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RESEARCH ARTICLE

Preparing Rice Farmers for Climate Change

Direct Seeded Rice in India

By Takashi Yamano, Architesh Panda, and Sampriti Baruah

Introduction

The mean temperature in India has seen a significant increase of 0.56°C over the period of 1901-2007, with accelerated warming in the recent 1971-2007 period. It is expected to increase further due to climate change, although predictions vary under different scenarios (World Bank, 2012). Climate change is expected to increase the frequency and intensity of extreme weather events and make the monsoon unpredictable. The majority of India's population is rural and agricultural production largely depends on the monsoon, with over 60 per cent of cropped area being rain-fed. Effective adaptation to climate change in the agricultural sector is increasingly recognized as a critical policy component for reducing vulnerability to and mitigating adverse climatic impacts (Rosenzweig and Parry, 1994; Bradshaw *et al.*, 2004).

In this article, we discuss a rice establishment technology known as Direct Seeded Rice (DSR) which can help farmers in adapting to climate change and reducing Greenhouse Gas (GHG) emissions. Under DSR technology, rice seeds are directly planted in the rice fields, rather than being first sown in nursery fields before transplantation to rice fields. Available evidence suggests that conventional puddling for transplanting rice is a major source of GHG emissions (Pathak *et al.*, 2013). Apart from reducing GHG emissions, DSR reduces the labour requirements and can enable farmers to diversify their income sources by releasing labour from transplanting, as we discuss later in this article. It also reduces the use of underground water needed for growing seedlings in nursery fields. DSR is a feasible alternative for farmers to adapt to climate change by saving on labour and underground water use and enabling them to diversify their income sources. In this article, we present results from our recent survey of 341 farmers in Eastern India who adopted DSR at least once in the 2009-2012 period and show how DSR users can save labour costs and earn profit, by comparing DSR users and non-DSR users in 2012. We also present farmers' perception of DSR along with policy recommendations.

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Climate change adaptation and DSR

Available evidence shows a significant drop in rice yields under different climate change scenarios (Dinar, 1998; Kumar and Parikh, 2001b; Sanghi *et al.*, 2008). Previous studies have focused on different types of adaptation actions by farmers to address climate risks in Sub-Saharan Africa, India, Nepal and Mexico. However, adaptation strategies may differ from situation to situation (Frankhauser *et al.*, 1999). Therefore, location-specific adaptation strategies need to be developed for different areas and technologies (Manandhar *et al.*, 2011; Traerup *et al.*, 2011; Noralene *et al.*, 2011). To the best of our knowledge, few economic studies have examined DSR and its role in climate change adaptation in South Asia.

The dominant method of rice establishment is transplanting in the rice growing areas of Eastern India. However, rising labour costs of establishing nurseries, puddling fields and transplanting rice seedlings have increased costs of transplanting for rice cultivation in the region. Furthermore, concerns about underground water depletion have made transplanting less attractive to farmers (Timsina and Connor, 2001; Rao *et al.*, 2007; Kumar and Ladha, 2011). DSR is an alternative method that can reduce the labour and irrigation water requirements as explained. Traditionally, farmers have used broadcasting of rice seeds in some areas of Eastern India, especially in upland areas. By broadcasting, farmers can save on the labour cost of transplanting rice. However, rice yields remain low under broadcasting. Broadcasting is not part of DSR technology as discussed in this article which defines DSR as the direct line-seeding of rice seeds by using machines. Because of line-seeding, rice plants receive soil nutrients and fertilizers evenly, and weeding becomes easier for farmers, compared to broadcasting of seeds. This is because under broadcasting, rice seeds are scattered randomly and thus difficult to identify among weeds. Farmers can use either dry or 'wet' rice seeds. Wet rice seeds are those where germination has begun before they are planted. In our survey areas, however, most farmers use dry seeds for DSR.

Because DSR is done with machines, it does not require labour and the reduced labour requirement can help farmers in adapting to climate change by allowing them to diversify labour, especially to non-agricultural activities. In rural India, farmers and landless agricultural workers have access to paid work opportunities under the Mahatma Gandhi National Rural Employment Guarantee Act programmes. Other non-farm income opportunities are also expanding. Because non-agricultural income sources are less climate-sensitive than farm activities, diversification of labour into non-agricultural activities can be a promising adaptation strategy in the face of adverse climate change impacts.

Table 1. DSR use among sample households in EUP and Bihar

State	Number of households	% of farmers applying DSR in 2012	Years since first application of DSR	Average size of DSR plots in 2009-2012
	(A)	(B) %	(C) years	Ha
EUP	195	54.8	2.5	0.69
Bihar	147	69.2	3.3	0.94
Total	342	61.4	2.9	0.84

Data

To examine DSR technology as a means to adapt to climate change, we compare rice farmers with and without DSR. A comparison of DSR users with farmers who would never adopt DSR could be misleading. A possible place to identify a realistic counterfactual group is where farmers have discontinued the use of DSR. Therefore, we have compiled a list of farmers who adopted DSR at least once. The list comes from two sources: farmers who participated in DSR training provided by the Cereal Systems Initiative for South Asia (CSISA)[1] project during the 2009-2012 period and farmers who obtained DSR services from CSISA-assisted service providers.

