

Trend Analysis of Area and Productivity of Some Basic Crops in Northern Kazakhstan

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ABSTRACT

Northern Kazakhstan is the core zone of crop production for the Republic of Kazakhstan. The three provinces viz. North Kazakhstan, Kostanay and Akmola account for about 85% of the total wheat production of the country thus adding significance to the region so far as the food security of the Republic is concerned. The research paper is written with an aim to analyse the trends shown by the productivity and the area under basic crops by the different provinces of the area under study during the selected time period of 15 years from 2004 to 2018. Trend analysis has been used to track the path of the variables in the time series. The area under wheat crop has declined from the previous few years reflecting the Government directed crop diversification policy in Northern Kazakhstan. The land was devoted to oilseed crops and fodder in order to increase the profitability of its crops. Agriculture is a risky endeavour in Kazakhstan with most of the risks associated with climatic events. The area is frequently affected by droughts thus influencing the magnitude of the production process. The Republic is suggested to frame certain policies in order to mitigate the impacts of such climatic events and to increase the profitability of its crops that can benefit the agricultural sector and make the Republic food secure.

1. Introduction

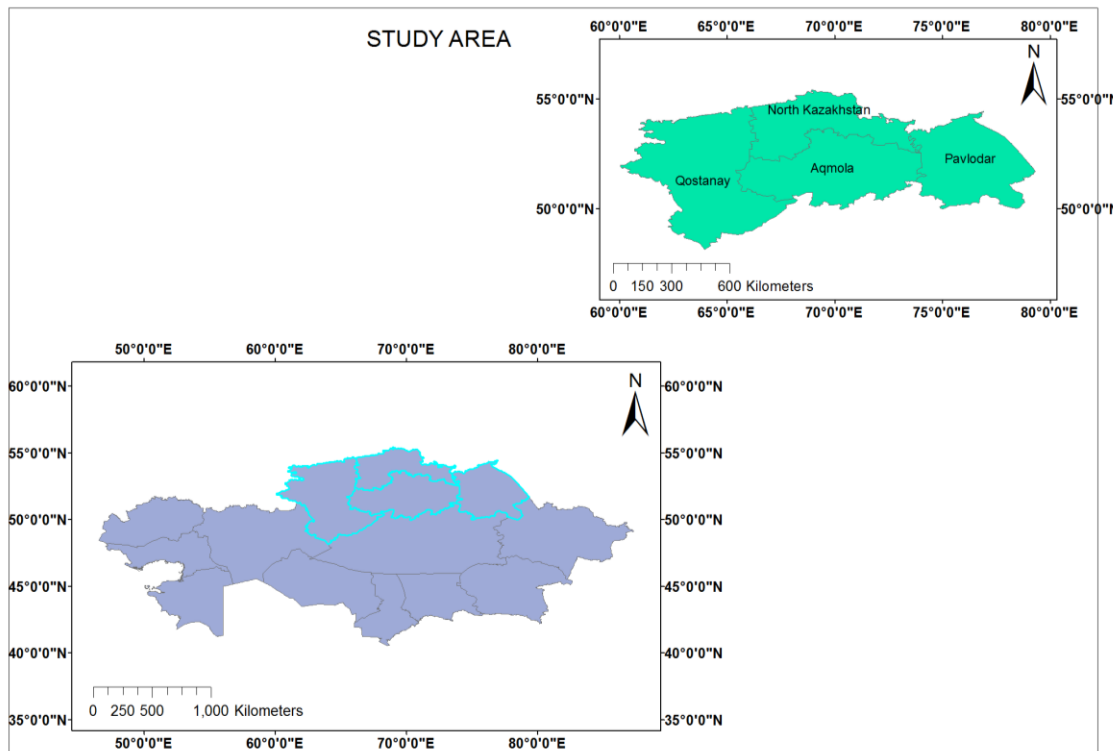
Achieving food security and improving the quality of life, while preserving the environment, is posing major challenges to scientists, decision makers and technicians presently as well as in future (Wrachien DD, 2003). There is an increasing demand for the food mainly due to the pressures from the rising population. It is here where the agriculture becomes so significant. There are mainly two ways to produce more from the land – one is to expand the area under crops and the other is the intensive use of the land already under crops by elevating its productivity. Expansion of the crop area seems to be cumbersome as the extra people exploding in great numbers are to be accommodated on the same land. So, most communities prefer intensification of agriculture to produce more from the holdings. The current paper will focus on these two things – area and productivity of some basic crops grown in the study area. Global agricultural production will need to supply substantially more feed, food and bio-energy in the coming decades, but crop yields are stagnating, soil degradation is widespread (Godfray et.al. 2010, FAO 2011, Foley et.al. 2011). Several studies have shown that global crop production needs to double by 2050 to meet the projected demands from rising population, diet shifts and increasing bio-fuel consumption (Ray KD, Mueller ND, Wust PC, Foley JA, 2013). Although food is globally traded, the relative distribution of food production is crucial to food security. The evolution of these trends at national and regional levels is therefore critical (Ritche H, 2017). According to researchers if the world is to grow enough food for the projected global population in 2050, agricultural productivity will have to rise by at least 60%.

