Talgat Kussainov[1], Baurzhan Tolysbayev[2], Ermek Abilmazhinov[3]

FARMING SYSTEMS AND GRAIN PRODUCTION CONDITIONS IN THE NORTHERN KAZAKHSTAN

In this paper the calculations have been made to estimate the correlation between production, including hydrothermal and grain yield indices. As a result of this estimation, only the most significant factors have been included in the econometric model. Considerable inconsistency has been discovered in the correlation dependence between grain productivity and hydrothermal indices in the years before the 1990s and afterwards (due to changes in economic and climatic conditions, as well as in the use of production technologies).

Keywords: *farming system; agricultural technology; economic feasibility; weather conditions; Northern Kazakhstan.*

Талгат Кусаінов, Бауржан Толисбаєв, Ермек Абільмажінов

СИСТЕМА ЗЕМЛЕРОБСТВА І УМОВИ ВИРОБНИЦТВА ЗЕРНА В ПІВНІЧНОМУ КАЗАХСТАНІ

У статті проведено розрахунки для оцінювання зв'язку виробничих, в т.ч. гідротермічних, показників і врожайності зернових з метою оцінювання та відбору найбільш важливих факторів для включення в економетричну модель. Виявлено суттєві відмінності в кореляційному зв'язку між урожайністю зернових і гідротермічними показниками в період до 1990-х рр. і після (що пов'язано зі змінами в економічних і кліматичних умовах, а також застосовуваних технологіях виробництва).

Ключові слова: *система землеробства; сільськогосподарська техніка; економічна доцільність; погодні умови; Північний Казахстан.*

Форм. 2. Табл. 2. Літ. 17.

Талгат Кусаинов, Бауржан Толысбаев, Ермек Абильмажинов

СИСТЕМА ЗЕМЛЕДЕЛИЯ И УСЛОВИЯ ПРОИЗВОДСТВА ЗЕРНА В СЕВЕРНОМ КАЗАХСТАНЕ

В статье проведены расчеты по оценке связи производственных, в т.ч. гидротермических, показателей и урожайности зерновых с целью отбора наиболее важных факторов для включения в эконометрическую модель. При этом обнаружены существенные различия в корреляционной связи между урожайностью зерновых и гидротермическими показателями в период до 1990-х гг. и после (в связи с изменениями в экономических и климатических условиях, а также применяемых технологиях производства).

Ключевые слова: *система земледелия; сельскохозяйственная техника; экономическая целесообразность; погодные условия; Северный Казахстан.*

Introduction. Crop cultivation technologies development should be treated in the context of broader concept of crop farming system which includes crop rotations and land cultivation methods as its major elements. These elements are inseparable from each other. It is generally accepted that the history of crop farming system development in the grain-producing region – the Northern Kazakhstan – got started in the middle of the 1950s when the so-called "virgin lands campaign" was launched and millions of hectares of new lands were plowed up. In 1990 grain crops took up 23.8 mln ha, from which 13.3 mln ha were occupied by spring wheat. In doing so, in the

[1] S. Seifullin Kazakh Agrotechnical University, Astana, Kazakhstan.
[2] L.N. Gumilyov Eurasian National University, Astana, Kazakhstan.
[3] Shakarim State University of Semey, Kazakhstan.

Northern Kazakhstan there were 14.8 mln ha under grains, including 10.2 mln ha allocated for spring wheat. At the same time, it should be noted that grain production in the region has much longer history: for instance, in 1940 grain crops took 5.8 mln ha, spring wheat occupying 3.2 mln ha (National economy..., 1990).

Literature review. Similar studies and calculation methods on the impact of production conditions on wheat productivity level were carried out by (Nagy and Sanders, 1990; Morgounov et al., 2005). Different studies have assessed impacts of climate change on wheat productivity. C.W. Knight et al. (1978) analyzed the potential for wheat production in various regions of Alaska on the basis of air temperature. M. Ashfaq et al. (2011) came to the conclusion that climate change is the major determinant of wheat productivity at each stage of wheat growth. Majority of the existing methods are dedicated to labour productivity calculations as such and to its dynamics. At present the following researchers are studying the impact of production practices on labour productivity in Kazakhstan and throughout the Central Asian states: (Shegebaev, 1997; Baydildina et al., 2000; Meng, 2000; Morgounov et al., 2007). Peer-reviewed journals have a small number of publications that touch upon the research question one way or the other; it is necessary to point out the first of all the following works (Griffith et al., 1995; De Beurs and Henebry, 2004, Kussainov et al., 2015).

The purpose of the paper is to study crop farming system development in the Northern Kazakhstan and to examine the impact of changing production conditions (specifically weather conditions and production practices) on the wheat productivity level.

Methods. An econometric model to examine the impact of technology on wheat productivity has been constructed.

The relation between wheat productivity and production factors in this numerical research model includes the following important variables:

1. Quantitical variables – precipitation from October to July and the temperature regime in June.

2. Categorical variables – growth technology (including used classes), which is included in the model as a binary variable, taking 1, if used, and 0 if not used in any of the analytical periods (Kussainov et al., 2015).

