Pulses as replacement of summer fallow in semiarid steppes of Northern Kazakhstan

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INTRODUCTION

In the 1950’s wheat-fallow monoculture cropping system was chosen for two reasons. First, it was planned to produce as much as possible bread wheat for the whole country. Secondly, the Canadian experience of farming in the western prairies where fallow-wheat monoculture was practiced with summer fallow occupying about 40% of cropland was adopted. In northern Kazakhstan, it was decided to fallow 20-25% of cropland and use the remaining areas mainly to grow spring wheat and barley (Barayev, 1960) while marginal land was used to cultivate forages for livestock feeding. The possibility of growing oilseeds or pulses was not even discussed as they were not included into plans of agricultural production. Besides, this topic was not included in research programs.

It was only recently, about ten years ago, that crop diversification began with the introduction of oilseeds, followed by sunflower, then rapeseed and later flax. In 2013, these crops occupied a large area of about 1,460 000 ha whereas pulses were grown on a rather small area: dry pea on 53 000 ha and chickpea on 32 000 ha (FAO, 2013).

During this time in western Canada, most summer fallow areas was replaced by oilseeds and pulses and the country became a world leader in exporting these crops. Canadian scientists have long ago researched on the danger of nitrogen losses due to alternate wheat-summer fallow practice (Hill, 1954; Renni et al., 1976). Real reduction of summer fallow areas however started only when oilseed and pulse crop production became economically profitable because of crop improvement, better crop management practices and good market opportunities. Canadian scientists have reported the ability of pulse crops in fixing nitrogen from air (Beckie et al., 1997). Pulse crops were found to differ from grain crops in shallow root distribution which is their advantage as a preceding crop for wheat...
(Gan et al., 2009).

In northern Kazakhstan, considerable losses in soil organic matter under alternate wheat-fallow system have also been established (Suleimenov et al., 2014). Grain-fallow crop rotations produce less grain from total area including fallow compared to continuous wheat in both Kostanai province of northern Kazakhstan (Kuzhinov, 2013) and Kurgan province of western Siberia (Gilev et al., 2009; Nemchenko et al., 2009). Thus, wheat-fallow system has become a major problem in protecting croplands from degradation. The challenge is to find out the best alternative to this system by replacing fallow with pulse crops.

Research on crop diversification started in the region recently. In our previous research, it was shown that summer fallow could be replaced by oats or pulses (Suleimenov and Akshalov, 2007; Suleimenov et al., 2010). Replacement of summer fallow by field pea was found to be economical in both the semiarid steppe of northern Kazakhstan (Gilevich, 2015) and dry steppe of central Kazakhstan (Yushchenko, 2014), as well as in southern Ural semiarid steppe of Russia (Maksyutov, 2013).

In this paper, long-term research data is presented to show the possibility of replacing summer fallow with three pulses: dry pea, chickpea and lentil. Grain productivity of various pulses are presented as well as the effect of summer fallow and pulses as predecessors of spring wheat on productivity and economics of spring wheat production.

### MATERIALS AND METHODS

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 ha. and is comprises 4 provinces: Akmola, Kostanai, Pavlodar and North Kazakhstan. The study area used for this research is Shortandy (51.7°NL and 71°EL) located 60 km north of the capital Astana.

The soil of the study area is heavy clay loam southern calcareous chernozem with organic matter content with 3.5% of the land used for arable production. Long-term average annual precipitation is 322 mm. The area is characterized by monthly precipitation of 20-25 mm throughout autumn, winter and spring. During eight years of trials, two years were extremely dry (2010 and 2012) characterized by droughts, four years were dry (2006, 2008, 2009 and 2013) characterized by long droughts and two years were moderately dry with short droughts during vegetation period (Table 1). Snowfall is about one third of total annual precipitation and plays an important role in soil moisture accumulation. Annual average air temperature is 2.1°C with highest temperatures in July (20.1°C). This type of weather is typical in the northern part of Kazakhstan.

In this study, phosphorus fertilizer, P2O5, was applied to all seed crops at the rate of 20 kg ha⁻¹ while nitrogen was not applied. Economic evaluation of cropping sequences was made by calculating average net profit for two years: first year of fallow or pulses and second year of spring wheat. Market prices for crop grains in US$ per 1 ton were used: wheat – 200, dry pea – 250, chickpea – 500 and lentil – 600.