Agriculture is a very important socioeconomic sector in Kazakhstan. Approximately 7.3 million people (47.2 % of total population) live in rural areas and agriculture employs more than 22% of the labour force in the country, contributing around 6% of Kazakhstan's GDP (World Bank, 2012). Agricultural production in Kazakhstan is an extremely risky endeavour. Historically, Kazakhstan's agricultural production has suffered from serious drought events. As a result, the agricultural value added in Kazakhstan is marked by frequent and sharp year to year fluctuations (World Bank, 2012). The present paper is an attempt to analyse the area and productivity trends of the crops grown in the area to identify the inter-annual fluctuations in the area under crops and productivity which would in turn help the decision makers frame better policies for future sustained crop production.

2. Study Area

Northern Kazakhstan (see Fig.1) includes North Kazakhstan, Pavlodar, Akmola and Kostanay provinces of the Republic of Kazakhstan. The territory roughly sprawls from 48.19° N to 55.44°N latitudes and 59.99° E to 79.58° E longitudes. This region is situated in the utmost Northern part of the Republic in the basin of the Esil, Tobil and the Obagan rivers. Northern Kazakhstan occupies the territory of more than 1300 km from West to East and about 900 km from North to South. The climate of Northern Kazakhstan is sharply continental suffering from the extremes of temperature. The average temperature varies between -4°C and -19°C in January and between 19°C and 26°C in July. Precipitation mostly occurs in spring and summer seasons. It is little in winter and occurs in the form of snow. The average annual precipitation is around 250-350 mm.

Fig. 1- Study Area Map showing Northern Kazakhstan consisting of North Kazakhstan, Akmola, Qostanay and Pavlodar provinces of the Republic.



Source: Generated through ArcGIS 10.5

Chernozem is the dominant soil type. The soil is mostly fertile, rich in humus and with a lighter lime rich layer beneath. Soil fertility generally decreases while moving south in Kazakhstan. The area is a significant wheat producer with Kostanay, Akmola and North Kazakhstan producing about 5% of the total *Triticum* output of the Republic (World Bank).

3. Materials and Methods

Trends and growth rates in the area and productivity of major crops were studied by collecting the data of the last 15 years (2004-2018) from the Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics. The procedure was run on three major crops grown in the region. Parametric trend model was used to find the path followed by the time series data. The model relates Y to a function of X and β.

$$Y = f(X, \beta)$$

Where Y is dependent variable (area or productivity), X is independent variable (time in years) and β is the coefficient showing marginal impacts. The model has been preferred on the basis of the goodness of fit (R²) and the statistical significance of the estimated parameters. Scatter plots were prepared from the given data which provided an insight into the fluctuations shown by the selected variables over time. Data pertaining major crops was dropped in the ArcMap 10.5 to examine the spatial variability of the yield across the study area. Growth rate over the time period has been calculated to see the change in the area and productivity. It was calculated as under:

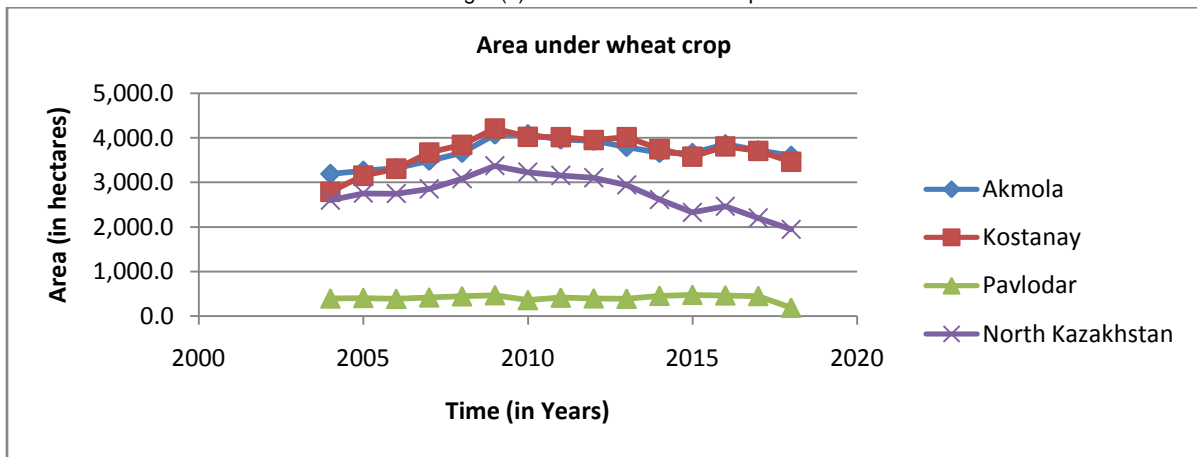
$$\text{Growth rate} = \frac{X - Y}{Y} \times 100$$