From the aggregated list of 2,386 farmers, we selected 342 farmers using a stratified sampling method as follows: First, we purposively selected seven districts where most of the CSISA DSR trainings were conducted in Uttar Pradesh and Bihar states. Second, we stratified the sample by the year that the farmers were listed in the aggregated list for the first time because we wanted to study the continuous use of DSR among farmers who started using DSR in different years. The interviews were conducted using the Computer-Assisted Personal Interview (CAPI) software called Surveybe that can be used to design surveys and collect data.

It may be noted that our sample households are not representative farmers in the survey areas. We randomly selected our respondents from a list of farmers who applied DSR at least once in the four-year period between 2009 and 2012. The selected respondents were mostly better-off and progressive farmers eager to learn new

[1] CSISA is a collaborative research project of four international agricultural research organizations aimed at improving livelihoods of farmers through sustainable intensification of cereal cropping systems. The International Rice Research Institute (IRRI), International Maize and Wheat Improvement Center (CIMMYT), International Livestock Research Institute (ILRI) and the International Food Policy Research Institute (IFPRI) are participating in the project. The project is funded by the Bill and Melinda Gates Foundation and the United States Agency for International Development (USAID).

EDITORIAL

Dear Palawija News readers,

Climate change is expected to have extensive impacts on the agricultural sector, many of which are already apparent. Given the key role of agriculture in ensuring food security and providing livelihood for people in the Asia-Pacific region as well as globally, it is critical for this sector to be prepared to effectively address the challenge. SATNET Asia, a project funded by the European Union and coordinated by CAPSA, recently organized a regional workshop on 'Climate Resilient Smallholder Agricultural Farming Systems in South Asia' in New Delhi, India. The workshop focused on ways to increase agricultural productivity in the context of climate change adaptation and strengthened awareness and knowledge among relevant stakeholders on climate resilient farming practices (more information on this workshop can be found in the 'CAPSA News and Activities' section).

In continued recognition of this global and regional priority, this issue of the newsletter is focused on 'climate change and agriculture'. The contribution by Sangmin Nam provides an overview of some of the key issues and priorities in this area as well as relevant implications for food security.

The research article by Takashi Yamano *et al.* discusses the application of Direct Seeded Rice (DSR) technology in Eastern India. DSR is a rice establishment technology which can help farmers adapt to climate change and reduce Greenhouse Gas (GHG) emissions from rice transplantation. Their analysis notes that DSR can help farmers diversify allocation of labour, conserve water resources and protect the soil. The short article by Ghani Akbar highlights the potential of use of Skimming Wells with Pressurized Irrigation Technologies for managing the problem of soil salinity resulting from climate change-induced extraction of low-quality groundwater in the Indus Basin. Various aspects of these technologies are discussed along with other relevant measures for controlling or curing soil salinity.

The recent FAO publication *Climate-Smart Agriculture Sourcebook* which elaborates the concept of CSA (Climate-Smart Agriculture) and demonstrates its potential and limitations is also reviewed in this issue. In addition, we share a success story on the floating gardens of Gaibandha district in Bangladesh which showcases a technology promoted by the international non-governmental organization Practical Action. The story provides a good example of a low-cost farming method suitable for climate change adaptation by small-scale farmers.

We hope that the information in this issue is useful and welcome feedback and contributions to future issues of the newsletter.

agricultural technologies. Therefore, we do not try to estimate an adoption rate of DSR in the target areas, but study the continuous use of DSR among farmers who applied it once to examine DSR technology as a means of adapting to climate change. Table 1 shows the distribution of sample farmers by district. On average, it has been three years since their first application of DSR. The farmers in Bihar are more experienced than farmers in Eastern Uttar Pradesh (EUP). The average plot size under DSR is also larger in Bihar (0.9 ha) than in EUP (0.7 ha). However, the average rice yield is much higher in EUP (4.8 tons per ha) than in Bihar (about 3.0 tons per ha).

Labour saving

Our data shows that total labour use, in person-days per ha, on a DSR plot is about 50 per cent less than on non-DSR plots. Table 2 shows that the total person-days of labour required per ha on a DSR plot is 68 person-days per ha as against 114 person-days per ha for a non-DSR plot. Thus, the total labour use is about 46 person-days per ha lower on a DSR plot than on a non-DSR plot. In the table, we find that a large share of this reduction in labour use comes from a reduction in hired female workers. This is because in Eastern India, manual transplanting of rice is mostly done by hired female workers. On a non-DSR plot, hired female workers worked about 50 days per ha on average, while they worked for only 23 days per ha on a DSR plot: the difference is about 28 days. Although the analysis is not presented in this article, we also find that the reduction in hired female workers comes from reduced labour use in the transplanting of rice. On a DSR plot, the amount of work by other workers is also less. Male and female family members work about 10 and 3.5 fewer days, respectively, on a DSR plot than on a non-DSR plot. Hired male workers also do slightly less work on a DSR plot than on a non-DSR plot.