All treatments were done in three replicates. Plot size was 60 m and 4 m in length and width, respectively. ANOVA analysis was used for statistical analyses (Agros, 2008). Soil moisture assessment was done by collecting soil samples from 0-100 cm layer with 10 cm intervals and then drying. Nitrates assessment was carried out by collecting soil samples and replicating them using standard ionometric method (GOST 26951-86). Protein was measured with the Kjedahl method (GOST 10846-91).

A 4-year rotation which began in 2003 was used for this study with data collected from 2006. The control crop rotation was fallow-wheat-wheat-barley. The other three crop rotations were applied by replacing summer fallow with pulses: dry pea (Pisum sativum L.), chickpea (Cicer arietinum L.) and lentil (Lens culinaris L.). Varieties used were: spring wheat – local variety Akmola 2, Dry pea – Omskiy neospayushchiysya from Omsk, chickpea – Krasnokutskiy 123 from Saratov province, Lentil – Vekhovskaya 1 from Penza province. The seeds of all varieties used were tested by the State commission on Variety Testing and registered. The second crop was spring wheat (Triticum aestivum L.) sown after summer fallow and pulses. In this paper, we will discuss data obtained from the first two fields of crop rotations to compare the effect of

### Table 1. Monthly rainfall distribution (mm) during vegetation period

<table>
<thead>
<tr>
<th>Year</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>21</td>
<td>46</td>
<td>27</td>
<td>16</td>
</tr>
<tr>
<td>2007</td>
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<tr>
<td>2008</td>
<td>9</td>
<td>6</td>
<td>73</td>
<td>26</td>
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<tr>
<td>2009</td>
<td>31</td>
<td>6</td>
<td>76</td>
<td>44</td>
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<tr>
<td>2010</td>
<td>16</td>
<td>7</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td>2011</td>
<td>44</td>
<td>62</td>
<td>84</td>
<td>16</td>
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<td>2012</td>
<td>9</td>
<td>29</td>
<td>58</td>
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</tr>
<tr>
<td>2013</td>
<td>31</td>
<td>12</td>
<td>90</td>
<td>38</td>
</tr>
</tbody>
</table>
Table 2. Soil moisture storage (mm) in 0-100 cm layer prior to sowing spring wheat as affected by different predecessors of spring wheat

<table>
<thead>
<tr>
<th>Year</th>
<th>Predecessor</th>
<th>LSD&lt;sub&gt;0.05&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fallow</td>
<td>Dry pea</td>
</tr>
<tr>
<td>2006</td>
<td>117</td>
<td>80</td>
</tr>
<tr>
<td>2007</td>
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<tr>
<td>2008</td>
<td>120</td>
<td>118</td>
</tr>
<tr>
<td>2009</td>
<td>116</td>
<td>74</td>
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<tr>
<td>2010</td>
<td>113</td>
<td>109</td>
</tr>
<tr>
<td>2011</td>
<td>138</td>
<td>114</td>
</tr>
<tr>
<td>2012</td>
<td>118</td>
<td>92</td>
</tr>
<tr>
<td>2013</td>
<td>126</td>
<td>109</td>
</tr>
<tr>
<td>Average</td>
<td>121</td>
<td>102</td>
</tr>
</tbody>
</table>

pulse crops replacing fallow.

Summer fallow was traditionally tilled four times during 2006-2010 with a blade at 10-12 cm depth to control weeds and once with a sweep blade at 25-27 cm depth to improve infiltration of snowmelt water in spring. During 2011-2013, summer fallow was sprayed with herbicides twice and tilled with a sweep plough once.

