Chapter 30
Principles of Conservation Agriculture in Continental Steppe Regions

Mekhlis Suleimenov, Zheksenbai Kaskarbayev, Kanat Akshalov and Aibek Tulegenov

Abstract In western Siberia, summer fallow-based crop rotation is practiced. These tillage-based cropping systems are not sustainable. They lead to a decline in soil fertility and damage to humans and the environment. The objective of this chapter is to analyze the principles of conservation agriculture (CA) and to replace wheat-fallow monocultures by stubble mulch farming. We conducted multi-factorial field experiments on crop rotations, tillage, and soil fertility management on three sites over more than five years. The research data include the results of studies in northern Kazakhstan, central Kazakhstan, and western Siberia. Furthermore, we analyzed results from other cool steppe regions such as Canada. In studies conducted in northern Kazakhstan, we found that cropland is most efficiently used in diversified crop rotations with no fallow. Summer fallow can be replaced by food legumes or legume forages. No-till has an advantage in terms of crop yields over traditional tillage on light textured soils of the Kostanai province, thanks to better moisture conservation. On heavy textured soils of the Akmola province, traditional tillage has an advantage in some cases, thanks to better snowmelt water intake and more active nitrogen mineralization. On Leached Chernozems of Trans-Ural Siberia, no-till is feasible only with the application of higher rates of nitrogen fertilizer. In the forest-steppe zone of western Siberia, no-till in the autumn provided the same grain yields as ploughing only when it was combined with the application of fertilizers, herbicides, fungicides, and growth regulators. Research in northern Kazakhstan

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M. Suleimenov (✉) · Z. Kaskarbayev · K. Akshalov · A. Tulegenov
Scientific Production Center of Grain Farming named after A.I. Barayev,
Shortandy 021601, Kazakhstan
e-mail: mekhlis@yahoo.com

Z. Kaskarbayev
e-mail: tsenter-zerna@mail.ru

K. Akshalov
e-mail: kanatakshalov@mail.ru

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shows that for soil fertility conservation, one should combine a reduced to minimum area under summer fallow with the replacement of summer fallow by pulses or legume forages and the application of nitrogen fertilizer, and thus avoid soil tillage.

Keywords Conservation agriculture · Soil tillage · No-till · Kazakhstan · Siberia

1 Objectives

After 42 million hectares of grasslands in northern Kazakhstan and western Siberia were ploughed back in 1954–1956, these lands were initially used for continuous spring wheat production. This was similar to practices in Canadian prairies of the early 1950s, where monocultures of spring wheat rotated with summer fallow were common (Hill 1954). For Canadian farmers, the advantage of this cropping system was avoiding crop failure in dry years. In 1956, when Barayev (1960) visited Canada, he returned with the idea that frequent summer fallows (with no crop for one year) was the only way to farm in dryland conditions, while stubble mulch farming was the best method to control wind erosion.

This is why the crop rotation study established at Shortandy in 1961 included wheat-fallow rotations, with fallow occupying 50, 33, and 25 % of the rotation area. There was also continuous wheat treatment with no fertilizer applied. A radical change in the methodology of the crop rotation study was made in 1984, when continuous wheat plots were started to be given necessary fertilizers. Since then, grain production from the total area including fallow has been at its highest in continuous wheat (Suleimenov 1988).

Advocates of wheat-fallow rotations emphasize the following advantages of summer fallow: better moisture accumulation, better weed control, and better accumulation of nitrates. According to our data, summer fallow accumulates 15–20 mm more moisture compared to stubble fields (Suleimenov and Akshalov 2007). As compared to controlling weeds efficiently in summer fallow, cereal cropping regions in Europe have no more fallow at all, and thus farmers control weeds efficiently. As to nitrate accumulation, this is true but this practice results in a more rapid loss of organic nitrogen. This was the main reason for stopping wheat-fallow rotation in western Canada (Gan et al. 2003; Larney et al. 2004).

In perennial grass-based cropping systems, which were widely practiced in the Soviet Union before 1954, the main tillage equipment was the moldboard plough. However, after testing Canadian tillage equipment it became obvious that conservation tillage using blades and sweeps was more suitable for steppe regions. The major advantage of conservation tillage was that it left standing stubble in the field to trap snow and accumulate more moisture, and protect the soil against wind erosion. Various tillage depths were identified for different soils, and in some cases no tillage was recommended in the autumn (Barayev 1984).