Climate Change and Food Security

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A changing climate affects food security in complex ways. While the four main elements of food security, viz., availability, stability, utilization and access are all affected by climate change, studies to date indicate that climate change impacts largely affect the dimension of food production, i.e., availability. Global food production will need to double over the next 30 years to feed the growing world population. Continuing population growth and stagnant global per capita cereal production are now coupled with changing meteor-hydrological conditions and increasingly severe and frequent extreme weather events. The Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report (2007) expects substantial decreases in the cereal production potential in Asia, in particular in Central and South Asia, as a consequence of climate change. At the same time, the agriculture sector is a major source of greenhouse gas (GHG) emissions, accounting for 10 to 12 per cent of global total anthropogenic GHG emissions in 2005, in particular, by sharing about 60 per cent of nitrous oxide and 50 per cent of methane emissions. The GHG emissions from agriculture comprise four key subsectors: (i) nitrous oxide from agriculture soils through the process of nitrification and denitrification intensified by fertilizers; (ii) methane from enteric fermentation in ruminant livestock and both methane and nitrous oxide from manure management; (iii) methane from anaerobic decomposition in rice cultivation; and (iv) carbon dioxide from residue burning and forest clearing.

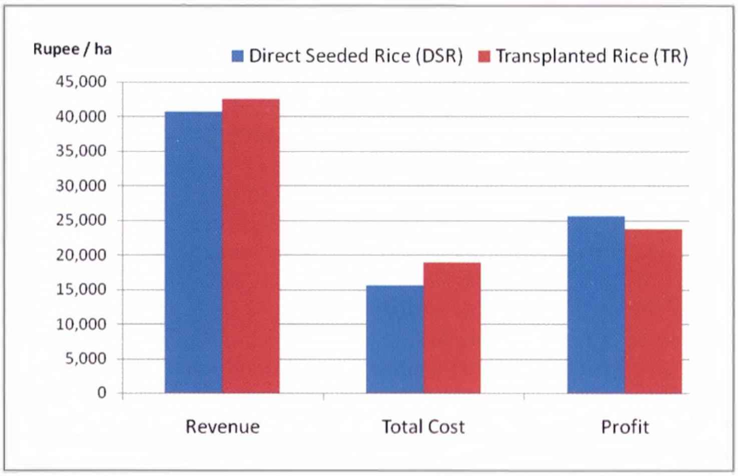
As the agriculture sector is a major source of GHG emissions, in particular in developing Asia-Pacific countries, and at the same time highly vulnerable to extreme climate variability and climate change, GHG mitigation in the four subsectors as well as adaptation measures to safeguard food production and food security are imperative. Immediate adaptation measures for food production could focus on shifting seasons and sowing dates, different varieties or species of crops, water supply and irrigation, other inputs such as fertilizer as well as tillage methods and grain drying. Adaptation measures for food security extend beyond changing agricultural practices to identifying present vulnerabilities, adjusting agricultural research priorities, protecting genetic resources, strengthening agricultural communication systems and increasing training and education among others. Furthermore, as an integrated approach towards both mitigation and adaptation, it is critical to have better management of the natural resource foundation for agriculture covering water, land, agroforestry and ecosystems, which help buffer the impact of changing meteor-hydrological conditions on the sector and enhance the capacity of natural carbon sinks.

Table 2. Labour use per ha in 2012 by activity: DSR vs. non-DSR plots

Unit: Person-days/ha

Descriptors	By DSR use in 2012		
	DSR plots (A)	Non-DSR plots (B)	Difference (C)
Total labour	68.6	113.6	- 45.5**
By activity			
Seedbed and land preparation	2.6	12.5	- 9.9**
Transplanting	1.5	45.9	- 44.4**
Direct seeding	5.4	0.5	+ 4.9**
Weeding	44.0	40.6	+ 3.3
Application of herbicide	2.5	1.0	+ 1.5
Application of other inputs	12.6	13.1	- 0.6

Note: 16 cases of broadcasting and 4 cases of machine transplanting are included with 117 cases of manual transplanting. ** indicates the 1 per cent significance level.



Profit

Mostly because of the reduced labour costs, the average profit from DSR plots is higher by about Rs. 1,971 (USD 35.8) per ha compared to non-DSR plots (see Figure 1). The average total cost of DSR plots is Rs. 15,629 (USD 284.2) per ha while the average total cost of non-DSR plots is Rs. 18,868 per ha (USD 343.1). The difference is Rs. 3,239 (USD 58.9) per ha. Thus, we can say that the average total cost is lower on DSR plots than on non-DSR plots. But the revenue from DSR plots is also lower because yield is slightly lower on DSR plots which reduces the profit from DSR plots. The low costs on DSR plots are due to lower labour costs. The average hired labour cost is Rs. 5,114 (USD 93.0) on DSR plots and this is Rs. 3,157 (USD 57.4) less than the average hired labour cost on non-DSR plots. However, the difference between DSR and non-DSR plots shrinks when we add the costs of inputs and service providers because these costs are higher on DSR plots than non-DSR plots.