All the plots dedicated for sowing pulse crops were tilled in the fall with the sweep plough at 20-22 cm depth to control weeds and improve snowmelt water infiltration during early spring. In winter, snow ridding was done to produce snow windrows 4-5 m apart to trap more snow. All crops, including spring wheat and pulses were planted during 20th-25th May. Seed bed preparation was done by a duck foot cultivator and sowing by a cultivator-drill at 5-6 cm deep. Seed rates used in were: spring wheat – 120 kg ha<sup>-1</sup>, dry pea – 200 kg ha<sup>-1</sup>, chickpea – 200 kg ha<sup>-1</sup> and lentil – 45 kg ha<sup>-1</sup>. Prior to sowing, seeds of pulses crops were treated with Rhizobia to produce Rhizobia nodules to fix more atmospheric nitrogen. Spring wheat was harvested in mid- and end of September, while pulses were harvested by the end of August – beginning of September.

RESULTS

Soil moisture

Soil moisture is major factor affecting crop yield in dry land agriculture. It is most important to collect snow by snow ridding which is a common practice in northern Kazakhstan. In summer fallow, it is common practice to collect water hence it is characterized by water storage against annual crops. In our trial, soil moisture was measured prior to sowing of spring wheat after summer fallow and pulse crops (Table 2).

Traditionally, delayed sowing dates of spring wheat are practiced even when soil is ready for sowing in early May. However, with delayed sowing, soil moisture evaporates and water storage is reduced remarkably. Hence, by the time of sowing spring wheat in most years, significantly more moisture is left on summer fallow plots compared to wheat sown after pulses. In some years, the difference is usually smaller. This happens when winter is snowy and thus more snowmelt water infiltrates into the soil for early spring. In most years, there were no significant differences in moisture accumulation between different pulse crops. In two years, there was less moisture after lentil than after dry pea rotation. The same advantage of summer fallow in moisture accumulation was recorded during 2006-2010 when fallow was intensively tilled and during 2011-2013 when minimum tillage was used during fallow period.

Nitrate nitrogen

Nitrate nitrogen availability was affected by both spring wheat and tillage method in summer fallow period (Table 3). Intensively tilled summer fallow in 2006-2010 produced significantly more nitrate nitrogen compared with pulse crops due to more rapid decomposition of soil organic matter. However, summer fallow with minimum tillage practiced in 2011-2013 did not manifest this advantage. Moreover, in 2011 more nitrate nitrogen was produced under pulses. Year 2011 experienced significantly more rainfall in May compared with other years. There was no difference in nitrogen accumulation between different pulse crops.

Crop yield

The years of trials were analyzed in three groups: very dry, dry and moderately dry. This allowed the evaluation of efficiency of different pulses crops under various weather conditions (Table 4).

In all the years, dry pea was the highest yielding pulse crop while chickpea and lentil yields amounted to 76 and 68% respectively, compared to dry pea. In the very dry years, chickpea yields were similar to dry pea (91%) whereas lentil yield was dramatically lower (52%). This shows that chickpea is more drought resistant than lentil.
Table 3. Nitrate nitrogen availability in 0-40 cm soil layer (mg kg⁻¹) prior to sowing spring wheat as affected by predecessors

<table>
<thead>
<tr>
<th>Year</th>
<th>Summer fallow</th>
<th>Dry pea</th>
<th>Chickpea</th>
<th>Lentil</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>23</td>
<td>9</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2007</td>
<td>15</td>
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<td>2008</td>
<td>24</td>
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<td>7</td>
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<tr>
<td>2009</td>
<td>23</td>
<td>8</td>
<td>7</td>
<td>9</td>
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<tr>
<td>2010</td>
<td>16</td>
<td>8</td>
<td>7</td>
<td>9</td>
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<tr>
<td>2011</td>
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<tr>
<td>2012</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>7</td>
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<tr>
<td>2013</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Average</td>
<td>16</td>
<td>9</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 4. Grain yield (t ha⁻¹) of different pulse crops as affected by weather conditions

