of its economy, and the ratio of rice land to arable land being high in the region (Bishwajit 2013).

Groundwater Situation

Agriculture is by far the biggest consumer of water and this makes the quantity of water that a person 'eats' everyday much greater than the volume of water that a person drinks. Rice is a water-intensive crop with around 3,000-5,000 litres of water required to produce 1 kilogram of rice (WWF). Given that extensification of rice cultivation in South Asia is ruled out, achieving a yield growth of 1% to 1.3% to catch up with the population growth is still reasonable. However, growing uncertainties such as growing water shortages, increasing frequency of extreme weather events, and emerging pest outbreaks due to climate change can make things even more challenging. There is a rapid depletion of groundwater resources in parts of India and Bangladesh that has been reported. This is of serious concern for agricultural productivity growth in future. Illustrating this point is the exponential rise in the number of shallow tube wells from 21 in 1980 to about 1.62 million in 2012 in Bangladesh alone. Similar to Bangladesh, many rice-growing states in India are facing declining water tables because of rice-wheat and rice-rice cultivation following the water-intensive system of cultivation (Mohanty 2014).

The need to adopt water-conserving system of crop cultivation in general and rice cultivation in particular South Asian context can be gauged from the fact that 24-30% of the world's accessible freshwater resources are used to irrigate rice. And this is the dominant mode of rice cultivation in practice around the world at a time when water scarcity is already a reality for as many as 2 billion people. Hence, water for agriculture is becoming increasingly scarce. This will be exacerbated by climate change-induced higher temperatures that will increase crops' water requirements, so shortages will become more serious in future. It has been reported that by 2025, 20-25 % of the world's irrigated rice lowlands, which provide three-quarters of the world's rice supply, are expected to face some degree of water scarcity (WWF-ICRISAT 2010).

While there is need to adopt cropping systems that provide better yields, the prevalent water situation dictates that the systems to be adopted be resource conserving as well. Thakur and Uphoff (2017) have, in the light of such concerns, termed the sustainability of the commonly practiced rice cultivation methods 'questionable', given the degradation in soil and water quality. From the perspective of high water productivity, the rice production system known as the system of rice intensification (SRI) is among the well-recognized systems in application in various agro-ecological regions of the world. This system enhanced yields 50–100 % or even more and it entails merely half of the water than the conventional rice system.

Climate Smart Strategy

Certain areas in South Asia are reported to be among the regions most vulnerable to climate change (Sapkota 2014). Further, it has been reported that weather extremes are expected to rise worldwide as a result of climate change leading to reduced food production (Powell 2016). Moreover, climate change is expected to lead to higher temperatures, greater water demand by crops, more variable rainfall, and extreme weather events, causing negative effects for agriculture in many regions (Noltze 2012). It has been reported that South Asia would be the worst affected region in terms of absolute change in rice production, with production projected to change from 169 million t in 2050 under the no-climate-change scenario to slightly above 100 million t under a climate-change scenario, a difference of more than 65 million t (GriSP 2013).

According to a FAO report, the number of climate-induced disasters has increased significantly over the last decade. Of all natural hazards, floods, droughts and tropical storms are reported to affect the agriculture sector most showing the severe impact of climate-related disaster with more than 80 percent of the damage and losses caused by drought being in the agriculture sector (FAO-UN 2015). As things stand, currently the annual loss in rice production due to weather extremes in South Asia alone is estimated to be 4 million t (Ricepedia).

The dependence on new seed varities in a roadblock in the widespread adoption of agroecological management practices. A report published by International Rice Research Institute in 2013 notes that farmers in Asia rice farmers need to modify their management practices to counter the negative effects of climate change rather than just depending on new stress-tolerant varieties. The management practices referred to in this report include water-saving technologies such as alternate wetting and drying, land leveling, improved tillage, bund preparation, and direct seeding, which can make a significant difference in keeping plants standing in the face of water shortage and irregular rainfall (GriSP 2013). Nitrogen fertilizer has been described as “the third major threat to our planet, after biodiversity loss and climate change” by John Lawton, former Chief Executive of the Natural Environment Research Council, UK.

In this context, Mohanty (2014) notes that a combination of appropriate policy reforms, the development and dissemination of climate-resilient and resource-conserving technologies and improved production practices is vital to ensure South Asia’s sustainable food security in the future. Referring to the system of rice intensification (SRI) as 'an approach to increase rice production at affordable costs for small-scale farmers, without harming the environment', Noltze et al (2012) call for sustainable agricultural innovations to meet rising food demand in an environmentally and socially acceptable way (Noltze 2012).

