UDC 338.436

A.M. Kabdulsharipova, S.N. Suieubayeva, G.I. Dzhempeisova

D.Serikbaev East Kazakhstan State Technical University, Ust-Kamenogorsk
(E-mail: Suyeubaeva@mail.ru)

Optimization the production and processing of agricultural production in horizontal-integrated system

Effective development of agro-industrial complex of Kazakhstan in the conditions of the competitive pressure and external social and economic threats isn't possible without implementation of new system forms of the organizational decisions which are based on the principles of integration and cooperation. The article substantiates the need for horizontal integration of agricultural production. Optimization of process of a feed production as main technological process in livestock production is offered. Calculations for optimization of the main technological process, namely, a forage production which purpose is security of livestock production with various sterns are carried out: mineral, vegetable and animal origin. The model of the horizontally integrated business process of production of grain was calculated on the basis of imitating modeling. The optimum plan is received as a result of optimizing calculations with application of a simplex method of linear programming. The integrated production of agricultural production is the effective solution of recovery from the crisis of agrarian sector of economy.

Key words: horizontal integration, agricultural production, optimization the production, a simplex method of linear programming.

Development of integration of agricultural production is one of the main factors that have a significant impact on the efficiency of the agricultural enterprises and increasing their organizational and economic and financial stability. A special role in the restructuring of the economy of Kazakhstan is given to new forms of flexible integration to organizational management, which created a vicious cycle: production - processing - realization, so that processors avoided price pressures, trade, and numerous commercial intermediaries [1]. Therefore, one of the most effective ways to rationalize agricultural production and the integration of the production to other industries and sectors. The tendency of such systems in the form of agricultural holdings in the CIS economies are characterized by generally large states, primarily Russia, Kazakhstan and Ukraine. However, it should be noted that the controversial issues remain related to the formation and development of horizontally-integrated structures of the agricultural sector in different regions. From this perspective, the practical issues of formation and development of industrial organizational mechanism of integration in a particular region is relevant, and of scientific interest.

Integrated production of agricultural products on the horizontal «vector» involves pooling of farms (CH) on the example of two specializations: livestock and grain production. For example, the farm, the main activity of which is directed to the production of crops, certainly has some potential in livestock. To develop this trend to significant volumes have been marginal, and suggests a solution to bring together the resources available with the farm specializes in breeding. Attraction of additional resources by integrating with farm where livestock production is not the main business process, opens up new possibilities in expanding production.

At the first stage in livestock production let's make calculation for optimizing the primary process, namely, feed production, the aim of which is to provide a variety of animal feed: mineral, vegetable and animal origin. Feed the first two groups — it just agricultural products or the result of its processing (fodder, starch wastes, fish, meat industries, etc.). For feed of animal origin include milk and its waste (whey, butter), meat, fish, bone meal and others. Foods of plant origin are divided on the composition of the following four groups: concentrates (grain and grain products, animal feed, oil cakes, meal, etc.), coarse (hay, straw, silage), green (grass and pasture feeding), juicy (silage, root vegetables, potatoes, melons, etc.) [2].

The most common in East Kazakhstan silage-hay, silage, and silage concentrated type of feeding cattle. When silage hay-feeding type depending on the milk production rate of roughage (hay generally) may be from 17 to 40 % of the total nutritional diet [2]. With increasing milk production of cows specific weight silage and hay (nutritionally) in the diet decreases and increases the amount of concentrated feed. The diet of highly concentrated feed cows make up 40–45 % of the total nutritional value [3]. Calculate optimal diet taking into account both economic and zootechnical requirements of traditional (including a variant) in complex ways, and with a large amount of factors considered virtually impossible. To this end, increasingly using modern mathematical methods, the dignity of which in finding the best solution under the given conditions.

The rate of growth of economic efficiency of feed production is largely dependent on how well and efficiently use existing resources and reserves, among which occupies an important place to improve the structure of sown areas of forage crops. Therefore, in each sector must be allocated the area under fodder crops, grassland and arable land for sowing forage crops, and considered as a single entity planning and organization of production of feed. The most effective is the production of perennial grasses for hay, haylage and silage maize cultivation. It is also possible to include in the feeding straw that remains after threshing commodity and feed grains. When preparing feed rations take into account the need for animals in nutrients, the presence of feed in the economy and their quality, as well as animal housing conditions.