<table>
<thead>
<tr>
<th>Year</th>
<th>Dry pea</th>
<th>Chickpea</th>
<th>Lentil</th>
<th>LSD₀.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very dry years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>0.76</td>
<td>0.78</td>
<td>0.51</td>
<td>0.12</td>
</tr>
<tr>
<td>2012</td>
<td>0.78</td>
<td>0.61</td>
<td>0.30</td>
<td>0.15</td>
</tr>
<tr>
<td>Mean</td>
<td>0.77</td>
<td>0.70</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>Dry years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>1.74</td>
<td>1.03</td>
<td>0.94</td>
<td>0.20</td>
</tr>
<tr>
<td>2008</td>
<td>1.17</td>
<td>1.05</td>
<td>0.67</td>
<td>0.11</td>
</tr>
<tr>
<td>2009</td>
<td>1.12</td>
<td>0.59</td>
<td>1.29</td>
<td>0.21</td>
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<tr>
<td>2013</td>
<td>1.48</td>
<td>1.01</td>
<td>0.79</td>
<td>0.19</td>
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<tr>
<td>Mean</td>
<td>1.38</td>
<td>0.92</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td>Moderately dry years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>1.80</td>
<td>1.79</td>
<td>1.22</td>
<td>0.18</td>
</tr>
<tr>
<td>2011</td>
<td>1.76</td>
<td>1.74</td>
<td>1.48</td>
<td>0.24</td>
</tr>
<tr>
<td>Mean</td>
<td>1.78</td>
<td>1.77</td>
<td>1.35</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>1.33</td>
<td>1.08</td>
<td>0.90</td>
<td></td>
</tr>
</tbody>
</table>

In dry years, chickpea had lower yields compared to dry pea (67%) while lentil produced on average in four years, the same yield with chickpea. However, lentil yields were unstable compared with the two other pulses. In moderately dry years, there was no significant yield difference between chickpea and dry pea while lentil yields were significantly lower. This shows that chickpea is well adapted to very dry and relatively favorable weather conditions even though it was severely affected by Ascochyta blight aggravated by cold spell during grain filling in 2009.

Pulses as preceding crops for spring wheat were compared with summer fallow. The efficiency of pulses against summer fallow was different under various weather conditions (Table 5).

In very dry and dry years, the advantage of summer fallow as a predecessor of spring wheat was very clear due to better water storage and nitrogen availability prior to sowing. On the average of two very dry years, grain yield of spring wheat sown after dry pea, chickpea and lentil amounted to 70, 69 and 65%, respectively, against wheat yield sown after summer fallow. There was little difference among the pulse crops. The same trend was observed in the dry years even though wheat yields were much higher. On the average of four dry years, spring wheat yield sown after dry pea, chickpea and lentil amounted to 74, 71 and 70%, respectively, against yield of wheat sown after summer fallow. Pulse crops as predecessors of spring wheat were as efficient as summer fallow only in moderately dry years. On the average of two such years, spring wheat yield sown after dry pea, chickpea and lentil amounted to 94, 103 and 90%, respectively, as compared to yield of wheat sown after summer fallow. Under favorable weather conditions, chickpea was the better predecessor of spring wheat than summer fallow, dry pea and lentil. On the average of eight years, the best predecessor of spring wheat was summer fallow. The average yield of spring wheat sown after dry pea, chickpea and lentil amounted to 79, 81 and 72%,
Table 5. Yield of spring wheat (t ha⁻¹) sown after different predecessors under various weather conditions

<table>
<thead>
<tr>
<th>Year</th>
<th>Fallow</th>
<th>Dry pea</th>
<th>Chickpea</th>
<th>Lentil</th>
<th>LSD₀₅</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2010</td>
<td>1.16</td>
<td>0.92</td>
<td>0.84</td>
<td>0.87</td>
<td>0.14</td>
</tr>
<tr>
<td>2012</td>
<td>1.00</td>
<td>0.50</td>
<td>0.64</td>
<td>0.53</td>
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</tr>
<tr>
<td>Mean</td>
<td>1.08</td>
<td>0.71</td>
<td>0.74</td>
<td>0.70</td>
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<tr>
<td>2006</td>
<td>2.39</td>
<td>1.32</td>
<td>1.30</td>
<td>1.29</td>
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<tr>
<td>2008</td>
<td>2.10</td>
<td>1.79</td>
<td>1.56</td>
<td>1.75</td>
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<td>2009</td>
<td>2.32</td>
<td>1.78</td>
<td>1.79</td>
<td>1.64</td>
<td>0.21</td>
</tr>
<tr>
<td>2013</td>
<td>2.95</td>
<td>2.31</td>
<td>2.28</td>
<td>2.10</td>
<td>0.28</td>
</tr>
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<td>Mean</td>
<td>2.44</td>
<td>1.80</td>
<td>1.73</td>
<td>1.70</td>
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<tr>
<td>Dry years</td>
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<td></td>
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<tr>
<td>2007</td>
<td>2.17</td>
<td>2.32</td>
<td>2.39</td>
<td>2.17</td>
<td>0.20</td>
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<td>3.21</td>
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<tr>
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<td>2.57</td>
<td>2.80</td>
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<tr>
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<td>Moderately dry years</td>
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<td></td>
</tr>
</tbody>
</table>