Perception of DSR among farmers

Lastly, we examine the perception of DSR among farmers. By using DSR, farmers not only save labour costs but also reduce water use and protect the soil. Thus, the profit covers only the partial benefits of DSR. To investigate how farmers consider the overall benefits of DSR, we have asked farmers about their perception of DSR, including non-monetary benefits. In the survey, farmers were asked if they agreed with 10 statements about DSR on a 5-point Likert scale: the score is 5 if respondents agree strongly with a statement, while the score is 1 if they strongly disagree with the statement. The 10 statements are grouped in three general categories: farmers' general attitude toward DSR, resource conservation of DSR and other characteristics of DSR.

In Table 3, we present average scores for the 10 statements from DSR users and non-users in 2012. As expected, we find that DSR users score higher on positive statements about DSR than non-DSR users. On both General Attitude and Resource Conservation, DSR users agree with positive statements about DSR more than non-DSR users. DSR users recognize that DSR is a good technology which can save resources, such as labour and water and protects the soil. In addition, DSR users agree that other farmers, including neighbours and friends, also think DSR is a good technology that is easy to adopt.

The positive perception of farmers that DSR saves water and further protects the soil indicates that it can help in adapting to climate change. DSR can help conserve water resources threatened by increasingly frequent droughts due to climate change. In the face of increasing population and growing demand for food, the upgrading of rain-fed areas through DSR can help in soil and water conservation and deal with risks arising from climate change. Further, DSR users also agree with Statement (7) which states that the technology helps reduce their labour requirements. This is probably because DSR users do not have to make seed preparations and carry out transplanting. They also agree that DSR allows them to plant Rabi crops early.

Conclusion

Our analysis shows that DSR can help farmers adapt to climate change in various ways. First, DSR is a labour saving technology which enables farmers to diversify labour allocation by releasing labour from agricultural activities. To the extent that non-agricultural income activities are less

Table 3. DSR perception among farmers in 5 point Likert Scale

Perception statement	DSR Users	Non-DSR Users	Difference A - B
	(A)	(B)	(C)
General Attitude toward DSR			
1. I think DSR is a very good technology (practice)	4.29	4.03	+0.26
2. Other men (women) think DSR as a good practice	3.97	3.67	+0.3
3. It is easy to adopt DSR	4.34	4.08	+0.26
Resource Conservation			
4. DSR requires less labour	4.26	4.09	+0.17
5. DSR saves water	4.07	3.86	+0.21
6. DSR protects soil	4.04	3.80	+0.24
Other Characteristics			
7. DSR requires my labour less	4.20	3.95	+0.25
8. DSR allows early planting for Rabi crops	3.82	3.69	+0.13
9. DSR requires more weeding	3.99	4.03	-0.04
10. DSR is risky (may suffer from a yield loss)	3.04	3.03	+0.01
Number of observations	164	162	

Note: 1-Strongly Disagree, 2-Disagree, 3-Neither, 4-Agree, 5-Strongly Agree

climate-sensitive than farm activities, further diversification of incomes out of agriculture could be a promising strategy to prepare farmers for climate change. Second, DSR requires less ground water, compared with transplanted rice. This is an added benefit from DSR that can help prepare farmers for climate change which is expected to increase incidence of drought.

Because climate change can have adverse impacts on farmers in different ways across place and time, it is important to provide farmers with more alternative agricultural technologies and practices. DSR can be such an option. To disseminate DSR, governments and public agencies need to engage in the following areas. First, as we find in this article, farmers recognize that DSR saves water and protects soil. Although some DSR benefits cannot be easily captured by economic parameters, farmers should be made aware of DSR benefits through extension services or public media. Second, most farmers need to rely on service providers to implement direct seeding because they cannot afford to buy the necessary machines. However, the number of service providers is still small. There is a great need for training of new service providers which can also promote entrepreneurship in rural areas. Farmers can prepare for climate change by increasing farming practice options and diversifying income sources, and need public support for this preparation.

