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Conservation agriculture in Kazakhstan allows achieving the objective of 4 per 1000 initiative

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According to FAO definition, conservation agriculture (CA) is a farming system that promotes maintenance of (1) minimum soil disturbance avoiding soil inversion (i.e. no tillage or minimum tillage), (2) a permanent soil cover with crop residues and/or cover crops, and (3) diversification of plant species through varied crop sequences and associations involving at least three different crops. Conservation agriculture has a large potential for carbon sequestration, however, the efficacy of no-till agriculture for increasing C in soils has been questioned in recent studies.

In Kazakhstan, the areas under no-till have been increasing from virtually nothing in 2000 to 2.5 million ha in 2016 that is, however, only about 1.1% of agricultural lands. Therefore, FAO consider Kazakhstan to be “high” in terms of the potential area for the further spread of CA. The objective of this study is to assess the potential of each CA component for soil C sequestration in Kazakhstan.

We performed a comparative assessment of SOC changes over 20 years under CA and conventional cropping systems by using the dynamic simulation model ARMOSA that simulates the cropping systems at a daily time-step at field scale. As input for ARMOSA, we used a set of daily data of maximum and minimum temperature and rain from 2002 to 2011. For model validation, we used soil and yield data from the long-term experiment (2002-2009) located in Almaty involving no-tillage and conventional tillage treatments for spring barley (Hordeum vulgare) monoculture. Barley yields were measured annually. Dry bulk density and SOC content were measured annually at 0-30 depths. The soil used for the simulation was silt loam texture and a 1.41% of organic carbon in the 0-30 cm surface layer. Barley was fertilized with 60 kg N/ ha at sowing.

We simulated the following cropping systems:
Conventional 1: ploughing at 0.25 m, spring barley monoculture, and crop residues (straw) removed;
Conventional 2: as conventional 1, but residues retained;
CA 1: no-tillage, crop rotation: winter wheat (Triticum aestivum) – winter wheat – spring barley – chickpea (Cicer arietinum), residues removed and no cover crop;
CA 2: no-tillage, monoculture, residues retained and no cover crop;
CA 3: as CA2, but crop rotation;
CA 4: as CA 1, but Italian ryegrass (Lolium multiflorum) as a cover crop undersown in spring;
CA 5: as CA 4, but residues retained.

Model results showed that both conventional systems decreased SOC by 480-560 kg/ha/yr (0.87-1%). In contrast, no-tillage with crop rotation and residues retained and/or cover crop increased SOC by about 300-1000 kg/ha/yr (0.45-1.52%) in the ploughing layer. It seems that the contribution of each CA element into SOC stock decreased in the following order: cover crops > residues > rotation. In particular, attention should be paid to cover crops, which seem to have significant role in C sequestration, but are not yet widely spread in practical farming in Kazakhstan. Conservation agricultural practices involving, in addition to no-tillage, crop rotation, residues retained and/or cover crops allowed achieving the objective of 4 per 1000 initiative.