TECHNICAL REPORT

KAZAKHSTAN YIELD REPORT

AUGUST 2014

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Engility Corporation Contact:
Glen Anderson, Chief of Party, Glen.Anderson@EngilityCorp.com
Engility Corporation
1320 Braddock Place
Alexandria, VA 22314

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Prepared by:

WeatherPredict Consulting Inc.

Raleigh, North Carolina

Contact: Michael E. Cote, Engility Corporation, Michael.Cote@EngilityCorp.com

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ACRONYMS

BWI	Basist Wetness Index
DMSP	Defense Meteorological Satellite Program
NOAA	National Oceanic and Atmospheric Administration
PD	Probe Data
SAR	Synthetic Active Radar
SSMI	Special Sensor Microwave Imager
WI	Wetness Index

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Percent variation from the trended Yield as of August 2014

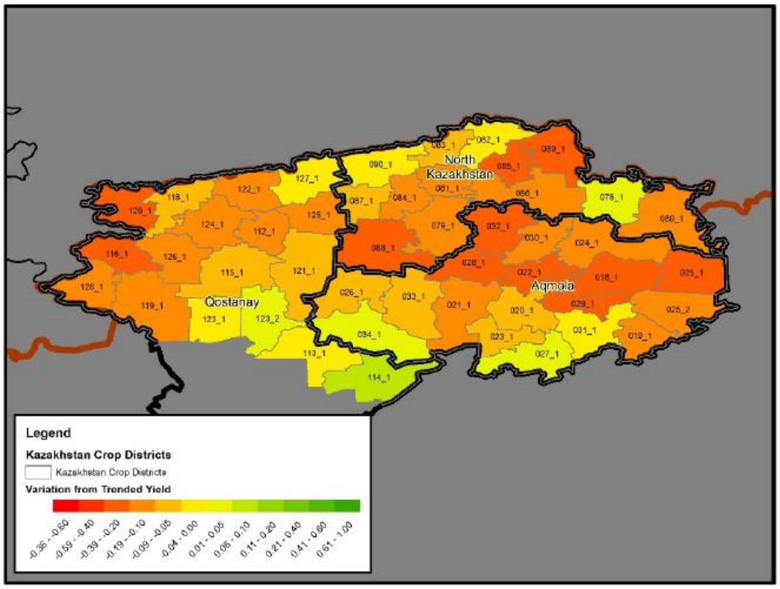

Figure 1a. Percent variation from the trended yield at the oblast resolution.

Predicted Yield as of August 2014

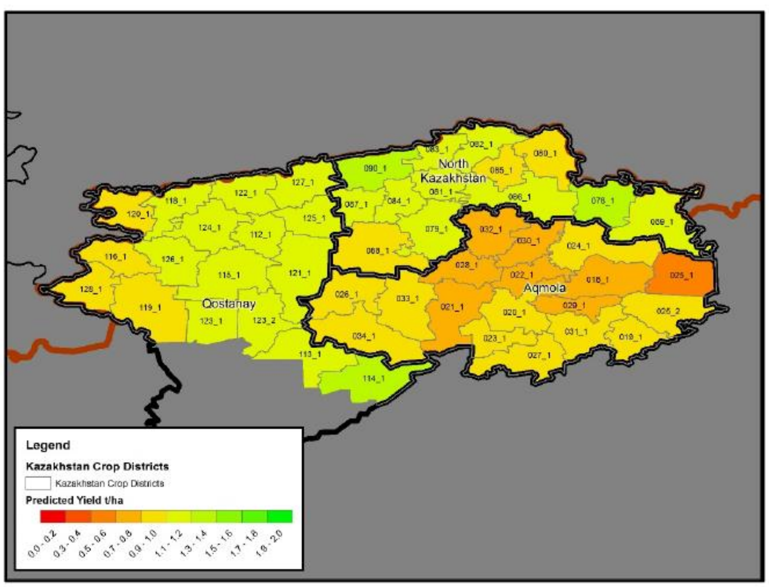

Figure 1b. Predicted production in spring wheat in mt/ha.