Preparation of rations produced by feeding standards and the initial data farms EKR (Table 1).

Table 1

Requirement of feed for the cows in winter housing period (225days)

Type of feed	Requirement for 1 cow per day, kg	Requirement for all period, tons
Silage	15	2396
Haylage	4	639
Hay	5	799
Straw	3	479
Concentrates	1	160

Concentrated feed given to animals depending on productivity and nutrient content of the diet. When this ratio feed the cow will receive daily 6.8 feed unit instead of the required 6.6 and 680 grams of protein. Requirement of feed for bulls - producers in winter housing period is presented in Table 2.

Table 2

Requirement of feed for bulls - producers in winter housing period

Type of feed	Requirement per day, kg	Requirement for all period, tons
Silage	7	27
Haylage	3	11
Hay	7	27
Straw	1	4
Concentrates	3	11

The Table 3 presents general requirement for feed of livestock farming of this farm for the period of 2014–2015 years.

Table 3

General requirement for feed of livestock farming for the period of 2014–2015 years (from harvest to harvest)

Type of feed	Requirement for feed,tons	The size of reserve stock, %	Quantity of feed, tons
Silage	4582	30	5957
Haylage	1226	25	1532
Hay	1545	25	1931
Straw	913	25	1141
Concentrates	687	10	

Cultivation of forage crops for tractor-field team must be based on crop yields, which is due to a dry summer in some plant food was below average. Sown area by crop, size of food portions and yield in centners of fodder units per 1 hectare are given in Table 4.

Table 4

Sown area under different crops

Feed crops	The yield in centners of fodder units per 1 ha for teams		Sown area, hectare
	Team 1	Team 2	
Cornmeal	10 x_1	12 x_2	600
Grass for hay	14 x_3	18 x_4	650
Corn for silage	30 x_5	28 x_6	200
Grass for haylage	15 x_7	18 x_8	200
Total area, hectare	750	900	1650

Dimensions of not known area of each plot, which should take at a particular culture let's place in a cell in the same Table 4.

Collecting fodder in centers of feed units will be determined by the following objective function. (formula 1):

$$C(x) = 14\, x_1 + 16\, x_2 + 14\, x_3 + 18\, x_4 + 30\, x_5 + 28\, x_6 + 15\, x_7 + 18\, x_{8 \to \max} \quad (1)$$

Required to find the greatest value of this function under the following conditions (formula 2):

$$\begin{aligned} X_1 + X_2 &= 600, \\ X_4 + X_5 &= 650, \\ X_5 + X_6 &= 200, \\ X_7 + X_8 &= 200, \\ X_1 + X_3 + X_5 + X_7 &= 750, \\ X_2 + X_4 + X_6 + X_8 &= 900. \end{aligned} \quad (2)$$

As a result of optimization calculations using the simplex method of linear programming to obtain an optimal plan. Implementation of this plan will allow the company to receive the 35600 quintals of feed units at the planned area of 95 hectares. The company, in which one of the participants is specialized in plant growing, forage production and increased efficiency, as the cost of rearing a feed unit are reduced.

As you can see, to increase production efficiency it was enough to take the decision on the organizational integration on the horizontal level.

In conditions of high economic isolation enterprises in agriculture, of course, actual problems of rational use of mechanization. The most important task in this case is a substantiation of optimum machinery complexes and compositions tractor fleet (ICC) with the specific production and natural and economic conditions. The basic concept in the strategy to improve the efficiency of integration into the cereal production sector is cooperation machines and tractors park small farms formed during the mass privatization in agriculture. However, in spite of the prospect of the integration process, the mechanical formation of such structures can increase the efficiency of ITC, if not to take into account all the complex factors and specificity are present in this case. You must first examine the entire production and economic background to precedent, as well as, as noted above, the level and amount of horizontal and vertical integration should be scientifically substantiated by attracting apparatus of mathematical modeling and simulation.