(References available upon request)

SHORT ARTICLE

Mitigating Climate Change and Soil Salinity Impacts in the Indus Basin Using Skimming Wells with Pressurized Irrigation

By Ghani Akbar

Introduction

Pakistan is a major irrigated agriculture country with more than 80 per cent of its cultivated land under irrigation. The annual influx of snowmelt and runoff into the Indus River system, one of the largest contiguous canal irrigation networks in the world, has a vital role in supporting national economic growth and the livelihoods of a large section of the population in the mainly rural nation. Unfortunately, Pakistan is located in a high-risk climate change zone (Shroder Jr. *et al.*, 2007). More than 95 per cent of the country's agriculture is dependent on snowmelt-derived irrigation, which is highly prone to climate change-induced water shortages and flooding. The growing demand for irrigation water, climate-induced water shortages and population growth are leading to increased groundwater extraction to supplement the limited canal water in the Indus Basin. While a fresh water layer overlies the saline water (McWhorter, 1980; Sufi and Javed, 1988) due to seepage from rivers and irrigation systems, the extraction of low-quality deep groundwater has resulted in saline water infusion and up-coning in many regions (Hafeez *et al.*, 1986). Both these processes have accelerated soil surface salinity (MREP, 1997), which is a challenge to agricultural sustainability in the Indus Basin. According to one estimate, around 0.247 million hectares of land cannot be cultivated in the Indus Basin due to soil salinity (GOP, 1992-93). Soil salinity and sodicity reduce soil infiltration, which increases the ponding period of flood water, exacerbating damage to standing crops. Therefore, controlling salinity is essential to mitigating climate change impacts and ensuring the agricultural sustainability of the Indus Basin.

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To address these issues, many research studies have been conducted in the Indus Basin, focusing on ways to treat the saline water. However, these curative measures cannot be effective unless accompanied with preventive steps. Skimming well technology is becoming popular in the Indus Basin as it can extract from the shallow fresh groundwater layer without affecting the underlying saline water layer. A skimming well extracts less water than a conventional deep tube well and thus can either be used in conjunction with canal water or coupled with more efficient pressurized irrigation technologies (Qureshi *et al.*, 2004) for irrigating larger areas with limited skimmed groundwater. Extraction of fresh groundwater by skimming wells and its efficient use through pressurized irrigation methods has been shown to have greater potential for controlling soil salinity (Akbar *et al.*, 2001b; Saeed and Ashraf, 2005) and increasing productivity in the Indus Basin (Akbar *et al.*, 2002), and is generally recommended.

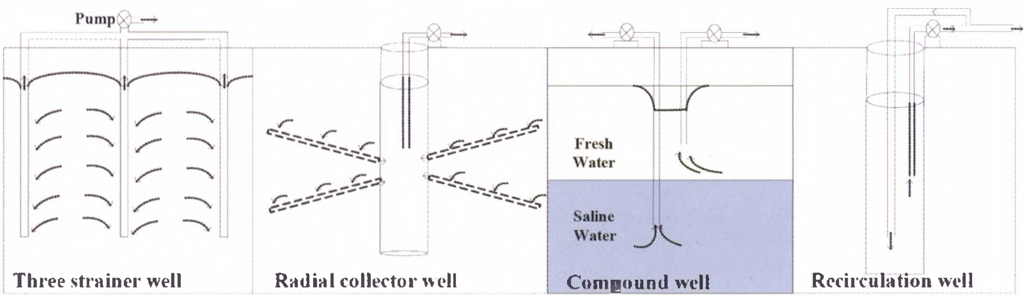
Skimming well technology

A skimming well is designed to extract the thin surface fresh groundwater layer and control the up-coning of the underlying saline groundwater layer (Akbar, 2000). There are many types of skimming wells (Figure 1) which can be adopted for specific aquifer conditions (Saeed *et al.*, 2003). A single strainer well can also be a skimming well if the gap between the lower end of the well and the fresh and saline water interface is sufficient to control the up-coning of saline water (McWhorter, 1980). A multi-strainer well is the most used skimming well in the Indus Basin (Saeed *et al.*, 2002) and is capable of extracting 25 to 30 per cent more discharge than a single well (Hunting Technical Services Ltd, 1965) under the same aquifer conditions. A radial collector well can exploit a thin layer of fresh groundwater through radial collector drains (Bennet *et al.*, 1968) which carry the freshwater horizontally from aquifer to the well. A compound or scavenger well comprises two wells located side by side. One well discharges water from the freshwater zone while the second operates at deeper depths and discharges saline water to control its up-coning. However, this well type has saline effluent disposal as well as environmental hazards (Stoner and Bakiewicz, 1992). A recirculation well works on the principle of injecting freshwater over saline water to control saline water encroachment. However, this technique, common in the petroleum industry, is new to the water industry. A dugwell can also be used as a skimming well (Akbar *et al.*, 2001c) due to its small discharge, large diameter (Singh *et al.*, 1992) and lower penetration depth.

weedicide and pesticide. Similarly, a water metre is used for measuring discharge and a pressure gauge for measuring water pressure generated by the pumping unit.