This report provides a yield prediction of spring wheat in Northern Kazakhstan as of August 24, 2014. It is based on satellite derived wetness and temperature anomalies measured by microwave instruments known as the Special Sensor Microwave Imager (SSMI). This series of satellites has been flown under the U.S. Department of Defense - Defense Meteorological Satellite Program (DMSP) in collaboration with the National Oceanic and Atmospheric Administration (NOAA) since 1988 and continues to provide measurements in near real-time.

The period of record serves as the foundation to calibrate yield prediction models. Monthly values of wetness and temperature anomalies serve as predictor variables in the regression equation. Since temperature and wetness do not work in isolation, but interact to promote drought or flood in many areas of the world, we attempt to simulate this interaction. Therefore, the models also contains a quadratic (interactive term) that allows these variables to become more than the sum of their individual influences.

The model is calibrated on the historic yield record provided by the Kazakhstan government. These data are used to predict yields during the middle and latter stages of the growing season in 2014. This report is the third in a series crop prediction models. There was a prediction at the end of June and July and the prediction at the end of August is the final number.

This report begins with a review of the crop's development. June was warm and dry, with some periods of severe heat in many areas, which introduced stress in the crop. In July, temperatures were exceedingly cold, which limited growth. July also brought an increase in precipitation, which improved the yield potential. August brought warmer and drier weather to the region and this limited crop development and potential yields. July and early August are traditionally the most important periods of the growing season.

Figure 1A shows the distribution of yield relative to average yield over the period of record. The region of northern Kazakhstan is a mosaic of color with the majority in shades of orange, which implies below average yields. Yellow values are average. While increasing shades towards dark red represent the lowest yields. There are some scattered areas of light green, which represents slightly above average yields. The lower values are in northern and western Akmola where extreme heat in June occurred (dark orange). Meanwhile, southern Kostanay had the highest yields (light green).

Predicted yield is displayed in figure 2B, showing the lowest yields near Akmola and the highest in Kostanay. Values ranged from 0.6 mt/ha in far eastern Akmola and increased to values over 1.4 mt/ha in some areas in Kostanay. North Kazakhstan had a mixture of yields and were predominately below average.

The wetness anomaly at the oblast resolution is shown in figure 2A. Some areas in Akmola did have above average upper level soil moisture in August. However, it appears that the moisture could only reduce the losses from early in the growing season. Otherwise there is a distributed pattern of slight below average moisture with some areas above average.

The temperature anomaly for August is shown in figure 2B. It illustrates the majority of the growing area had above average temperatures. The largest anomalies were in Akmola, while Kostanay was nearly as warm. Most of Northern Kazakhstan was also warm and there were some milder temperatures.