Table 6. Grain protein (%) in spring wheat grown after fallow or pulses under various weather conditions

<table>
<thead>
<tr>
<th>Years</th>
<th>Fallow</th>
<th>Dry pea</th>
<th>Chickpea</th>
<th>Lentil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Very dry years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>12.6</td>
<td>12.2</td>
<td>12.6</td>
<td>13.1</td>
</tr>
<tr>
<td>2012</td>
<td>17.0</td>
<td>17.3</td>
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<td>Mean</td>
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<td>14.8</td>
<td>14.5</td>
<td>14.8</td>
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<tr>
<td>Dry years</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>13.9</td>
<td>14.1</td>
<td>13.4</td>
<td>13.9</td>
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<td>2008</td>
<td>14.6</td>
<td>15.1</td>
<td>15.1</td>
<td>15.4</td>
</tr>
<tr>
<td>2009</td>
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<td>2013</td>
<td>13.4</td>
<td>13.8</td>
<td>13.1</td>
<td>13.5</td>
</tr>
<tr>
<td>Mean</td>
<td>13.8</td>
<td>13.8</td>
<td>13.3</td>
<td>13.6</td>
</tr>
<tr>
<td>Moderately dry years</td>
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<td>2007</td>
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<td>2011</td>
<td>12.4</td>
<td>14.2</td>
<td>14.5</td>
<td>15.0</td>
</tr>
<tr>
<td>Mean</td>
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<td>13.8</td>
<td>13.7</td>
<td>14.4</td>
</tr>
<tr>
<td>Average</td>
<td>13.6</td>
<td>14.0</td>
<td>13.7</td>
<td>14.1</td>
</tr>
</tbody>
</table>

respectively, as compared with yield of wheat sown after summer fallow.

**Grain protein**

Protein content in grain is one of major characteristics of grain quality. It depends on both weather conditions and predecessor of spring wheat (Table 6).

The protein content in spring wheat was highest in very dry 2012, but was rather low in 2010. The grain yield of spring wheat was very low in both years but there was some difference in rainfall distribution which affected protein production. In 2010, there was some rainfall during grain ripeness whereas in 2012, it occurred during grain filling. In both years there was no significant difference in protein content between summer fallow and the three pulses as predecessors of spring wheat. In four dry years, there was also no significant difference in protein content in grain of spring wheat sown after summer fallow and the three pulse crops. In moderately dry years, pulse crops as predecessors of spring wheat showed significant difference in yield against summer fallow. The difference was highest in 2011 under the most favorable weather conditions. In this year, the wheat yield was highest as there was
Table 7. Economic efficiency of production of different crops and of various crop sequences

<table>
<thead>
<tr>
<th>Crop sequence</th>
<th>Crop yield (t ha(^{-1}))</th>
<th>Revenue (US$ ha(^{-1}))</th>
<th>Cost (US$ ha(^{-1}))</th>
<th>Net profit (US$ ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallow</td>
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<tr>
<td>Wheat</td>
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</tr>
<tr>
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<td></td>
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<tr>
<td>Dry pea</td>
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<td>332</td>
<td>226</td>
<td>106</td>
</tr>
<tr>
<td>Wheat</td>
<td>1.72</td>
<td>346</td>
<td>200</td>
<td>146</td>
</tr>
<tr>
<td>Average</td>
<td></td>
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<tr>
<td>Chickpea</td>
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<td>276</td>
<td>264</td>
</tr>
<tr>
<td>Wheat</td>
<td>1.75</td>
<td>350</td>
<td>200</td>
<td>150</td>
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<tr>
<td>Average</td>
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<tr>
<td>Lentil</td>
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<td>203</td>
<td>337</td>
</tr>
<tr>
<td>Wheat</td>
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<td></td>
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<tr>
<td><strong>Average</strong></td>
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</table>

significant difference in spring wheat yield after summer fallow compared with pulses as predecessors of spring wheat and it was the only year when availability of nitrate nitrogen was higher after pulse crops than after summer fallow.