The high cost of pressurized irrigation systems is the main constraint to their adoption, especially under Pakistani farming conditions (Akbar *et al.*, 2001a). Therefore, the Climate Change, Alternate Energy, and Water Resources Institute (CAEWRI) of the National Agricultural Research Centre (NARC), formerly known as Water Resources Research Institute (WRRI) has developed a set of equipment and decision support guidelines for adoption of different sprinkler and drip irrigation systems (Ahmad *et al.*, 1993) suited to local needs and farm sizes. For instance, a low-cost, weather-resistant and durable Low Density Poly Ethylene (LDPE) pipe was developed in collaboration with local industry. Similarly, different raingun sprinkler system designs (Table 1) were developed to support decision-making by farmers.

Figure 1: Layout of different designs of skimming wells systems



Pressurized irrigation technology

Pressure-fed surface irrigation systems may either be sprinkler or drip irrigation types. The sprinkler system works at high pressure and the drip system works at low pressure. Sprinkler systems may either be set systems or continuous-move systems. Set systems are either periodic- move systems or fixed systems. Hand-move, end-tow, side-laterals, and gun-and-boom systems are examples of periodic-move systems. Fixed systems generally include small or big gun sprinklers mounted in stationary positions. Travelling gun or boom sprinklers, centre-pivot and linear-moving laterals are examples of continuous-move systems. The drip system is generally used for irrigating orchards or row crops by using different kinds of inline or online emitters such as microtubes, bubblers, key emitter, turbo-emitters, microsprinklers, pop-up sprinklers, overhead sprinklers and subsurface irrigation systems.

Pressurized irrigation systems usually consist of a prime mover, which can either be a diesel engine, electric motor or power take-off driven. A centrifugal pump with a single or multistage capacity is generally used. The distribution system consists of mainlines, submains, laterals, sprinklers or emitters, couplers, valves, bends, plugs, risers and debris removal equipment, among others. Additional accessories are required for tasks such as applying fertilizers,

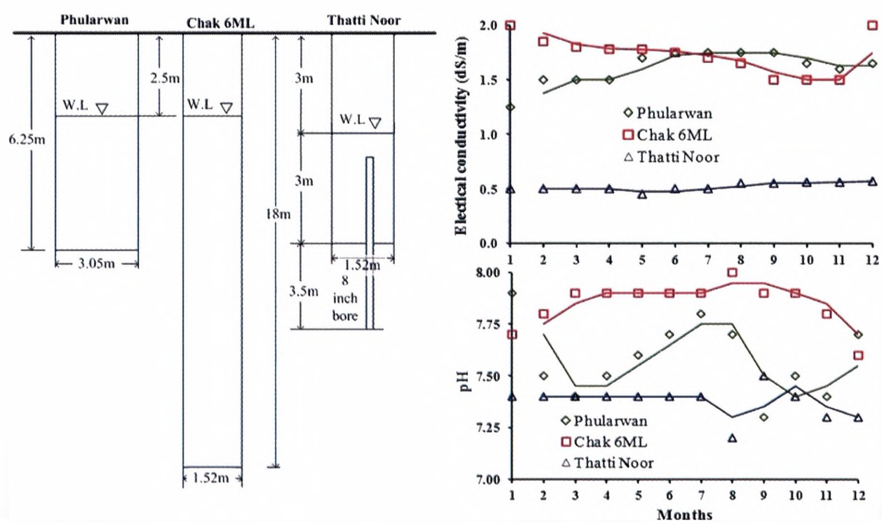
Options to mitigating climate change and soil salinity impacts in the Indus Basin

Irrigating crops with freshwater and restricting saline groundwater up-coning during climate-induced water shortages are key preventive measures for controlling salinity build-up in the Indus Basin. Skimming well and pressurized irrigation technologies can be instrumental in achieving this goal. For instance, skimmed groundwater quality from three different dugwells (Figure 2) under a 20-30m thick freshwater layer showed no temporal decline when used to sprinkle-irrigate five acres of land during two cropping seasons (Kharif: Maize and Rabi: Wheat) in the Indus Basin (Akbar *et al.*, 2002).

Table 1. Different Raingun sprinkler system designs (WRRI-NARC, 1993)

Raingun Type	Py1-20	Py1-30	Py1-40	Py1-50	Py1-60	Py1-70	Py1-80	Py1-80
ET Peak (mm/day)	5	5	5	5	5	5	5	5
Peak operation (hrs)	10	10	10	10	10	10	10	10
Nozzle size (mm)	8	12	16	20	22	24	26	34
Working pressure (psi)	57	57	64	71	85	85	100	114
Capacity (lps)	1.28	2.74	5.44	8.5	11.4	13.5	16.83	30
Application rate (mm/hr)	2.86	3.86	4.78	5.42	5.55	5.75	5.86	7.06
Radious of throw (m)	23	29	36	42	49	52	57	70
Farm size (ha)	1	2	4	6	8	10	12	20
Max. pipe length (m)	100	175	175	200	200	200	200	200
Total head (m)	51	59	60	70	74	80	90	100
Motor capacity (hp)	1.5	4	8	13	20	25	---	---
Engine capacity (hp)	1.8	5	8	16	24	30	41	80