Where X is the initial value of the variable and Y is the final value of the variable under consideration.

4. Discussion and Results

The province of Akmola has shown an overall increasing trend (a slope of 29.45 thousand hectares/year, R²=0.222) for the area under wheat crop during the selected time period of 15 years. The area for the province has increased from 3192.2 thousand hectares in 2004 to a peak value of 4080.9 thousand hectares in 2010 with a growth rate of 27.83% for the time period. After 2010 the area declined to 3599 thousand hectares in 2018 with a negative growth of 11.80% for the time frame. Kostanay also showed an overall increased trend (33.80 thousand hectares/year, R²=0.158) with the maximum area of 4211 thousand hectares under the crop in 2009. The area then decreased to 3464 thousand hectares with a negative growth of 17.73 % from 2009-2018. The area under the wheat crop for Pavlodar province remained more or less constant at an average value of around 400 thousand hectares but the value showed an abrupt fall in 2018 to a minimum value of 190.2 thousand hectares. North Kazakhstan has shown a decreasing trend (-49.34 thousand hectares/year, R²=0.294) over the 15 year period. Maximum area under the wheat crop peaked at 3373.9 thousand hectares in 2009 which then declined with a negative growth of 42.21% to 1949.6 thousand hectares in 2018.

Fig. 2(a) - Area under wheat crop

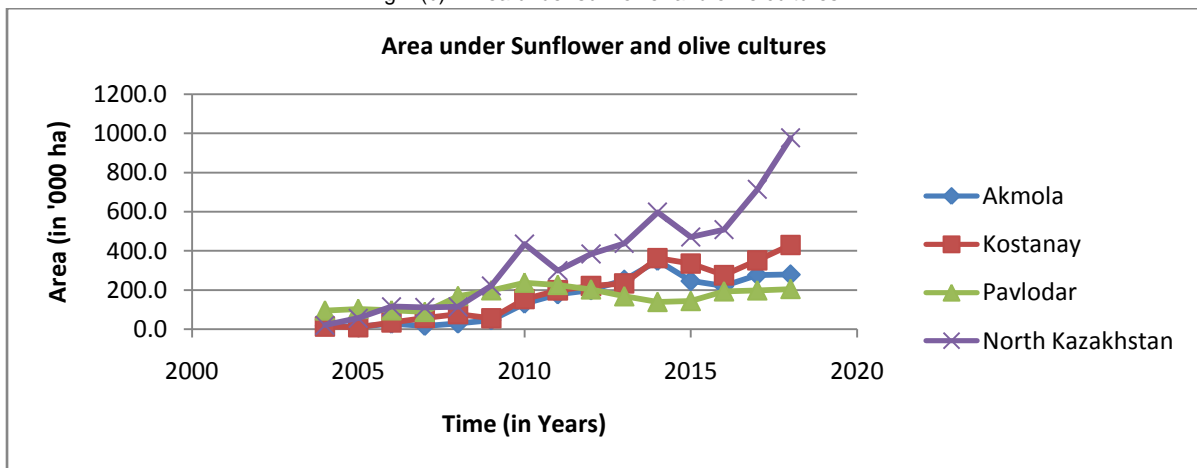


Source: Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics

The area under sunflower and olive cultures (see Fig. 2b) in the provinces of North Kazakhstan, Kostanay, Akmola and Pavlodar has shown an increasing trend over the time period. The maximum increase was shown by North Kazakhstan (56.75 thousand hectares/year, $R^2=0.881$) followed by Kostanay (30.64 thousand hectares/year, $R^2=0.927$), Akmola (24.01 thousand hectares/year, $R^2=0.830$) and Pavlodar (6.615