**Economic efficiency**

Summer fallow did not produce any value in the year of fallowing. This is why we have made economic assessment of crop sequences averaged for two years (Table 7).

Net profit of spring wheat production was highest when it was grown after summer fallow while it was lowest when grown after lentil. However, pulses produced big net profit in spite of rather low yields due to their high market value. The highest net profit was produced by cultivating lentil instead of summer fallow. It was much higher than that of wheat grown on fallow. Considering annual average net profit for two years of land use, economic efficiency of growing wheat after summer fallow was the lowest compared with wheat planted after pulse crops. The most profitable rotation was planting wheat after lentil due to the high market value of this crop. The net profit obtained by replacing fallow with chickpea was also very high due to its high market value and high grain yield compared to wheat grown after chickpea. Replacing summer fallow with dry pea was also economical however, net profit of such crop sequence was much lower than replacing fallow with lentil or chickpea.

**DISCUSSION**

The most significant result of the research is that pulses can compete successfully with summer fallow as predecessors of spring wheat. Including pulse crops into crop rotations was found to improve wheat grain yields in western Canada (Gan and Harker, 2007) as well as grain quality (Gan et al., 2003).

Comparison of three pulses crops productivity revealed the advantage of dry pea. In most years, chickpea competed with dry pea. Lentil yields were much lower than dry pea and chickpea. We can expect that with crop improvement research taking place in northern Kazakhstan, yields of pulse crops will improve. Analysis of research data from ten experiment stations located in the northern Great Plains showed that the most adaptive pulse crops are dry pea and lentils (Miller et al., 2002). Therefore this study shows that in northern Kazakhstan, chickpea is better adapted to the local climate than the Great Plains.

Although yield of spring wheat sown after fallow was higher than wheat sown after pulses, the most economic was spring wheat sown after lentil followed by wheat sown after chickpea and dry pea. This shows the advantage of replacement of summer fallow with pulses. Pulses prices are more stable compared to wheat whose market prices fluctuate between US$ 100 and 300, whereas lentil price never went below US$ 600. Data from several experiment stations in western Canada have shown the economic efficiency of rotating grain crops with pulses (Zentner et al., 2002).

There are three groups of farmers in with respect to their attitude to practice summer fallow in cropping systems of northern Kazakhstan. The majority of farmers for various reasons, keep summer fallow on 8-12% of cropland. Among these farmers, a small group still practices alternate fallow-wheat system (Akayev, 2014), some keep 15-20% of cropland under summer fallow (Latyshev, 2014), and however, there are some who have eliminated fallow (Latyshev, 2013).

Crop diversification in northern Kazakhstan began by introducing oilseed crops. On the average, oilseeds occupy about 10% of cropland, but there are farms where it occupies up to 40% of cropland (Latyshev, 2014a). A similar situation is observed in Russia where in Rostov province, sunflower replaced summer fallow and occupies...
about 40% of cropland (Galichenko, 2012). However, there are many farms on which both oilseeds and pulses are rotated with grains (Prokop, 2014; Grinetz, 2012). With improvement in marketing and seed production area, other pulses will grow.

Conclusions

Replacement of summer fallow with pulse crops leads to reduced yields in spring wheat but provides the opportunity to produce valuable crops.

Crop sequence of pulse crops followed by spring wheat is more economical than wheat sown after summer fallow. Out of the three pulse crops studied, the highest yield was observed in dry pea followed by chickpea whereas the most economical is lentil due to its high market value followed by chickpea.

Replacement of summer fallow with pulses is recommended as it is more economical and reduces land degradation in semiarid conditions of northern Kazakhstan where traditional intensive tillage is common practice.

Conflict of interest

No conflict of interest exits in the submission of this manuscript.

REFERENCES


GOST 10846-01 – State standard method of Kyeldal measuring protein in grain.

GOST 25951-86 – State standard ionometric method to measure nitrates.