Figure 2. Layout of three dugwells and resulting water quality (EC and pH) when used to sprinkle-irrigate five acres of land during two cropping seasons at three sites in the Indus Basin of Pakistan



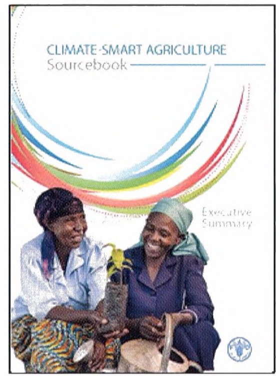
Additionally, ensuring adequate leaching and flushing out of soluble salts from the root zone through optimized irrigation management, appropriate land grading, soil profile modification, installation of appropriate surface and subsurface drainage system, is essential for controlling soil salinity. Moreover, reclamation of saline and sodic soils and water through physical, chemical and biological treatment have emerged as potential curative measures, which are important for mitigating climate change impacts and ensuring agricultural sustainability in the Indus Basin.

(References available upon request)

Climate-Smart Agriculture Sourcebook

Food and Agriculture Organization of the United Nations (FAO), 2013

BOOK REVIEW



Between now and 2050, the world population is projected to increase by one-third. Most of these additional 2 billion people will live in developing countries. FAO estimates that agricultural production will have to increase by 60 per cent by 2050 to satisfy the expected demand then for food and feed. Agriculture must, therefore, transform itself if it is to feed a growing global population and provide the basis for economic growth and poverty reduction. Climate change will make this task more difficult under a business-as-usual scenario, due to adverse impacts on agriculture, requiring spiralling adaptation and reduction of related costs

Climate change is already having an impact on agriculture and food security with an increase in extreme weather events and increasingly unpredictable weather patterns which can reduce farm production and incomes in vulnerable areas and also affect global food prices. Smallholder farmers and pastoralists in developing countries in particular are being hit hard by these changes. Adaptation to climate change and lower greenhouse gas emissions per unit of output will be necessary to achieve food security and agricultural development goals. This transformation must also be accomplished without depletion of the natural resource base. Small-scale producers, already coping with a degraded natural resource base, often lack knowledge about potential climate change adaptation options and have limited assets and risk-taking capacity to access and use technologies and financial services.

Climate-smart agriculture (CSA) can enhance food security while mitigating climate change impacts and preserving the natural resource base and vital ecosystem services. This requires a transition to agricultural systems that are more productive, more efficient, less variable and more stable in output, and more resilient to risks, shocks and long-term climate variability. Making agriculture more productive and resilient requires a major shift in the way land, water, soil nutrients and genetic resources are managed in order to ensure greater efficiency in their use. This, in turn, requires considerable changes in national and local governance, legislation, policies and financial mechanisms. This transformation will also involve improving producer access to markets. By reducing greenhouse gas emissions per unit of land and/or agricultural product and increasing carbon sinks, these changes will contribute significantly to the mitigation of climate change.

CSA, as defined and presented by FAO at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. The magnitude, immediacy and broad scope of the effects of climate change on agricultural systems create a compelling need to ensure comprehensive integration of these effects into national agricultural planning, investments and programmes. The CSA approach is designed to identify and operationalize sustainable agricultural development within the explicit parameters of climate change.

A reference tool for national and subnational-level planners, practitioners and policymakers in the agriculture, forestry and fisheries sectors, the Climate-Smart Agriculture Sourcebook elaborates the concept of CSA and demonstrates its potential, as well as limitations. It aims to help decision makers at a number of levels, including political administrators and natural resource managers, to understand the different options available for planning, policies and investments as well as suitable climate-smart practices for different agricultural sectors, landscapes and food systems. The Sourcebook indicates some necessary ingredients of a climate-smart approach to agriculture, including existing options and barriers.

Source:
http://www.fao.org/climatechange/climatesmart/en

NEWS AND ACTIVITIES

CAPSA and NARI Collaborate to Strengthen Smallholder Market Participation in Papua New Guinea

As part of the Centre's advisory services in support of national efforts for poverty reduction and food security through sustainable agriculture, CAPSA Regional Adviser, Dr. Upali Wickramasinghe, conducted a week-long training session on agricultural policy analysis for research staff at the Enabling Environment Programme of the National Agricultural Research Institute (NARI) in Lae, Papua New Guinea from 10 to 14 June 2013. The sessions covered the use of survey data and modelling for policy analysis and strategies for promoting market participation of smallholder family farms.

Dr. Wickramasinghe also led two seminars and presented key results of the CAPSA-NARI research project 'Market participation of smallholder farm families in Papua New Guinea'. The seminars were held at NARI in Lae and the National Research Institute (NRI) in Port Moresby. The research findings will contribute to identifying the most pressing constraints being faced by smallholder family farms in the Morobe province of Papua New Guinea and developing a set of proposals for addressing these.

