Comparative Advantages of Conservation Agriculture Based Rice-Wheat Rotation Systems under Water and Salt Dynamics Typical for the Irrigated Arid Drylands in Central Asia

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Extended summary

In Central Asia, the increasing water shortage and labor scarcity, high cost of production, increasing secondary soil salinization, and land abandonment are compelling farmers to change to water saving irrigation and conservation agriculture (CA) technologies. Such CA practices aim at maximizing profits while making a better use of soil and water resources lowering labor demands, farm power and production costs. The CA experiments with rice-wheat systems combined two establishment methods (beds and flats) with three residue levels (all zero tillage) and with alternate wet and dry (AWD) irrigation followed by surface seeded wheat (SSW); and conventional tillage (dry tillage) and continuously flooded rice (water seeded rice, WSR) followed by SSW were evaluated for 2 years (2008-2010) by using several financial indicators such as gross margins (GMs) estimates and benefit/cost ratio (BCR) while accounting for the soil water balance and soil salinity dynamics. The GM and BCR were higher under WSR-SSW than under treatments of dry seeded rice (DSR)-SSW. Both were higher under residue removal compared to residue retainments in DSR-SSW. Surface seeded wheat, which involved minor production costs, yielded >6 t ha^{-1} in both years in all treatments. Furthermore, >80% of the total irrigation water was applied to rice. Yet, >90% irrigation water from WSR-SSW and ~67% from DSR-SSW were lost through seepage and percolation. Dry seeded rice in bed (DSRB)-SSW saved 15% more irrigation water compared to dry seeded rice in flat (DSRF)-SSW and 67% compared to WSR-SSW. Soil salinity decreased with rice cultivation. After 2 years, WSR-SSW had the lowest while residue-removed DSRB-SSW had the highest salinity level at all soil depths. Groundwater salinity under deep groundwater tables was higher under treatments of DSR-SSW than under WSR-SSW. However, under shallow groundwater tables, groundwater salinity was higher under WSR-SSW than under DSR-SSW. Under the conditions that irrigation water is subsidized or even free of charge, conventional WSR-SSW into the standing rice field (20 days before rice harvest) is the most profitable option. However, under water scarce conditions, the CA based rice-wheat system could be a suitable alternative to cope with water scarcity and secondary soil salinization. This research could have several implications for agronomist both in research (new methodologies and results), for agriculture engineers to design appropriate machinary options to promote CA innovations, and eventually for decision makers. Despite enormous water saving through the adoption of CA practices, given the concurrent reduced yields and reductions in GMs, farmers will not sufficiently be incentivized to adopt CA-based practices with water-saving irrigation. However, as CA

practices with water saving irrigation can be make better use of soil and water resources, it can be considered more sustainable and its adoption can be rapid by easing subsidies to the farmers in regard of soil and water conservation, and through the advocation and promotion of adequate water pricing policies.

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Photo: Conventional method of flood irrigation and rice transplanting

Photo: No till dry seeding of rice under standing residue of wheat

Photo: Rice Establishment under no-till bed and flat treatments with different levels of residue retention.

Photo: Surface seeded wheat (wheat surface seeded 2 weeks before rice harvest) in flat plots

Photo: Rice under conventional method of establishment and flood irrigation

Photo: Rice under bed 50% residue retention and alternate wet and dry (AWD) irrigation

Photo: Rice harvesting