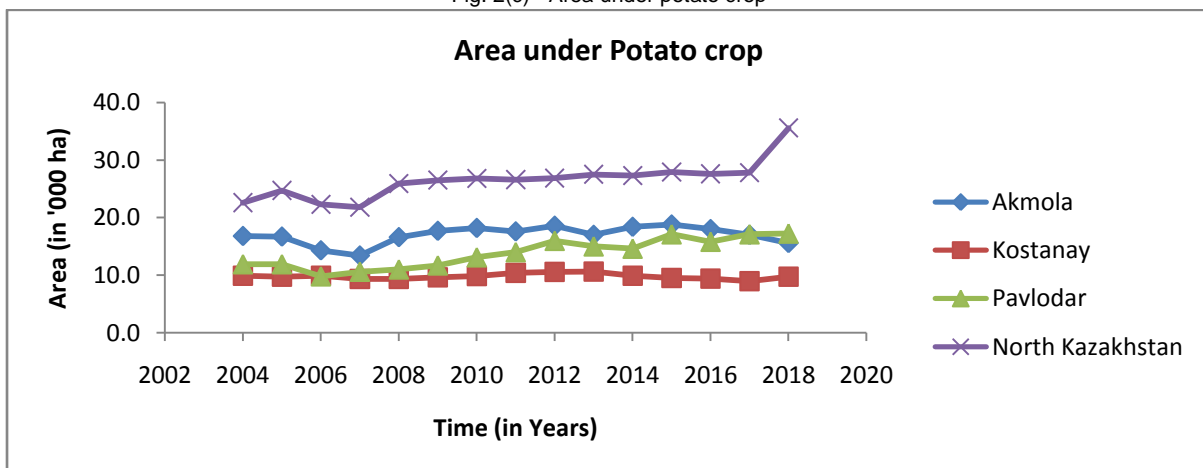
thousand hectares/year, $R^2=0.347$). The area under the potato crop (see Fig. 2c) in all the four selected provinces has remained more or less constant over the time period of 15 years. There has been a slight increasing trend shown by North Kazakhstan, Akmola and Pavlodar and a slight decreasing trend by Kostanay.

Fig. 2(b) - Area under sunflower and olive cultures



Source: Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics

Fig. 2(c) - Area under potato crop



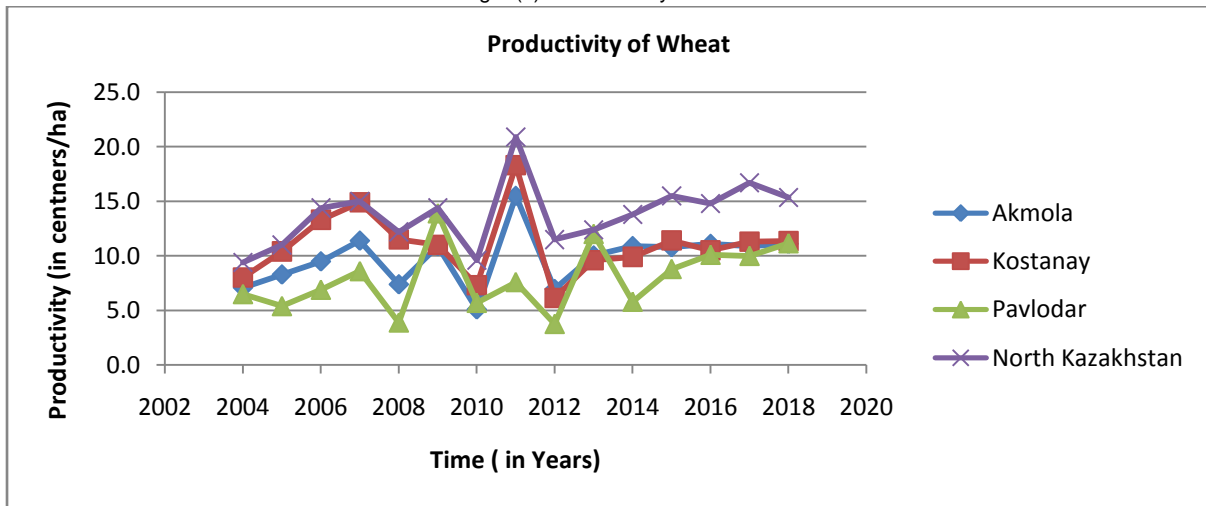
Source: Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics

If we look at the area curve of the wheat crop (refer to Fig. 2a) all the four provinces have shown a dip from the past few years. This was in response to the crop diversification policy introduced by the Ministry of Agriculture (MOA) in the Northern Kazakhstan where the maximum concentration of wheat production is concentrated. In order to increase the profitability of the crops sown and retain the fertility of the soil the area was devoted to more forage and oilseed crops. Pavlodar has the most diversified agriculture among the four selected provinces of the Republic while as the Akmola province has the least

agricultural diversification. The diversification in Pavlodar was supported by the drier climatic conditions and the less fertility of the soil. The specialization of wheat in Akmola, Kostanay and North Kazakhstan was because of the demand for the wheat from the processing and exporting units.

