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Overcoming barriers to climate-smart agriculture in South Asia

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Despite the promise of climate-smart agriculture (CSA) to improve food security in South Asia, most CSA practices and technologies have not been widely adopted. We identify the key barriers to CSA adoption in South Asia and suggest strategies to overcome them to increase CSA adoption at scale.

The rice–wheat cropping system in South Asia accounts for 27% and 16% of global rice and wheat production, respectively, and sustains more than 129 million farmers, most of whom are smallholders[1]. However, rice and wheat yield trends in this region have slowed or stagnated owing to the impacts of climate change, and these negative impacts are projected to worsen over the coming decades[2]. By 2050, South Asia will be one of the largest food-deficit regions and so requires a substantial increase in production to meet growing food demand. As one potential solution to this impending crisis, climate-smart agriculture (CSA) has been widely advocated for by governments, researchers, and food and agriculture organizations. Studies suggest that CSA practices and technologies can increase crop yield while reducing greenhouse gas emissions and increasing the resilience of farming communities to climate shocks[3,4].

Despite the promise of CSA, most CSA practices and technologies have not been widely adopted across South Asia[5–7]. Although some practices and technologies have been used for a long time (for example, crop diversification and green manure), many others are struggling to gain momentum despite their proven effectiveness (for example, zero tillage, alternative wetting and drying). Here we identify the key reasons for the low adoption of CSA practices and technologies in South Asia and present a set of promising strategies that could increase their adoption at scale (Fig. 1).

Weak organizational capacities

Across South Asia, it is challenging to reach all farmers with new CSA practices and technologies because of the large proportion of the rural population that practices agriculture, their limited integration with markets that promote CSA, and limited government resources. Thus, it is critical to develop far-reaching and effective networks in the region that can provide access to information about CSA practices and technologies to increase adoption at scale.

Government agricultural extension departments are primarily responsible for CSA information dissemination and adoption in South Asia. However, these departments are often inadequately staffed with staff who are poorly trained to disseminate CSA information and have limited resources across multiple domains, including a lack of field extension agents, transportation and finances. Consequently, the number of field schools, demonstration plots and training programmes located in rural communities to increase CSA adoption is not sufficient. Allocating more financial resources and developing the capacities of these departments have high potential for increasing CSA adoption. Additionally, farmers are more likely to adopt a new technology if they learn about it through peer-to-peer networks, thus there should also be investments in farmer-to-farmer extension.

Custom hiring centres and service providers established in Bangladesh, India and Nepal as part of agricultural mechanization programmes have also facilitated CSA adoption. Farmers with low financial capital can rent expensive CSA technologies from these centres and from service-providing farmers who own these technologies[8]. But the effectiveness of custom hiring centres and service providers is often marred by mismanagement, unskilled workers, poor professional support, local politics, elite capture, profit mongering and social marginalization[9]. Increasing the number of custom hiring centres and service providers can facilitate more inclusivity through competition. However, this can only be a viable way to increase CSA adoption if the management skills of custom hiring centre operatives and service providers are strengthened, and if such operatives and providers consider local market demand and equity concerns.

Furthermore, because of individual agendas, various government, non-government and private organizations often pursue and promote different CSA practices and technologies and start competing with one another[10]. Such lack of coordination between these actors can result in mixed messages to farmers about which CSA practices and technologies are most effective, resulting in reduced adoption. To increase the adoption of CSA practices and technologies, coordination between CSA-promoting actors and cross-sectoral convergence on the most appropriate CSA strategies is imperative.

Inadequate targeted incentives

Across much of South Asia, chemical fertilizers, pesticides and electricity- and diesel-based irrigation are largely subsidized, whereas the adoption of locally appropriate CSA practices and technologies has not been adequately incentivized. Adopting some CSA strategies requires higher financial capital, because the upfront costs to purchase some CSA technologies (for example, laser land levellers and drip or sprinkler irrigation) are higher than those associated with traditional