Meanwhile, in the USA, Canada, Australia, and in some countries of Latin America the idea of no-till was widely adopted (Derpsch 2008; Kassam et al. 2011). This is the idea of stopping any tillage except minimum soil disturbance when sowing seeds, leaving all residues on the soil surface, crop rotations, cover crops, and the application of fertilizers based on soil tests. Using no-till systems, the yield can be stabilized and soils can be protected from wind erosion in an effective way (Meinel et al. 2014). No-till systems and other soil fertility protecting measures, such as the elimination of fallow and providing crop rotations instead of monocultures, are part of Conservation Agriculture (CA).

CA is defined as “a production system in which crop, soil, nutrient, pest, water and energy management components and operations are based on a sustainable ecological foundation provided by three interlinked principles of: (1) minimum soil disturbance (no-till direct seeding); (2) maintenance of soil cover (mulch cover from crop residues and cover crops); and (3) diversification (rotation and/or association) of crops, including cover crops” (Kassam et al. 2011). Conservation agricultural systems create an ecologically protective interface between the soil profile and the atmosphere. This protects the soil surface from natural physical forces that can cause degradation by wind, water, and traffic, and allows soils to function to their highest potential (Franzlubbers 2009).

Current global studies show that expectations about possible crop yield are increasing (Pittelkow et al. 2014) or the climate mitigation (Powlson et al. 2014) thanks to no-till is limited, in humid regions in particular. A global meta-analysis study showed that no-till reduces yields by about 5–10 % in humid regions (Pittelkow et al. 2014). However, this yield deficit was lowest in combination with crop residue retention (mulch) and crop rotation. In dry climates, a significant increase in crop productivity of about 5–10 % was observed, though only if the cropping system comprised all three principles of CA (Pittelkow et al. 2014).

Those systems and principles have been tested in field trials in comparison with traditional systems. Since, the beginning of this century scientists in northern and central Kazakhstan and western Siberia have conducted no-till studies. The objective of this chapter is to provide an overview of the methodology of research on CA and to present some results of this research.

2 Materials and Methods

Our studies have been conducted in the continental steppe regions of Northern Kazakhstan and West Siberia. Northern Kazakhstan is a territory between 50° and 54°N latitude and between 60° and 78°E longitude. It covers an area of 57 million hectares, and comprises 4 provinces: Akmola, Kostanai, Pavlodar, and North Kazakhstan. The locations of the sites referred to in this chapter are as follows: Shortandy—51.7°N and 71°E, Kostanai Research Institute of Agriculture (RIA)—53.1°N and 63.8°E, Kokshetau RIA—53.2°N and 69.2°E, Karaganda RIA—49.8° N and 72.8°E. The Western Siberia area is located adjacent to and north of Northern

Kazakhstan and includes the provinces of Omsk, Altai, Novosibirsk, Kurgan, and Kemerovo. The dryland area is located between 50–55°N latitudes and 62–86°E longitudes. The locations of the sites referred to in this chapter are as follows: Omsk —58.6°N and 73.2°E, Kurgan—55.3°N and 65.2°E.

At Shortandy, CA has been studied in a number of multifactorial trials. The soil is a heavy clay loam Southern Calcareous Chernozem with an organic matter content of about 3.5 % in its arable layer. The long-term average annual precipitation is 322 mm. The distribution of precipitation is characterized by monthly falls of 20–25 mm throughout the autumn, winter, and spring and more rainfall in June (40 mm), July (54 mm), and August (35 mm). Snowfall makes up one-third of total annual precipitation and plays an important role in soil moisture accumulation. The annual average air temperature is 2.1 °C, with the highest temperatures in July (20.1 °C). This type of weather is typical for all the northern part of Kazakhstan and adjacent areas of western Siberia. In all parts of northern Kazakhstan, the application of phosphorus fertilizers at a rate of 15–20 kg ha^{-1} along with the seeds is the generally adopted practice, while nitrogen is applied based on soil analyses (Chernenok and Barkusky 2014).

At the Kostanai site, the soil is a Chernozem, sandy loam, with an organic matter content of 4.7 %, the average annual precipitation is 320 mm, and the average annual temperature is 2.5 °C. At the Karaganda site the soil is a Kastanozem, heavy clay loam, with an organic matter content of 2.5–2.8 %, the annual precipitation rate is 280 mm, and the temperature is 2.8 °C. At the Kurgan RIA site, the soil is a Leached Chernozem, clay loam, with an organic matter content of 4–5.2 % and a topsoil pH of 5.0–5.4, the annual precipitation is 350 mm, and the temperature is 1.8 °C. At the Omsk site of Siberian RIA, the soil is a Leached Chernozem, heavy clay loam, with an organic matter content of 6–7 %, the annual precipitation rate is 340 mm, and the temperature is 1.8 °C.