Productivity of all the three crops has shown continuous inter-annual fluctuations. Average values for wheat productivity (Fig. 3a) for the four selected provinces have shown a variable character.

Fig. 3(a) - Productivity of wheat

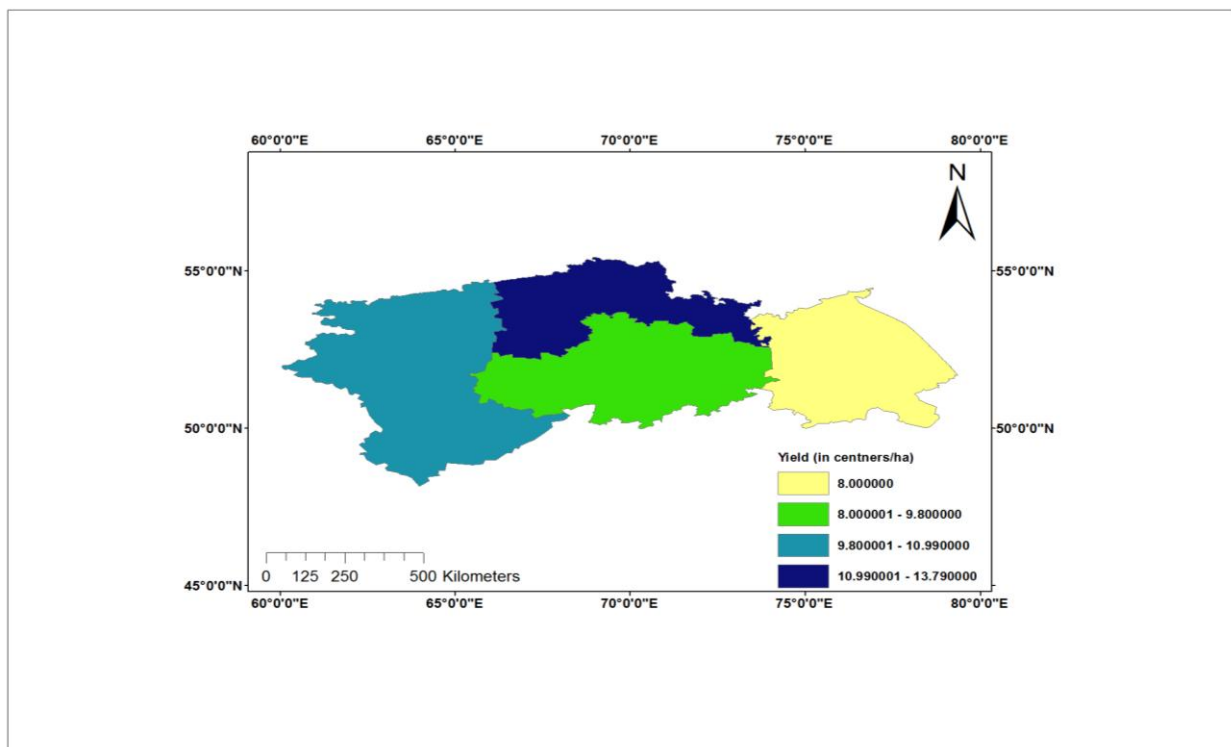


Source: Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics

The average values for the productivity of wheat crop have varied from 8 centners/ha to 13.79 centners/ha. The highest value of 13.79 centners/ha, a value above the national mean (11.06 centners/ha), was reflected by North Kazakhstan,

followed by Kostanay (10.99 centners/ha), Akmola (9.8 centners/ha) and Pavlodar (8 centners/ha). Fig. 4 (a) provides a spatial view of the variability of productivity of wheat grain across the Northern Kazakhstan.

