Comprehensive Evaluation of Adopting Conservation Agriculture Technologies and Policies in the Irrigation -induced Salt-affected Area of Uzbekistan, Central Asia

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Summary

Sustainable agriculture in the salt-affected, irrigated croplands of Uzbekistan, Central Asia, is threatened by human-driven land degradation caused by permanent intensive soil tillage, mismanagement of irrigation water leading to growing soil salinity, low water use efficiencies and increasing production costs. These phenomena cause changes in soil quality classifications as well. To cope with the environmental and economic challenges, the existing agricultural systems need to be urgently altered while considering practices leading to sustainable agricultural systems in general and more specifically prevent soil quality loss and increase water use efficiency and hence increase overall productivity.

This comprehensive study disclosed the financial and economic benefits of currently practiced dominant cotton-based cropping systems (C-C, C-W and C-W-M for CT and C-cc-C, C+R-W+R and C+R-W+R-M+R rotations for BP) in conventional technologies (CT) compare to conservation agricultural practices (here permanent bed with mulch) PB with crop residue (mulch). Comparative analysis was conducted on base level (TRCT 7) and other grade of land productivity (bonitet) classes (TRCT 1, TRCT 2 …TRCT 9). Various scenarios of sensitivity test results were presented to propose optimal rotation-tillage allocation, while considering fluctuated commodity prices under different policy systems (currently determined state procurement pricing system (SPP) and simulated free Market Pricing systems (MP).) Furthermore, simulation analysis compared the subsidy levels (0%, 15%, 25%, 35%) used under the SPP-driven scenarios (case 1) and a taxation with the same rates (0%, 15%, 25%, 35%) in free MP system (case 2), with various cases of new potential water charging (in the range 0-0.18 m^3/ha) policies .

The findings revealed that the C-cc-C and C-C rotation systems had the lowest profitability among all the systems tested (at any level of land classes) and are therefore least likely to be adopted by the risk averse farmers in Uzbekistan, if there is no any higher rates of subsidy or better supportive services are provided by government. There is a big gap between optimal and currently determined commodity prices. The scenario analyses showed that at higher than 249 $ and 267 $/t raw cotton prices (in base level or TRCT 7), which are at present only 91 and 85 % of the current prices paid to farmers at SPP level, these back-to-back cotton cropping systems could be kept competitive with the C+R-W+R and C-W rotations. Unless the farm-gate price was increased to as high as 422 $ and 443 $/t respectively, raw cotton could not become the most profitable cropping system, which is presently far out of reach. The situation is even worse on marginal lands (or low fertility lands which land classes are TRCT 2 and TRCT 3). Even under the presently employed, subsidized state procurement system, the cultivation of marginal lands remain non-profitable, unless raw cotton prices are increased up to 275 $/t in BP and 342 $/t in CT. However, in contrast to cotton, wheat and maize under PB with crop residues (M+R) showed the highest potential. Especially maize, yielded the highest (630.6 $/ha) Gross Margin (GM) owing in particular to increased yields (29%). However, this practice under BP concurrently had a much lower RR than under CT, owing to the high costs of mulching (10t/ha). However, the current level of residue amounts (10 t/ha) tested is far from an optimal value, generating substantially high costs (about 40 % of TVC) owing to the high demand for livestock as fodder. The simulation results indicated that the level of 10 t/ha wheat, used as mulch for maize, can be reduced by half on already productive land classes (TRCT 7). As for wheat as well 6 t/ha mulch (cotton stalk) was found more than necessary. From an economic point of view, 30-35% of the current mulch amount of ca 6 t/ha cotton stalk can be reduced to 3.9 t/ha - 4.2 t/ha to reach the optimum benefits. Also, the share of cover crops could be increased (1.3-1.5 fold) for reaching the best residue effect on crop establishment.