SSMI Wetness Anomaly as of August 2014

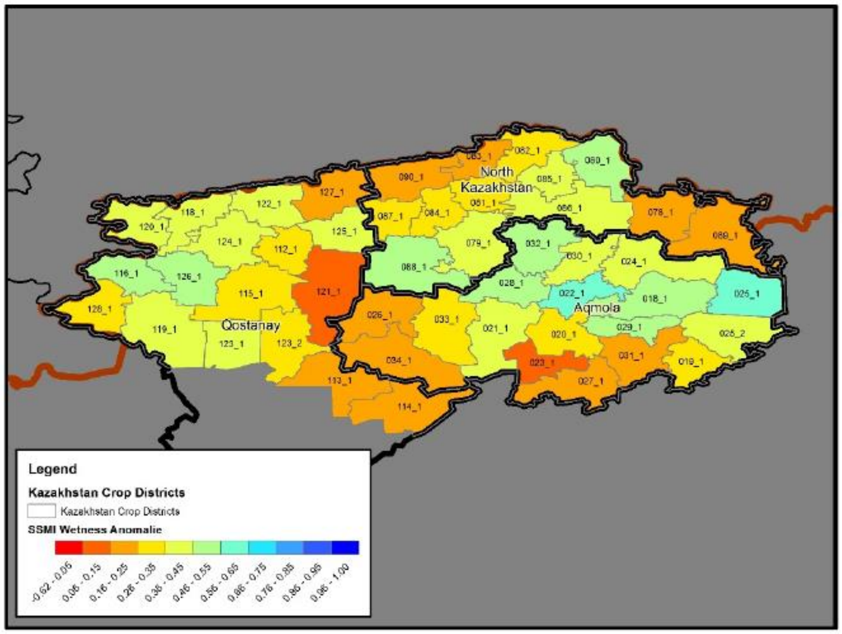

Figure 2a. Surface wetness for August 2014.

SSMI Temperature Anomaly as of August 2014

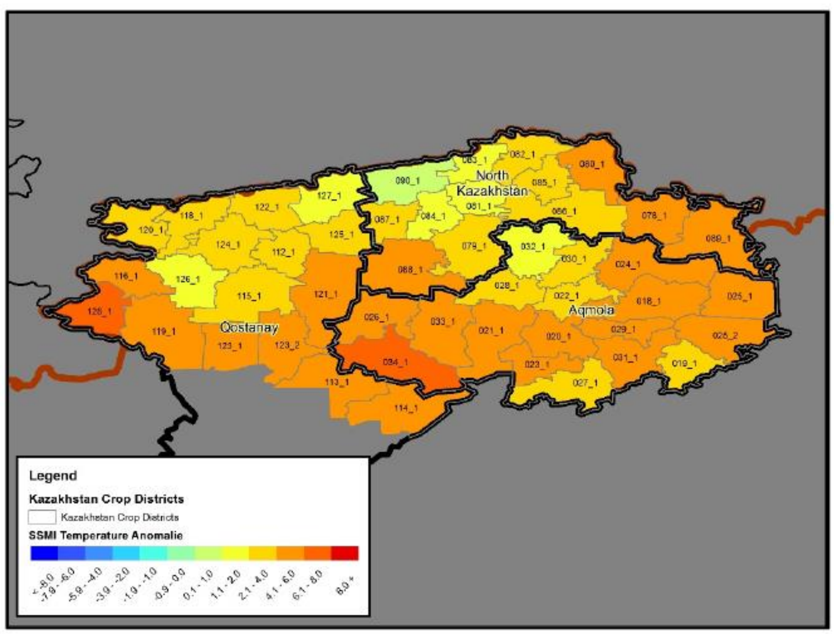

Figure 2b. Surface temperature for August 2014.