Our goal is not only to justify continuous wheat but to look for the best crop rotations with no fallow. For this purpose, back in the late 1990s, new crop rotation studies started at Shortandy. The traditional crop rotation of “fallow-wheat-wheat-barley-wheat” was taken as a control variant (Suleimenov et al. 2014). The new crop rotations were established by replacing summer fallow by crops: oats, dry pea, or rapeseed. These crop rotations were compared with three cropping technologies: simple, traditional, and no-till. Simple technology means that no intensification was used. Under traditional technology, tillage in the autumn and seedbed preparation was used, as well as snow ridging, fertilizer application, and chemicals to control weeds. Under no-till, direct seeding with tine was used as well as fertilizer being applied and chemicals to control weeds being sprayed (Fig. 1). In this chapter, only the yields of two crops of the rotations are presented.

In the second trial at Shortandy, three tillage methods in the autumn (deep, shallow and no-till) were studied in a 4-course rotation “3 times wheat-fallow” with a background of 4 tillage treatments during the summer fallow period: traditional (tillage to control weeds), minimum-d (one deep tillage + chemicals), minimum-s (one shallow tillage + chemicals), and chemical fallow (only herbicides to control weeds).

Fig. 1 No-till wheat

In the third trial, three factors were tested: (1) tillage, (2) sowing time, (3) wheat varieties (Suleimenov et al. 2014). The tillage treatments were traditional, minimum, and zero. The sowing dates were 19 May, 27 May, and 2 June. The wheat varieties were 3 varieties of bread wheat: Astana 2, Tselina 50, and Tselinnaya 2007, as well as 2 varieties of durum wheat: Korona and Damsinskaya yantarnaya. The total number of treatments was 45, and there were 135 plots. Plot size: width—4 m, length—50 m.

At Karaganda, no-till and traditional tillage has been applied in a five-year rotation "summer fallow—4 times wheat," since 2001 (Yushchenko 2012).

At Kurgan RIA a trial was conducted in a "fallow-wheat-wheat" rotation (Gilev et al. 2011). Two tillage treatments were tested: moldboard plough at a depth of 20–22 cm and no-till. In the no-till treatment, weeds were controlled by glyphosate at a rate of 2 litres ha^{-1} and sowing was direct, using tine sowing machines. Two fertilization treatments were tested: no fertilizer and 60 kg of N ha^{-1}.

At Omsk a trial was conducted in a 5-course crop rotation "fallow-wheat-maize-wheat-barley," which was established in 1972 (Kholmov and Shulyakov 2006). Four treatments of tillage in the autumn were tested: plough, mixed, blade, and zero. Moldboard plough was used at 20–22 cm depth. Mixed tillage treatment included plough in the fallow year and used for maize, while blades at 10–12 cm were used for grains. Three treatments of chemical application were tested: no, herbicides + fertilizer and complex. Fertilization included 60 kg ha^{-1} of P_2O_5 in fallow, 60 kg ha^{-1} of N and P_2O_5 for wheat, and 45 kg ha^{-1} of N and P_2O_5 for barley. Complex application of chemicals included fertilizers, herbicides, fungicides, and plant-growth regulators.

Soil moisture was determined by drying off soil samples at temperature 105 °C. Assessment of organic matter content in soil was made by method based on dissolving organic matter to carbonic dioxide and water (Tyurin method modified by TSINAO, standard GOST 26213-91 (1991)). Nitrates content in soil samples was determined by standard disulfurphenol method after Grandval Lyazhu (Piskunov 2004).

3 Results

3.1 Crop Rotations

In a trial at Shortandy, the yield of different crops was compared in two fields of four crop rotations. This comparison shows the advantage of replacing summer fallow by sowing various crops grown under different tillage technologies (Table 1).

Simple technology involves growing crops with no intensification. Traditional technology involves the application of all recommended intensification which means under the traditional tillage system. No-till involves the application of the same intensification means under the no-till system.

The best crop to replace summer fallow proved to be dry pea. The grain yield of wheat sown after fallow and after pea under both tillage methods was at the same level. However, dry pea itself provided 2.34 and 2.42 t ha^{-1} under no-till and traditional tillage methods, respectively. Replacing the summer fallow by rapeseed was less profitable because of the reduced yield of wheat sown after rapeseed, while the rapeseed yield was also rather low. Oats look much more advantageous than fallow, providing 3.76 t ha^{-1} of grain instead of a reduction in the wheat yield by 0.29–0.31 t ha^{-1}. However, it is less profitable than dry pea, which has much better market prices. No-till provided a reduced grain yield in wheat and dry pea because of lower nitrate availability, and a lower moisture storage in some years because of the lower snowmelt water permeability in early spring.