Fig. 4(a) – Map showing spatial variability of mean wheat crop yield values for the study area

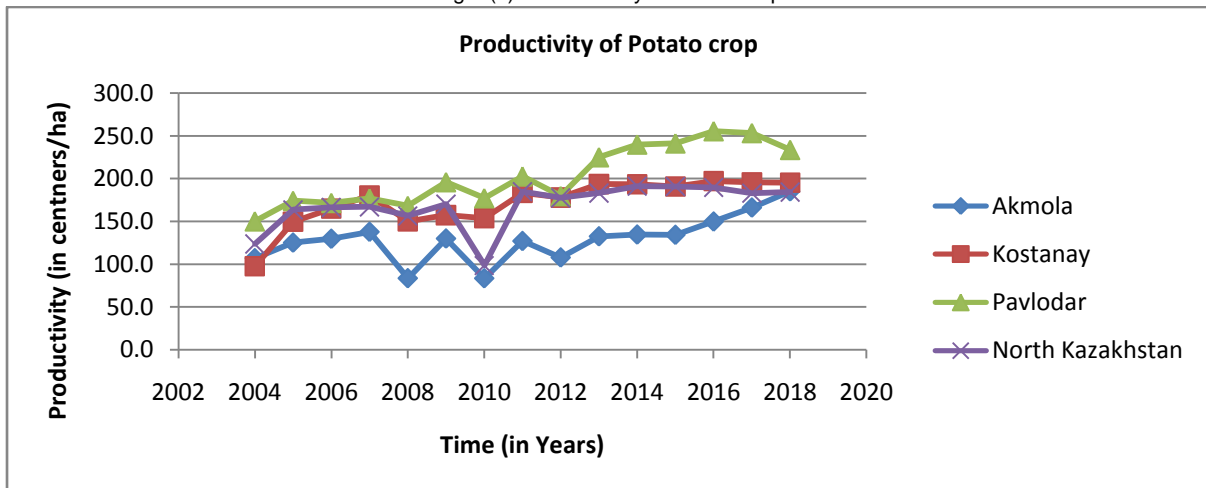


Source: Generated from ArcGIS 10.5

All the four provinces have shown an increasing trend (see Fig. 3b) for the yield of the potato crop. The steepest slope was shown by Pavlodar and the gentle slope by North Kazakhstan.

Productivity of potato crop has varied from an average value of 203.15 centners/ha to 129.06 centners/ha across the four selected provinces of the study area.