Formally this model looks like:

$$Y = b_0 + \sum b_i X_i + \sum b_j T_j, \quad (1)$$

where Y – crop productivity, centners per ha; X_j – quantitical variables depended on natural conditions and resource costs (precipitation and temperature regime); T_j – categorical variables (cultivation technologies used); b_0, b_i, b_j – parameters (coefficients) of the model.

The parameters b_i with the quantitical variables X_i show the value of wheat productivity change Y depending on the change of the value of corresponding factors per unit. The parameters b_j with the variables T_j confirm the change in wheat productivity level Y when using the corresponding wheat growth technology (Kussainov et al., 2015).

Results. Evaluation of parameters and calibration of the relationship model (1) under conditions of "Rodina" LLP, located in the Zelinogradsky district of

Akmolinskaya oblast (province), has been carried out on the basis of the specified production data for 1971–2012. Related data is given in Table 1.

Table 1. **Parameters of the relationship model between wheat productivity and production factors in Agrofirma "Rodina" LLP** (Kussainov et al., 2015)

Item #	Factors	Values of parameters
1	Hydrothermal production conditions:	
1.1	Precipitation (October-July)	0.03
1.2	Temperature (June)	-0.88
2	Production technology:	
2.1	Intensive	0.47
2.2	Simplified	1.56
2.3	Minimized	3.51
3	Free coefficient	20.74

The econometrical relationship model in the numerical format takes the form:

$$Y = 20.74 + 0.47 \times IT + 1.56 \times ST + 3.51 \times MT + 0.03 \times P - 0.88 \times T, \qquad (2)$$

where IT – intensive technology; ST – simplified technology; MT – minimized technology; P – precipitation; T – temperature.

Multiple correlation coefficient is high enough (0.69); the determination coefficient is 0.47. The assessment of the relationship model according to Fisher's criteria shows that on the level of trust of 0.05 received equation is relevant and gives reliable enough results (the estimated rate $F_{est.}$ = 8.28 as compared to F_{table} = 2.42).

The results of the relationship model callibration, presented in Table 1, suggest the following: the increase of the total amount of precipitation from October to July by 1 mm from its average provides wheat productivity growth by 0.03 c/ha; the increase of air temperature in June by one degree from its average leads to crop productivity decrease by 0.88 c/ha; the transition to intensive technology in the early 80s led to wheat productivity increase by 0.47 c/ha in comparison with conservation tillage technology; simplified technology provided wheat yield growth by 1.56 c/ha in comparison with conservation tillage technology; the substitution of conservation tillage technology with minimized technology increases wheat productivity by 3.51 c/ha. The influence of various factors on wheat productivity formation is shown in Table 2.

Table 2. **Change of wheat productivity level under the alteration of production conditions in "Rodina" LLP (1971–2012)** (Kussainov et al., 2015)

New/old technology	Wheat yield growth, c/ha, subject to the change of:			Total growth	Wheat productivity under new/old conditions, c/ha
	precipitation	temperature	technology		
Intensive/No till	0.14	-0.81	0.47	-0.2	10.3/10.5
Simplified/Intensive	0.16	0.83	1.09	2.08	12.4/10.3
Minimized/Simplified	0.07	-1.01	1.95	1.01	13.4/12.4

It follows from Table 2 that on account of average annual precipitation in the period of using intensive technology, wheat productivity increased by 0.14 c/ha in comparison with conservation tillage technology; productivity decreased because of less favorable temperature (-0.81 c/ha), which had been compensated by productivity growth because of the use of a more progressive technology (0.47 c/ha); and the overall growth made up 0.2 c/ha, which means that average productivity in the period of intensification decreased from 10.5 c/ha to 10.3 c/ha in comparison with the conservation tillage technology application period (Kussainov et al., 2015).

After the transition from intensive to simplified technology, the average productivity increased by 0.16 c/ha because of the large amount of precipitation during the simplified technology application period; productivity increased by 0.83 c/ha because of the favorable temperature regime in June, and the use of simplified technology increased productivity growth by 1.09 c/ha; the overall growth made up 2.08 c/ha; and the average productivity during the simplified technology application period equaled to 12.4 c/ha (Kussainov et al., 2015).

During the minimal technology application period, wheat productivity increased by 0.07 c/ha because of high precipitation; productivity decreased because of a less favorable temperature regime (-1.01 c/ha), and new technology caused productivity growth by 1.95 c/ha; the overall growth made up 1.01 c/ha. The average productivity during the minimized technology application period equaled to 13.4 c/ha.

Conclusions. Currently, there is no clear understanding among Kazakh agricultural entrepreneurs that rational crop diversification requires a careful analysis of the covariance between economic outcomes from growing different crops. Moreover, producers' attitude to risk should be taken into account when making business decisions (Hardacker et al., 2004; Lien and Hardaker, 2001; Schoney et al., 1994; Kussainov, 2003). Taking into account these factors in decision-making allows determining a rational crop structure which ensures greater income stability. It is noteworthy that the optimal crop structure changes when shifting from one technology to another. The possibility of an economically unacceptable outcome is significantly reduced when using resource-saving technologies (Kussainov and Volkov, 2014). It is becoming obvious for Kazakh farmers that when selecting crops for cultivation it is necessary to proceed, first of all, from actual market prospects and the potential economic benefits.