Table 1 Grain yield (t ha^{-1}) of preceding crops and of subsequent spring wheat under different tillage technologies at Shortandy (average for 2009–11)

Field	Preceding crop			
	Fallow	Oats	Pea	Rapeseed
Simple				
First	–	2.00	0.87	0.46
Wheat	1.32	1.25	1.11	0.98
Traditional				
First	–	3.76	2.42	1.16
Wheat	2.92	2.61	2.85	2.27
No-till				
First	–	3.76	2.34	1.15
Wheat	2.78	2.49	2.74	2.28

Crop rotation studies in northern Kazakhstan have shown that there is a considerable advantage in replacing summer fallow by other crops, first of all food legumes (Gilevich 2013; Sagalbekov et al. 2013). A number of studies have supported the idea that summer fallow can successfully be replaced by a variety of crops in dryland agriculture in a great deal of research carried out in Canada (Gan et al. 2003; Larney et al. 2004).

Diversified crop rotations are being adopted by the farmers of northern Kazakhstan, but not all farms are ready to reduce the summer fallow area and replace it by oilseeds or pulses. There are farms where alternate fallow-wheat rotation is preferred (Akayev 2011). However, there is a general trend toward considerably reducing the area under summer fallow.

3.2 Soil Tillage

In the second trial at Shortandy, three tillage methods (deep, shallow and no-till) were studied in a 4-course wheat-fallow rotation on the background of 4 tillage treatments during summer fallow: traditional, minimum-d, minimum-s, and chemical fallow. The results of the study showed that the tillage method had a significant influence on the wheat grain yield in the third year after fallow (Table 2).

Traditional tillage in the fallow includes 4–5 tillage operations during the summer to control weeds. Minimum-d treatment includes one tillage at 20–22 cm plus herbicide application. Minimum-s includes one shallow tillage at 12–14 cm plus herbicide application. Chemical fallow includes two applications of herbicides in summer to control weeds.

In the second year after fallow, in most cases the tillage methods in the fallow and in the stubble land did not affect spring wheat yields significantly. There was no need for tillage in the autumn with a background of tillage in the fallow. In the third year after fallow, no-till negatively affected the wheat yield with a background of

Table 2 Spring wheat yield (t ha^{-1}) as affected by tillage method in fallow and autumn tillage on stubble at Shortandy (average for 2007–09)

Tillage in fallow	Tillage in the autumn		
	Deep	Shallow	No-till
Second year after fallow			
Traditional	2.02	2.14	1.93
Minimum-d	1.93	1.93	1.98
Minimum-s	2.05	2.07	2.02
Chemical	2.09	2.08	2.11
Third year after fallow			
Traditional	1.75	1.97	1.76
Minimum-d	1.93	2.01	1.64
Minimum-s	1.85	1.89	1.69
Chemical	1.74	1.94	1.72

LSD_{05} t ha^{-1}: second year—0.08, third year—0.06

tillage or no tillage in the fallow. The best treatment was shallow tillage in the autumn, especially with a background of deep tillage in the fallow. This can be explained by two factors: better infiltration of thawing water in early spring and more active mineralization of nitrogen due to soil loosening.

In the third trial during the same period, a comparison of the two tillage methods has shown the advantage of zero tillage in bread wheat and durum wheat grain yields (Table 3).

The grain yield of two wheat types was higher with the delayed sowing date of 26 May. This is explained by the higher rainfall in July, which was better utilized by wheat sown later. At all sowing dates, no-till had an advantage over traditional tillage, thanks to better moisture conservation. The yield gains were higher at optimal sowing dates. Both bread wheat and durum wheat produced more nitrogen in grain under the traditional tillage method, which once more demonstrated the advantage of traditional tillage for organic matter decomposition.