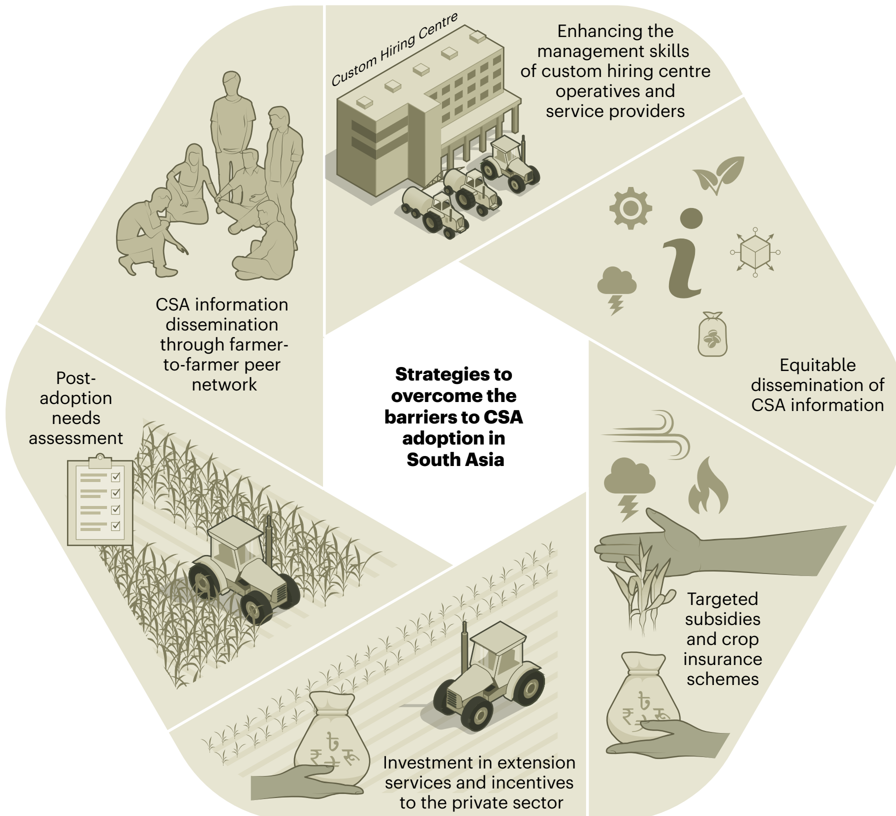

Fig. 1 | Strategies to overcome the barriers to CSA adoption in South Asia.

practices, especially in regions where effective machinery service provision does not exist[5]. Furthermore, even when CSA technologies have been subsidized, governments have also offered subsidies for conflicting practices, such as in the case of zero tillage and conventional tillage machinery subsidies in India.

Scaling up CSA practices and technologies would require an institutional environment that increases the affordability of CSA strategies for smallholder farmers, which can be achieved through policy, market and government programmes that provide targeted subsidies and incentives for adoption. For example, targeted subsidies have promoted water-saving measures in Punjab, Pakistan and Gujarat, India, and zero-tillage technologies in India's Indo-Gangetic Plains[11,12]. Additionally, governments can incentivize CSA adoption through bundling with crop insurance by subsidizing insurance schemes for those farmers who also adopt CSA.

The private sector in South Asia can play an important role in increasing farmers' access to climate-smart technologies. However, the private sector often promotes highly profitable, non-CSA technologies (for example, shallow tillage machinery), and even when CSA technologies are promoted, they are primarily high-demand technologies that provide a large return on investment within a short period of time. Yet, many beneficial CSA practices and technologies currently have low demand because of a positive feedback loop — low adoption leads to low market demand, which results in low supply and low adoption. To address this, businesses may need to receive incentives from governments to promote the most effective CSA technologies and integrate CSA into corporate social responsibility plans.

Limited post-adoption follow-up

Most work to increase access to CSA practices and technologies in South Asia focuses largely on adoption initiation, and limited emphasis is given to post-adoption follow-up. Yet, post-adoption follow-up is particularly important in South Asia given the high heterogeneity in farm outcomes and the drivers of decision-making across diverse smallholder farmers.

Monitoring and evaluating CSA adoption over time can identify whether farmers continue to use CSA practices and technologies, and if not, what the challenges are that farmers encounter. For example, a paucity of repair parts or maintenance personnel has been shown to diminish the adoption of CSA technologies, such as zero tillage and micro-irrigation[13]. Furthermore, some CSA practices and technologies (for example, mulching and cover crops) do not provide immediate benefits, and it may take several years for farmers to realize the full potential. In addition, some CSA technologies (for example, micro-irrigation) may provide the most benefits in years with stressful conditions (for example, drought). Finally, the adoption of some CSA technologies may result in lower yields unless additional management practices are also simultaneously changed. For example, the presence of weeds often increases with the adoption of zero tillage and direct seeding, and these weeds must be managed through weedicides or labour to achieve yield benefits. As a result of these multiple factors, farmers often dis-adopt some CSA practices and technologies after one to two years. Post-adoption follow-up coupled with careful information provisions, maintenance and resources to address knock-on effects can alleviate these concerns and result in the long-term adoption of CSA practices.

Inequities in information dissemination

CSA information and technology dissemination in South Asia is often marred by inequity. For instance, farmers with more wealth and greater social networks are often prioritized for CSA demonstrations and provisioning[14], perpetuating existing societal inequities and marginalization. Furthermore, women's participation in farming is increasing across South Asia, particularly in Nepal, Bangladesh and eastern India, where rural male out-migration is dominant. Even so, gender inequality is still rampant in CSA dissemination, with little involvement of women in the process.

To address these concerns, it is critical to develop information and technology dissemination that is targeted to marginalized farmers, including those who are poor, less socially connected and/or women. Previous work has suggested that such targeting can lead to greater total rates of adoption of a given technology and increased adoption by marginalized farmers[15]. However, simply targeting marginalized groups may not be enough given that these groups have less access to resources and the market, which are key determinants of CSA adoption. Thus, more transformative work that creates institutions that enhance economic participation and empowerment, such as self-help groups, is needed along with targeted CSA dissemination to alleviate these constraints. Designing CSA dissemination to be more equitable across socioeconomic, cultural and demographic factors will lead not only to more CSA adoption but more socially just adoption.

Conclusions

Although we present each of these barriers separately, for efforts to be the most effective, they should be tackled in tandem while considering their synergies and associated tradeoffs. Doing so can help increase the adoption of CSA practices and technologies at scale across South Asia, enhancing food production and the security of millions of smallholder farmers in the face of climate change.

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Competing interests

The authors declare no competing interests.