It should also be noted that the economic feasibility considerations dictate the need to test new technologies and crop rotations at experimental fields of research institutions only after thorough economic analysis of crops structure and combination are held. This approach ensures practical usefulness and relevance of the experiments.

Acknowledgments. *The authors would like to thank several organizations and researchers who helped make this paper a reality. Namely, the authors are indebted to the staff of the Kazakh Grain Farming Research Institute (Shortandy), special thanks go to Kanat Akshalov, for their comments and suggestions. The encourager force behind the paper has been Raushan Bokusheva from the Swiss Federal Institute of Technologies (Zurich). We are also grateful to professionals at Kazakh Agrotechnical University (Astana) for their close cooperation in preparing the paper, namely Renat Karipov, Professor of Agronomy Faculty, and Mubarak Aduov, Professor of Technical Faculty.*

References:

Кусаинов Т.А. Управление устойчивостью агроформирований: теоретико-методические аспекты (на материалах Республики Казахстан): Дис... докт. экон. наук. — Астана, 2003. — 227 с.

Кусаинов Т.А., Волков И.В. Диверсификация растениеводства как фактор стабилизации сельскохозяйственных доходов: методические аспекты оптимизации структуры и сочетания посевов // Балтийский гуманитарный журнал.— 2014.— №4. — С. 132—135.

Народное хозяйство Казахстана за 70 лет: Стат. сборник / Ред. М.К. Абдрахманова. — Алма-Ата: Казахстан, 1990. — 392 с.

Ashfaq, M., Zulfiqar, F., Sarwar, I., Quddus, M.A., Baig, I.A. (2011). Impact of climate change on wheat productivity in mixed cropping system of Punjab. Soil and Environment, 30(2): 110—114.

Baydildina, A., Akshinbay, A., Bayetova, M., Mkrytichyan, L., Haliepesova, A., Ataev, D. (2000). Agricultural policy reforms and food security in Kazakhstan and Turkmenistan. Food Policy, 25(6): 733—747.

De Beurs, K.M., Henebry, G.M. (2004). Land surface phenology, climatic variation, and institutional change: Analyzing agricultural land cover change in Kazakhstan. Remote Sensing of Environment, 89(4): 497—509.

Griffith, G.R., Vere, D.T., Bootle, B.W. (1995). An integrated Approach to Assessing the Farm and Market Level Impacts of New Technology Adoption in Australian Lamb Production and Marketing Systems: the Case of Large, Lean Lamb. Agricultural Systems, 47: 175—198.

Hardacker, J.B., Huirne, R.B.M., Anderson, J.R., Lien, G. (2004). Coping with risk in Agriculture. CAB International, Wallingford.

Knight, C.W., Wooding, F.J., Lewis, C.E. (1978). Relationships between temperature and wheat adaptation in Alaska. Agronomy Abstracts 11.

Kussainov, T.A., Maitah, M., Kurmanov, N.A., Hajek, P., Tolysbaev, B.S., Baidakov, A.K. (2015). Economic Analysis of the Impact of Changing Production Conditions on Wheat Productivity Level. Review of European Studies, 7(11): 125.

Lien, G., Hardaker, J.B. (2001). Whole-farm planning under uncertainty: impacts of subsidy scheme and utility function on portfolio choice in Norwegian agriculture. European Review of Agricultural Economics, 28(1): 17—36.

Meng E., Longmire, J., Moldashev, A. (2000). Kazakhstan's wheat system: priorities, constraints, and future prospects. Food Policy, 6: 701—717.

Morgounov, A., Braun, H.J., Ketata, H., Paroda, R. (2005). International cooperation for winter wheat improvement in central Asia: results and perspectives. Turk. J. Agric. For., 29: 137—142.

Morgounov, A., Rosseeva, L., Koyshibayev, M. (2007). Leaf rust of spring wheat in Northern Kazakhstan and Siberia: incidence, virulence, and breeding for resistance. Crop and Pasture Science, 58(9): 847—853.

Nagy, J.G., Sanders, J.H. (1990). Agricultural technology development and dissemination within a farming systems perspective. Agricultural Systems, 32: 305—320.

Schoney. R.A., Taylor, J.S., Hayward, K. (1994). Risk Reduction from Diversification and Crop Insurance in Saskatchewan. In: Economics of Agr. Crop Insurance: Theory and Evidence. Ed. Darrell L. Hueth and William H. Furtan (pp. 293—305). Norwell. MA: Kluwer Academic Publisher.

Shegebaev, O.S. (1997). Scientific support for spring wheat production in Kazakhstan (pp. 24—30). Eds. A. Morgounov, A. Satybaldin, S. Rajaram and A. McNab. Spring Wheat in Kazakhstan: Current Status and Future Directions. Mexico, D.F.

Стаття надійшла до редакції 13.10.2015.