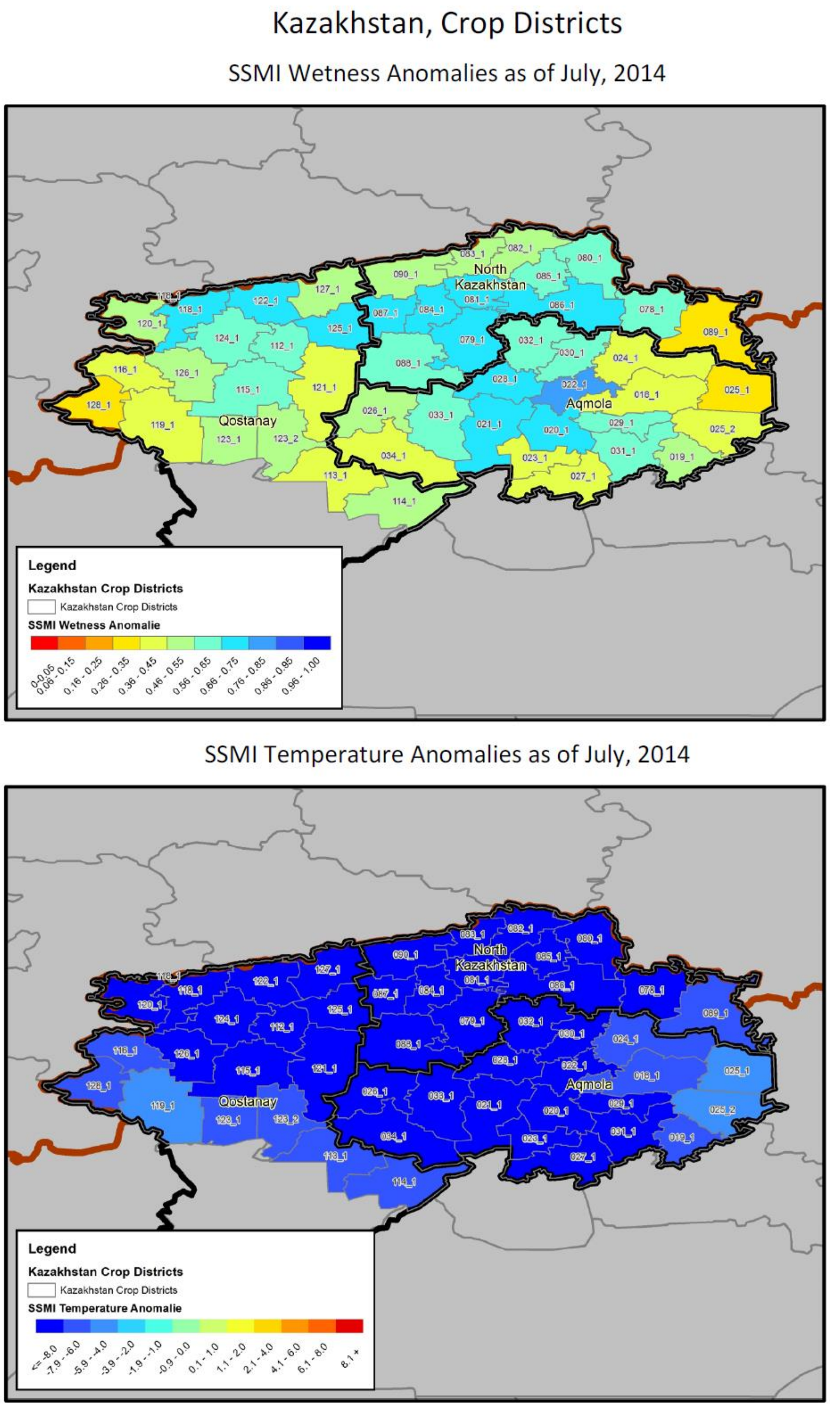

Figure 3a (top). Surface Wetness for July 2014.

Figure 3b (bottom). Surface temperature for July 2014.

Many oblasts were wetter (figure 3a) in July. The moisture therefore benefited crops, which had experienced adversity early in the season. The dry areas in the far eastern oblasts had some of the lowest predicted yield at the end of August. Figure 3b shows that entire area was much colder than average. Most of the area was more than 8 degrees Celsius below average. These temperatures may have retarded growth in the crop by severely lowing cooling degrees days.

Predicted Yield for Kazakhstan Spring Wheat in 2014 by Crop Region						
Input data for model ends on August 24, 2014						
State	**GeoID**	**Slope**	**Intercept**	**Pred Yield**	**Trend Yield**	**Percent Variation from Trended**
	Crop Region	mt/ha	mt/ha	mt/ha	mt/ha	
Aqmola	02	0.00	0.90	0.84	0.94	-10.1%
North Kazakhstan	07	0.00	1.23	1.13	1.26	-10.5%
Qostanay	10	0.00	1.13	1.12	1.16	-4.2%

Figure 4. Model derived predictions for spring wheat yields at the end of August 2014.