System of Rice Intensification

The Green Revolution strategy of improving the yields of rice and other crops by using high yielding varieties and greater application of mineral fertilizers and other agrochemicals is encountering rising economic, social and ecological costs. The SRI suggestion of using less inputs for better yields, by changing the management strategy, is divergent from the Green Revolution thinking. This deviation and the achieved results with SRI prompt a review in the dominant paradigm in current agricultural research and development as the Green Revolution thinking of using more inputs has been reported to be counterproductive in the long run. Rice breeders at the IRRI have acknowledged that the yields from their trials have not increased significantly over the last 30 years (WWF-ICRISAT 2010).

In order to meet the demands of a growing population in the next decades the increase in rice production must be accomplished ‘with less land per capita, smaller and less reliable water supplies, less degradation of the environment, and less drain on the resources of smallholder farmers, who constitute the majority of the world’s poor‘ (WWF-ICRISAT 2010). The System of Rice Intensification (SRI) has been described as among the best current options available to farmers and nations to promote community-led agricultural growth, while consuming soil and water resources more sustainably and even enhancing their future productive capacity. The implementation of SRI has, on average, resulted in 47% yield increase, 40% water savings, 23% reduction is costs per hectare, and 68% increased income per hectare (WWF-ICRISAT 2010).

SRI is a systems approach that gives rise to a domino effect with regards to other resource conservation strategies like waste managment and composting. As an example, weeds, which in conventional cultivation practice are treated as something to do away with, are treated as an amendment to the soil instead of waste in SRI. Noltze et al (2012) define a system technology as 'an integrated innovation to improve agricultural productivity and agroecosystem resilience, involving different agronomic and management components with synergistic relationships, as opposed to a single new high-yielding crop variety for instance'. Prominent system approaches other than SRI are conservation agriculture, agroforestry, or organic farming (Noltze 2012). A systems approach like SRI hence focuses not just on the yield dimension of the crop but also associated parameters like water conservation, soil health, disease and pest prevention as well as climate change mitigation.

The System of Rice Intensification (SRI) was developed as an innovation in Madagascar in 1980s. The term 'intensification' however has largely been associated with an increase in material inputs while as SRI refers to exactly the opposite—boosting production by making reductions in purchased agricultural inputs such as seeds and fertilizer (Uphoff 2014). SRI is an agro-ecological management strategy with plant management, seed management, water management, nutrient management, and soil management being the core areas. According to SRI International Network and Resources Center, the System of Rice Intensification is 'based on the cropping principles of significantly reducing plant population, improving soil conditions and irrigation methods for root and plant development, and improving plant establishment methods' (SRI-Rice).

The success stories of SRI from over 50 countries of the world have been extensively reported in research. For example, it has been reported that smallholder paddy rice farmers in Madagascar who had previously been producing only around 2 tonnes per hectare went on to get an average yield of 8 tonnes per hectare sustained over the years. And this fourfold increase was achieved with the same rice variety and on the same soil as used before, with reduced inputs of seeds, water, and fertilizer (Uphoff 2014). However, lack of institutional and policy support and capacity building appears to be the stumbling block that prevents its widespread adoption in the context of South Asia.

Noltze et al make a note of the propagation of resource management strategies like the System of Rice Intensification (SRI) in a smallholder farm context in the background of rising food demand, decreasing productivity growth, and environmental degradation (Noltze 2012). Various researchers have hailed System of Rice Intensification (SRI) as a potential approach to increase rice production at affordable costs for small-scale farmers, without harming the environment (Stoop 2002; Mishra 2007).

Conclusion

The resource management strategy of SRI promises to be an answer to the prevalent problem of lack of food sovereignity in the context of reduction in natural resources and effects of climate change on crop productivity. Already in implementation in more than 50 countries of the world with policy and institutional support existing in many, South Asian countries seem to lag behind in the latter aspect of SRI, which is surprising given the relevance of rice and the diminishing resources—particularly water—in these countries. Although the exact impacts of SRI have been reported to be context specific, yet, almost all studies on SRI point at positive environmental and resource conserving effects. SRI promises to be suitable for small-scale farmers, who often have limited access to inputs and credit markets (Noltze 2012). Hence, institutional and policy support for SRI in South Asian countries could prove to be a vital in building resilience in small-holder farmers—most vulnerable to negative affects of climate change—in South Asia.

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