Fig. 3(b) - Productivity of Potato crop

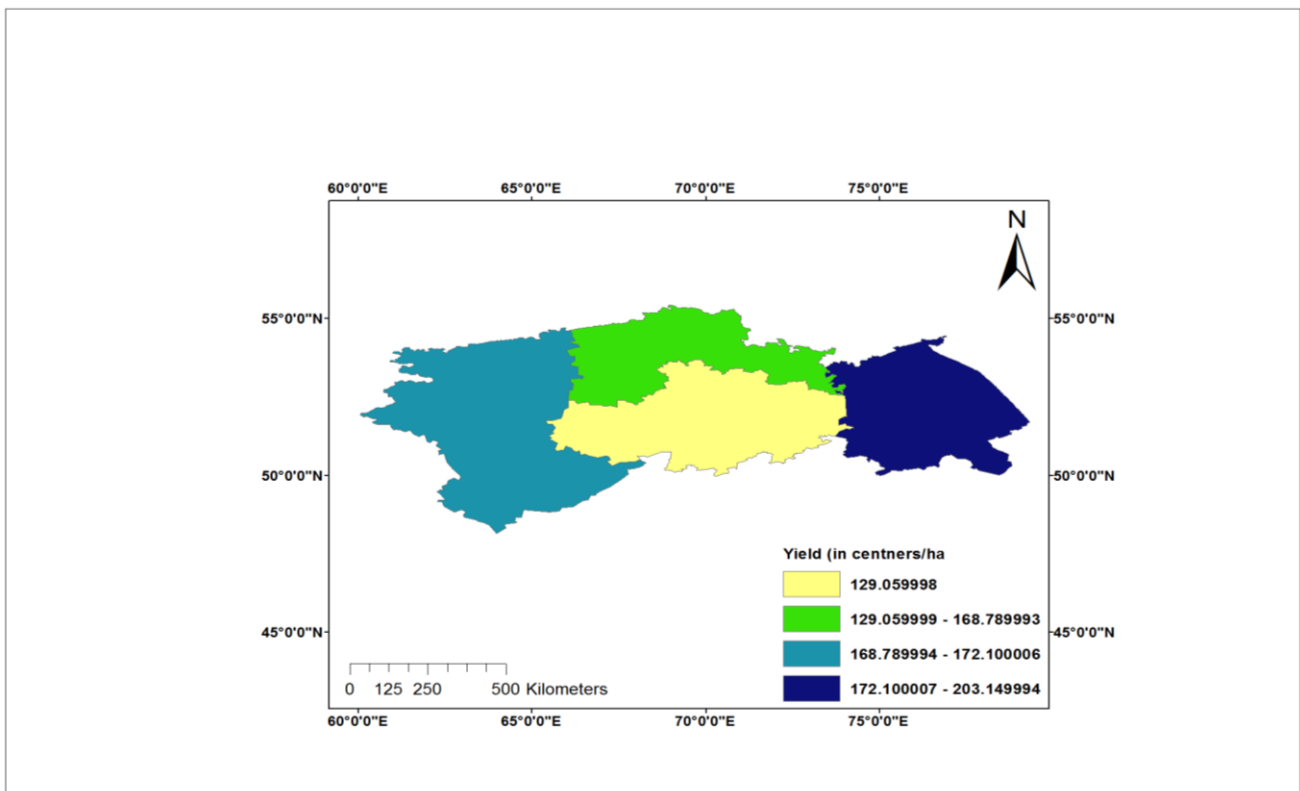


Source: Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics

Pavlodar, North Kazakhstan and Kostanay have productivity values greater than the national average (167.14 centners/ha) of the Republic for the potato crop. The least

value of 129.06 centners/ha was shown by Akmola. Spatial variation of the average potato crop yields across the four provinces is shown by the choropleth map (see Fig. 4b).

Fig. 4(b) – Map showing spatial variation of mean potato crop yield values for the study area

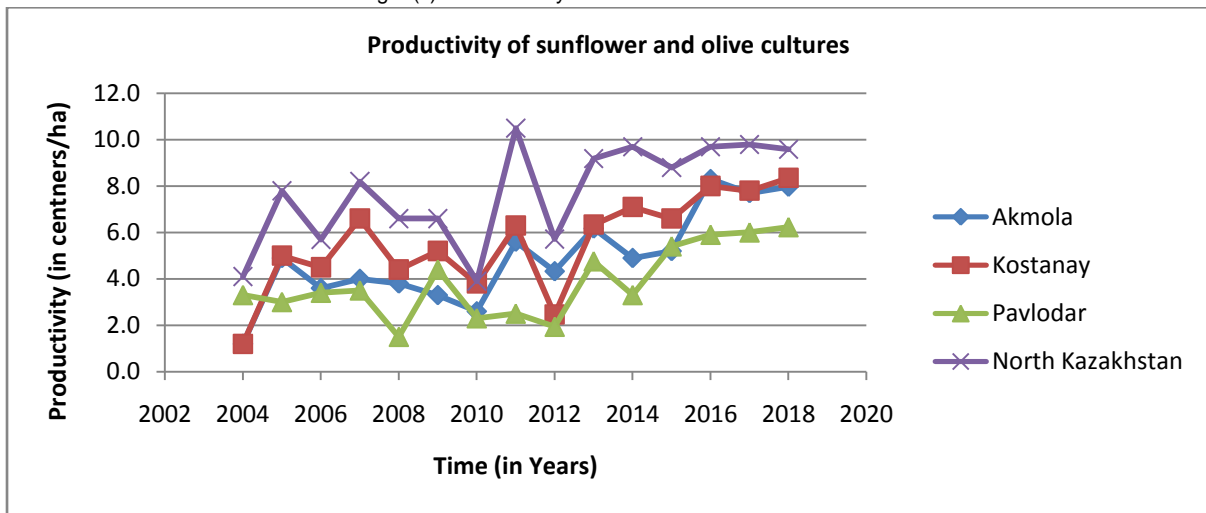


Source: Generated from ArcGIS 10.5

The yield for sunflower and olive cultures in all the provinces under study has shown an increasing trend for the

15 year time period. However the inter-annual fluctuations have been significant throughout the timeframe (see Fig. 3c).