Figure 4 lists the three oblasts and conveys information about their predicted yield based on the 2014 growing conditions and the regression equation. The slope value is only listed to the second decimal point. This is enough indication that there is only a nominal trend of yield over the period of record used for calibration of the model. The intercept of .90 shows during the first year of record 0.9 metric tons per hectare were expected. The predicted yield is the model derived yield at the end of August 2014. Kostanay had slightly below the trended yield at 1.12 mt/ha. The other two oblasts had yield around 10% below the expected value and averaged together are around 1 mt/ha.

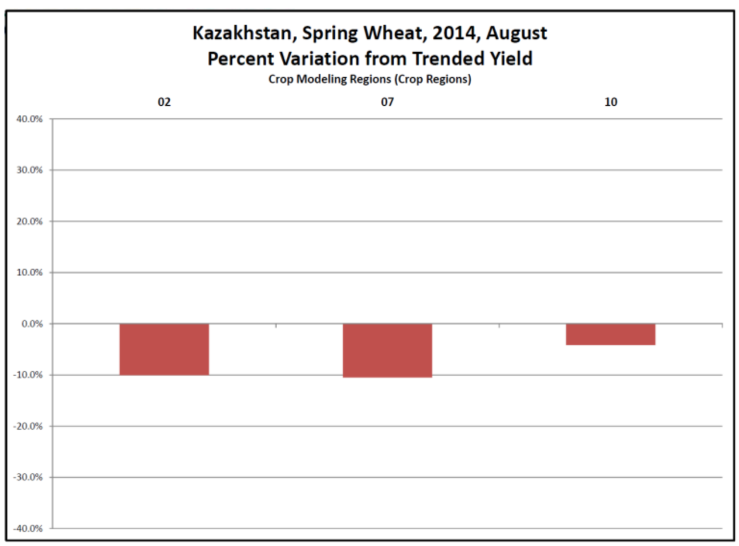

Figure 5. Deviation from trended yield at end of August 2014.

Figure 5 is a graphical display of the magnitude above the expected yield as derived by the model. Each of these bars represents different oblasts. The bar on the far left represents Akmola, the middle bar represents North Kazakhstan, and the far right bar represents Kostanay. All three of these bars show negative yields. Kostanay's yields are near normal.

Statistical Model Output for Kazakhstan			
Spring Wheat in 2014 (Selected Oblasts)			
Country		**Kazakhstan**	
State		**Kazakhstan crop regions**	
# observations	42	Adjusted R-squared	0.66
# variables	13	Prob (F-statistic)	-
degrees of freedom	28		
Variables	Coefficients () negative values	Significance (in Percent Probability)	Significance @ 90%
Constant	0.08	16.6%	
Temp May	0.02	74.3%	
Wet May	(0.07)	11.2%	
Interact May	(0.00)	35.4%	
Temp Jun	0.01	32.1%	
Wet Jun	0.01	1.7%	
Interact Jun	(0.00)	73.5%	
Temp Jul	(0.04)	95.7%	X
Wet Jul	0.96	95.9%	X
Interact Jul	0.00	89.3%	
Temp Aug	(0.06)	97.4%	X
Wet Aug	(0.97)	99.1%	X
Interact Aug	0.00	3.5%	

Figure 6. Model derived parameters and yield predictions.

Figure 6 lists the model statistics for the regression equation. These values show the skill of the model as well as the significance of the various predictor variables. Starting from the top left, the graph indicates that there are 42 independent observations and 13 variables used in the regression equation. Therefore there are 28 degrees of freedom in the model. The predicted skill of the model is shown by the adjusted R Square value of 0.66, which means 66% of the variability in yield is explained by the predictor variables. The lower two thirds of the plot lists the coefficients (beta) for the various predictor variables, and the parentheses indicate that the coefficient is negative. The significance value indicates the importance of the variable in the model. The column on the far right has an X if the variable is significant at the 90%, or greater, confidence level. The two variables that are most significant are July and August for both temperature and wetness.