In northern Kazakhstan, the best results in favor of no-till were obtained at Kostanai RIA (Aksagov 2010). In the trial, three tillage methods (traditional, minimum and no-till) were compared in a 4-course fallow-wheat rotation. In this study, the wheat yield advantage was in favor of no-till in the second and third years after fallow. The main reason was the advantage in water storage prior to sowing. Moisture storage in the 0–100 cm soil layer under traditional tillage in the first, second, and third years after fallow was 174, 121, and 118 mm, respectively, while under no-till it was 213, 161, and 140 mm, respectively. This is very different to the data obtained at Shortandy, which can be explained by the fact that this research was conducted on sandy loam black soil with an organic matter content of 4.7 %, while the soil at Shortandy is a heavy clay loam black soil with an organic matter content of 3.5 %. Additionally, in the study at the Kostanai site, traditional tillage did not include snow ridging to accumulate more snow and harvested straw was removed from the plots.

At Kurgan (Gilev et al. 2011), the moisture content prior to sowing after summer fallow was 102 mm on traditional tilled fallow and 109 mm on chemical fallow. On stubble land, no-till had a noteworthy advantage: 70 mm on plough and 110 mm on no-till. Traditional ploughing had a notable advantage on nitrate availability both after fallow and on stubble land. N-NO_3 availability on plough and no-till was 128 and 82 kg ha^{-1}, respectively after fallow and 71 and 56 kg ha^{-1}, respectively on stubble land. Spring wheat yields were affected by both the tillage method and the application of a nitrogen fertilizer (Table 4).

Table 3 Grain yield (t ha^{-1}) of bread wheat (average of 3 varieties) and durum wheat (2 varieties) as affected by tillage methods and sowing dates at Shortandy (average for 2009–2011)

Sowing date	Bread wheat		Durum wheat	
	Traditional	No-till	Traditional	No-till
19 May	1.32	1.38	1.20	1.38
26 May	1.39	1.58	1.46	1.73
2 June	1.32	1.42	1.25	1.42

Table 4 Spring wheat grain yield (t ha^{-1}) as affected by tillage method and fertilizer application in fallow—3 times wheat rotation in Kurgan, Trans-Ural central forest-steppe (average for 2007–10, Gilev et al. 2011)

Crop sequence	No fertilizer		60 kg of N ha^{-1}	
	Plough	No-till	Plough	No-till
Wheat after fallow	1.70	1.42	1.53	1.51
Wheat	1.05	1.10	1.12	1.59
Wheat	0.96	0.95	0.93	1.35

Wheat sown on fallow gave the highest grain yield when the soil was ploughed, which was obviously associated with more nitrate availability. In the second year after fallow, the wheat yield was a little higher under no-till thanks to the advantage in moisture availability. When nitrogen fertilizer was applied, ploughed fallow no longer had a yield advantage over no-till. The most noteworthy data on the advantage of no-till were obtained on stubble fields with nitrogen fertilizer applied. This was achieved, thanks to better moisture availability.

At Omsk, no-till treatment was not studied. There was a main tillage in the autumn tested together with chemical application treatments in a 5-course crop rotation. In spring, all plots were planted with a cultivator drill. The table below presents the average grain yield of wheat and barley (Table 5).

Plough—moldboard ploughing at 20–22 cm in the autumn. Blade—shallow tillage in the autumn at 12–14 cm. Mixed—plough for 2 crops and blade for 3 crops. Complex—application of fertilizers, herbicides, fungicides, insecticides, and plant-growth regulators. With no chemicals applied, tillage with a moldboard plough had a definite advantage in grain yield. When fertilizer and herbicides were applied, the best yields were obtained on plots tilled by plough annually or twice in five years. Only when all chemicals were applied, including fertilizer, herbicides, fungicides, and growth regulators, did all tillage treatments have comparable grain yields.

Comparative studies of no-till and traditional conservation tillage with sweeps and blades at the Shortandy site with a variety of combinations of crops, varieties, snow management, and sowing dates have shown that the results obtained provided a great number of data allowing a careful assessment of tillage treatments. In general, no-till on heavy clay loam soils may not be advantageous in some years when the intake of snowmelt water in early spring calls for tillage in the autumn.

Table 5 Grain yield in 5-course crop rotation as affected by tillage method and chemical application at Omsk (average for 2001–05) (Kholmov and Shulyakov 2006)

Chemicals	Tillage in the autumn			
	Plough	Mixed	Blade	Zero
None	1.94	1.76	1.69	1.64
Fertilizer + herbicides	2.97	2.90	2.73	2.73
Complex	3.95	3.97	3.96	3.91

LSD_{05} t ha^{-1}: tillage—0.15, chemicals—0.13

The most successful data in favor of no-till has been obtained at the Kostanai site on sandy loamy Chernozems. This can be explained by the fact that there is no problem of snowmelt water infiltration in early spring on light textured soils.