Fig. 3(c) - Productivity of sunflower and olive cultures

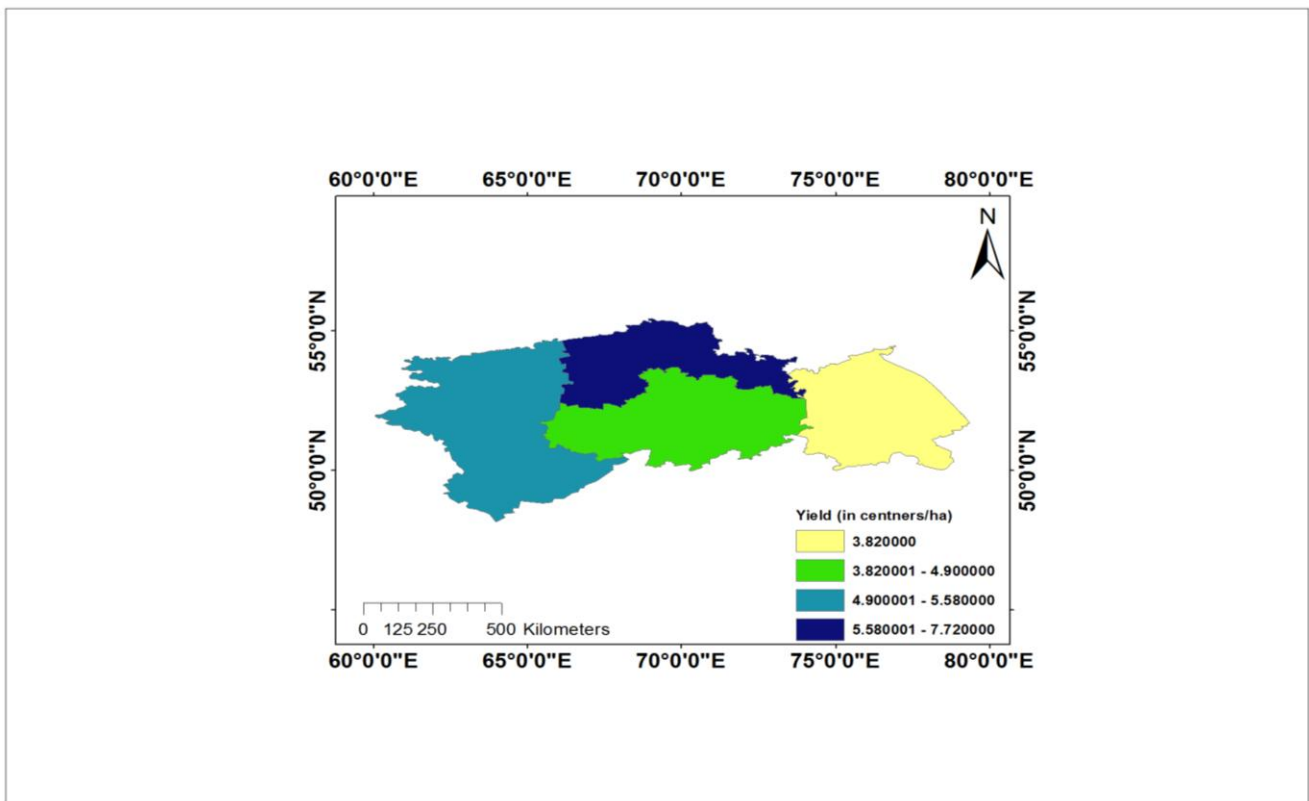


Source: Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics

The average values of the sunflower and olive cultures yield have varied from 3.82 centners/ha for Pavlodar to 7.72

centners/ha for North Kazakhstan. Fig. 4(c) shows the variation of these average values over the space under consideration.

Fig. 4(c) - Map showing spatial variation of mean sunflower and olive culture crop yield values for the study area



Source: Generated through ArcGIS 10.5

Agriculture in Northern Kazakhstan is an economic activity full of risks. The region falls in the Asian Arid zone (35°N-55°N and 60°E-120°E) receiving meagre precipitation averaging to about 250 mm per year with uneven distribution throughout the year. Since the agriculture is rain-fed and soil moisture is inadequate the cultivation of crops in such an environment becomes cumbersome. The area is vulnerable to droughts and is experiencing drought years at a frequency of around 2 out of 5 years. Thus Climate Change is considered as one of the most important factors restricting the improvements in the production and productivity of the various crops. Furthermore

the land has been depleted of its nutrients with the continuous cultivation of specialised crops like wheat in the region. In order to regain the lost fertility of the soil and neutralise the impacts from the climate change on crop production and yield the government of the Republic is suggested to take serious steps in framing policies that can benefit the agriculture sector of the Republic and make it a food secure nation.

5. Conclusion

Akmola and Kostanay provinces of the study area showed an overall increasing trend for the area under wheat crop while

North Kazakhstan and Pavlodar showed a negative trend during the time period of 15 years. However from the past few years the area under the wheat crop has declined in response to the crop diversification policy introduced by the Government of the Republic in Northern Kazakhstan. The area under sunflower and olive cultures has continuously increased in order to bring more land under the oilseed cultivation. The area

under the potatoes has remained more or less constant for all the four provinces of the study area. Continuous inter-annual fluctuations in the productivity of all the three crops for all the four provinces of the study area have been observed during the selected time frame. Average yield values for all the three crops have shown significant spatial variations in the study area.

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