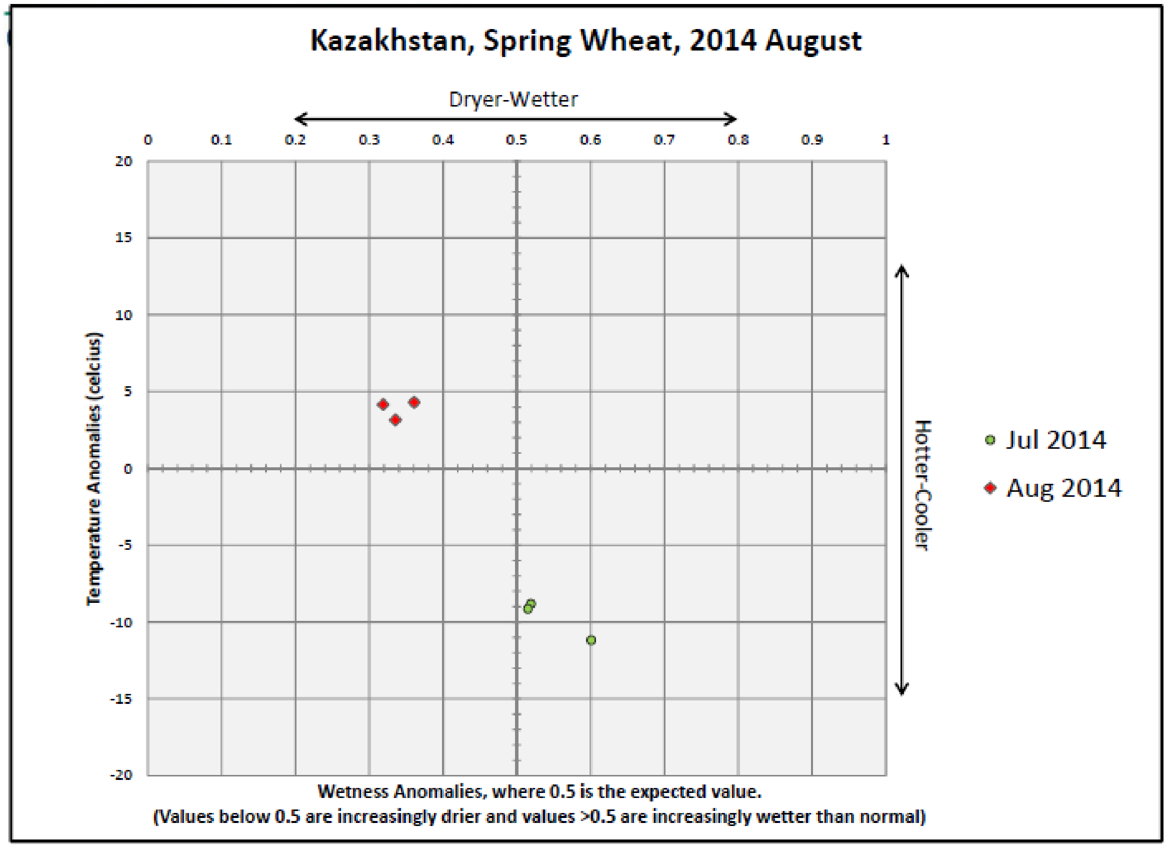

Figure 7. The graphical representation of the wetness and temperature anomalies for the month of June (green) and July (red) relative to average.

Figure 7 is an XY plot that graphically displays the relationship and interaction of temperature and wetness during June and July 2014. The green dots represent the wetness and temperature interaction of each oblast during the month of July, while the red dots represent the oblasts during the month of August. In addition, June was very dry (not depicted on the graph). July wetness was slightly above average, while temperatures averaged about 10°C below the expected value. During August the temperature rose above average and the upper level soil moisture was below average, which had a detrimental influence on the expected yields.

U.S. Agency for International Development

1300 Pennsylvania Avenue, NW

Washington, DC 20523

Tel: (202) 712-0000

Fax: (202) 216-3524

www.usaid.gov