'Writeshops' Take Research Findings to Farmers in Indonesia and Pakistan

In collaboration with partners, CAPSA organized two 'Writeshops' on translating research findings into knowledge accessible and understandable by farmers in Indonesia and Pakistan. The Writeshops, held in June and July, were part of capacity-building activities implemented under the European Union-funded 'Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and South-East Asia (SATNET Asia)' project being coordinated by CAPSA in collaboration with various partners.

The first Writeshop, held from 12 to 14 June 2013 in Bogor, Indonesia, brought together 25 senior extension workers from various parts of Indonesia. The event was organized in partnership with the Indonesian Center for Agricultural Technology Assessment and Development (ICATAD) and AVRDC – The World Vegetable Center.

The second Writershop, held from 1 to 5 July in Islamabad, Pakistan, targeted researchers under the Pakistan Agricultural Research Council (PARC) and was organized in partnership with PARC, the National Agricultural Research Centre (NARC) and the Food and Agriculture Organization of the United Nations (FAO). In addition to translating research findings into practical information, a module on sustainability

assessment was added to the programme to improve researchers' capacity to identify sustainable agricultural technologies in Pakistan.

The CAPSA-facilitated activities are enhancing development partners' capacities to identify sustainable and productivity-enhancing technologies as well as building skills to adapt and repackage existing knowledge to suit specific audiences, local conditions and needs. CAPSA envisions enhanced knowledge transfer, South-South dialogue and intraregional learning through SATNET Asia support for capacity-building in sustainable agriculture.

SATNET Workshop Addresses Climate Change Adaptation in South Asia

The SATNET Regional Workshop 'Climate Resilient Smallholder Agricultural Farming Systems in South Asia' was held in New Delhi from 24 to 27 June 2013. Supported by CAPSA, the workshop reviewed latest global and regional developments related to Climate Change Adaptation (CCA) and strengthened key stakeholders' capacity to promote climate-resilient smallholder farming systems.

The Workshop was divided into two parts.

The 24-25 June 'South Asia Regional Consultation on CCA', co-organized by SATNET and led by the United Nations Children's Fund (UNICEF) and the United Nations Disaster Management Team in India, examined recent CCA policy discourses and priorities in the context of the post-2015 sustainable development agenda with a focus on resilience. Over 170 experts in disaster risk reduction and climate change adaptation as well as representatives of national governments, civil society organizations, academia and the United Nations participated in the Consultation.

The last two days were dedicated to the training programme 'Climate Resilient Smallholder Agricultural Farming Systems in South Asia' led by the Asian and Pacific Centre for Transfer of Technology (APCTT). The training addressed ways to increase agricultural productivity in the context of CCA, and strengthened participant knowledge of climate-resilient farming practices. About 45 experts from government agencies, research institutions and civil society from Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka, as well as from some international organizations took part in the training. The event underlined the continuing need for a knowledge-transfer platform such as SATNET.

SUCCESS STORY

The Floating Gardens of Gaibandha: Adapting to Climate Change in Bangladesh

Bangladesh is one of the world's poorest countries, crossed by more than 230 of the world's most unstable rivers which overflow their banks during the monsoon season, making crop cultivation impossible in flooded areas in the mainly rural nation. Now farmers in the country's flood-prone Gaibandha district can grow food on their inundated lands using innovative 'floating gardens' developed by the international non-governmental organization Practical Action that specializes in using technology to overcome poverty in developing countries.

The floating garden is a clever solution that uses freely available water hyacinth to construct a raft, 8 m long and 1 m wide and covered with soil and cow dung, in which vegetables can be planted. A new raft needs to be built every year, but the old one can be used as fertilizer during the dry season.

Growing summer and winter greens such as gourd, okra and leafy vegetables, the floating gardens provide food even during the annual monga (period of food shortages) and can also provide alternative income through the sale of any surplus. They are suitable for farmers wanting to diversify from traditional land use, and, as the rafts can be moved from place to place, they can also be used by those who have temporarily or permanently lost their homes and land.

The floating vegetable gardens can also be set up in ponds, canals and other water sources. However, the gardens should not be used on water affected by tides or currents where they would be vulnerable to erosion and at risk of disintegrating.

Families are trained in pit cultivation - making 30cm x 30cm holes for planting vegetable seed. Every household has 10 pits to grow vegetables and is given 10 different high yielding varieties of fast growing vegetable and groundnut seeds.

Households are also trained in new techniques to cope with the conditions and improve crop output and quality throughout the year. They learn how to protect against plant disease and pest attacks using organic control methods, such as homemade botanical insecticides. Advice is also given in making seed-beds, preparing compost and enriching the sandy soil with compost and manure.

Trained by Practical Action, Tara Begum, a mother, built her own floating garden with help from her family and grew a number of crops including red onion, sweet pumpkin and okra. "This has made a great difference to my life. Now I have enough food in the floods and I can give some to help my relatives as well," she said.

The floating garden is an example of a low-cost farming method suitable for small-scale farmers which can help improve food security in Bangladesh.

Source:
http://practicalaction.org/climatechange_floatinggardens

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