To make sure the robustness of the findings, the cost characteristics of the rotation-tillage systems under BP and CT had been evaluated while assuming a wide range of input price of the crops and the case of a complete abolishment of current state procurement policy for cotton and wheat (for base case). It was concluded that when assuming a liberalization of market prices, the total variable cost (TVC) would increase in the range of 1.5-2 folds in both BP and CT systems and changed the profitability

ranking orders of the treatments. When assuming abandoning all the state subsidy and service support for cotton and wheat, the C-W and C+R-W+R crop rotations appeared to have the highest potential, where this ranking order changed from C-C < C-cc-C < C-W < C+R-W+R < C-W-M < C+R-W+R-M+R to C-C < C-cc-C < C+R-W+R-M+R < C-W-M < C-W < C+R-W+R. Cotton-wheat-maize rotation in CT therefore seems to be most resilient to the increase in the raw cotton prices and increases of costs in currently determined policy under SPP of commodity prices, but with state subsidy or services and almost free irrigation water. However, when higher rate of water charges was considered other crop rotation systems in BP took advantage depending on the the rate of charges and commodity prices. However, It was concluded that, although farmers simultaneously benefit from state subsidies and supportive services, their flexibility to change from conventional cotton and wheat cropping to new practices and adopting new technologies and innovations in the process is restricted, if they are not backed by any state support, policy changes and economic incentives. Introduction of water pricing system was found as one of the most powerful policies, if farmers were insured with technology transaction risk or this was bridged by targeted incentives to ease the burden of acceptance. Since the both farmers and the government have a high interest in rendering saline-prone, low fertility marginal lands productive again, this study results showed the urgency of support or subsidies to those farmers wanting to adopt CA practices. Currently, just 0.0025-0.005 $/m³ of irrigation water is charged for water service. The current system profitibility and also farmers behaviours are not responsive enough to such small rate of water charges. However, when consider all land classes and commodity prices with the subsidy levels used under the SPP-driven scenarios (case 1) and a taxation in free MP system (case 2), the simulation analysis provided optimal solutions. For case 1, optimal raw cotton price was estimated at 410 $/t, when assuming a water price of 0.06 $/m³. For case 2, at a 680 $/t raw cotton price and concurrently an imposed water charge of 0.05 $/m³, the total system (all land classes included) gained an optimal benefit. Actually, such high raw cotton prices 410 $/t (case 1) and 680 $/t (case 2) are presently far out of reach in currently determined production system (where raw cotton price is 227 $/t). Therefore, farmers in Uzbekistan can not efford such high (0.05 $/m³ and 0.06 $/m³) water prices as well. Since for land class 7 (the basic level), the C+R-W+R-M+R rotations remained profitable when assuming up to 0.09 $/m³ water charges. The cropping systems C-C, C-cc-C, C-W, C-W-M, C+R-W+R would become non-profitable at water charges of 0.07 $/m³ and more. This

study findings underlined that a water price rate in the range of 0.012- 0.036 $/m³ is proper and effective enough to make changes in current production system (base case) depending on the circumstance.

Cotton-wheat rotations in Uzbekistan occupy more than 70% of the irrigated land area and are subject to a set of state procurement conditions, under which farmers have to produce with imposed cultivation practices and sell their cotton and 50 % of their wheat products to the government at State Procurement Prices (SPP), which usually are less than Market Prices (MP). Other crop lands are devoted for commercial crops (free from SPP system), such as rice, vegetables and fodder oriented crops for livestock. Although farmers simultaneously benefit from state subsidies and supportive services their flexibility to change from conventional cotton and wheat cropping to new practices and adopting new technologies and innovations in the process is restricted, unless backed by state support, policy changes and economic incentives. It was estimated that currently 13% of water for irrigation is saved by adopting CA technologies for C-W-M cropping system and the water wastage could be reduced up to 20% in long run of CA practices.

To add up, Conservation Agriculture practices such as BP applied in various cotton-wheat rotations can substantially increase financial returns especially when implemented on marginal lands, but provided such innovations are flanked with careful farm managements and supportive policy measures. Under such conditions also water pricing systems can be considered which otherwise would hamper the adoption process.