3.3 Soil Fertility Management

As found by Canadian scientists, major soil fertility losses happened during the summer fallow period (Renni et al. 1976). Moreover, frequent summer fallow reduced potential crop yields because of reduced soil fertility. Most soils in Saskatchewan lost some 35–44 % of their original nitrogen and organic matter. It was calculated that only 30–33 % of nitrogen in the lost organic matter was taken up by plants. By 1974, the nitrogen lost was equivalent to 36 million tons. These scientists also calculated that about 600 kg N ha^{-1} was leached below the plant root system layer, mainly during the summer fallow period.

According to our observations at Shortandy, snowmelt water runoff and soil losses occur in summer fallow fields on southern slopes almost every year. Soil losses go up to 0.5 t ha^{-1} even after winters with little snow. In one year, the soil losses on summer fallow fields may reach up to 292 m^3 ha^{-1}. Our research has shown that the intake of snowmelt water on summer fallow does not exceed 17.4 %. After a second winter of summer fallowing, up to 92 % of the snowmelt water is lost as runoff and through evaporation.

According to data obtained at Shortandy, in 50 years the organic matter content in 0–20 cm soil layer was reduced from 3.90–3.26 % under continuous wheat due to the common decay of organic matter. At the same time, in alternate fallow-wheat rotation, the organic matter content dropped dramatically to 2.48 %. That is, our new data is in line with Canadian findings. This is why CA should include diversified crop rotations with no fallow or a minimal area under fallow. Summer fallow might be used occasionally for certain purposes, but it should not be a systematic, frequent fallow. According to Kokshetau RIA (Sagalbekov et al. 2013) replacing the summer fallow by sweet clover harvested for green mass, followed by ploughing, increased the soil organic matter in four-year rotation by 10 % compared with the original content.

The second direction for soil fertility improvement is direct sowing. It is obvious that if there is lack of nitrates under no-till because of slow nitrogen mineralization, this leads to soil fertility conservation. At the Shortandy site there was a trial with soil mulching with straw at rates of 2 and 4 t ha^{-1} during three times of 4-course wheat—fallow rotation. At the end of the third rotation, after 12 years the organic matter content in the 0–10 cm soil layer at 2 and 4 t ha^{-1} rates increased from 3.52 to 3.69 and 4.10 %, respectively. However, nobody wants to carry straw from one field to another for mulching purposes. This is why no-till itself will affect soil fertility slowly, and it should be combined with the introduction of diversified crop rotations with no fallow.

The effect of no-till on organic matter content was obtained in the longest no-till study conducted at a Karaganda site in the dry steppe zone of Central Kazakhstan (Yushchenko 2012). After ten years of continuous no-till, an increase in the organic matter was observed. The organic matter content increased notably in the top 0–10 cm layer from 3.11 % under traditional tillage to 3.26 % under no-till as a result of continuous no-till application over ten years in a five-year rotation "fallow-4 year grains" at the expense of less organic matter losses through nitrification processes in no-tilled soil. In larger farm fields, these losses might be increased by soil losses due to runoff water, especially on sloping lands.

Not only on research fields but also on many working fields in Siberia, there has been evidence of significant soil degradation and desertification due to traditional farming and tillage methods on silty and sandy soils (Meinel 2002; Schreiner and Meyer 2014). If cereal-cropping systems are to be maintained in steppe regions, and soil fertility is to be preserved for coming generations, there is no alternative to installing CA.

4 Conclusions

1. The principles of CA include crop rotations with no fallow, no-till or minimum tillage, leaving all residues on the soil surface and applying recommended rates of nitrogen and phosphorus.
2. Compared with fallow-based wheat monoculture, crop rotations provide crop diversification and a more economical use of land resources, and guarantee better soil fertility management, thanks to the removal of summer fallow from rotations.
3. In western Siberia on Leached Chernozems no-till is feasible only with the application of increased rates of nitrogen fertilizers.
4. No-till enables better soil fertility conservation. On light textured soils it guarantees a crop yield increase, thanks to better moisture accumulation and conservation. On heavy textured soils, in some cases, soil loosening in the autumn is necessary to facilitate a better intake of snowmelt water in early spring.
5. For soil fertility conservation, what is most important is the removal or considerable reduction of summer fallow and its replacement by food legumes such as peas and sweet clover. In addition to this, no-till or minimum tillage should be applied with nitrogen fertilizer.
6. Soil degradation by nonsustainable tillage systems must be stopped. Conservation agriculture including no-till is practicable and must become the dominating practice in cereal cropping systems of steppe regions.

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