To achieve this goal it is necessary to solve the following tasks:

– To develop a simulation model to optimize the structure and quality of technical support of machine-tractor fleet of CH on the basis of a new production - economic joints- machines and tractors complex (MTC);
– Present production and economic activities of the BCH database for earlier years in order to build forecasts, depending on the natural - climatic factors and the identification of data for simulation;
– Implement a computer experiment in order to optimize machines and tractors park.

The technological process of cultivation of crops begins in the spring with pre-cultivation, which determines the course of the subsequent process steps, as agricultural production is continuous. Numerous data CH indicates that the delay on the timing spring field work for various reasons, for one day against optimal timing shortage of grain on each hectare is 20–30 kg, while a delay of 6–8 days it increased to 3–4 CN [4]. Each economy should be interested in the quality of the spring sowing campaign, as it affects the productivity of crops.

In the studied farms processing is performed cultivators KPE-3.8 width of which is equal to 3.8 meters. The most frequent mistakes in conducting pre-processing - timeliness of operations, very shallow or too deep treatment, excessive looseness, and hence — the upper horizon of the soil, a large gap in time between operations, this leads to the sealing of seeds in a dry layer of soil and reduce germination.

In the fields of economy employs 11 field crop units. Their equipment technology is shown in Table 5 and Table 6, shows the dimensions of areas assigned to each link.

Table 5

Area, sawn feed crops by joints of КХ

Indicators	Joints											Total
	1	2	3	4	5	6	7	8	9	10	11	
Cereals:	-	1120	900	751	240	130	1576	1150	900	- -	1422	8187
Wheat	-	1120	900 -	751 -	240 -	130 -	1576 -	1150 -	900	- -	1422 -	8187
Buckwheat	-	150	-	-	-	-			-	-	-	150
Millet	-	-	-	-	40	-		-	-	-	-	40
Peas	-	-	-	-	-	-	95	-	-	-	-	95
Rye	286	-	-	-	-	-	-	118	-	-	105	509
Sunflower	90	380	400	525	413	200	500	4	240	210	430	3392
Corn	-	-	-	-	-	50	-	-	-	295	-	345
Total:	376	1650	1300	1276	693	380	2171	1272	1140	505	1957	12720

Table 6

Joints' facilities of agricultural equipment

Equipment mark	Joints											Total
	1	2	3	4	5	6	7	8	9	10	11	
Tractor: DT-75	1	-	1	1	1	-	-	1	1	1	2	9
MTZ-50	2	-	-	-	-	-	1	2	-	-	1	6
MTZ-80	2	-	-	1	2	1	4	3	2	3	1	19
T-40	5	2	1	1	1	1	7	4	2	1	3	28
К-701	-	-	-	-	-	-	1	1	-	-	1	3
К-700	-	1	3	2	-	-	1	2	-	-	1	10
Combine: «Niva»	1	2	6	3	-	-	-	1	3	1	3	20
«Enisey»	-	2	-	1	1	1	3	4	-	-	1	13
«Don»	-	1	-	-	-	-	1	-	1	-	-	3
«Hersony»	-	-	-	-	2	-	-	-	-	-	-	2
Cultivator: KPE-3,8				2	5	2	3	1	2	-	-	15
KPSH-5	-	-	-	-	-	-	6	5		-	-	11

Integrated farming includes two agricultural enterprises. If they operated separately, each would have on its balance sheet MTM, grain storage and contain labor. And because of it would have formed the corresponding costs for each enterprise, which are presented in Table 7. However, since they have structural units of the economy, there is no need to maintain two buildings MTM.

Table 7 shows the use of the ICC indicators. Improved utilization of existing tractors without additional investment will allow to increase the volume of mechanized operations reduce the time of their execution, raise the level of mechanization of labor-intensive processes, reduce production costs. Therefore, the ICC analysis of each sector is of great importance.

Table 7

Analysis of cost MTP, tengue

Indicators	Enterprise 1	Enterprise 2
Energy supply of MTM	112000	75760
Energy supply of field floor	33880	32350
Payment for the protection of buildings and equipment for the year	60650	60000
Remunerationlocksmiths	1666400	1449000
Remunerationtractor	9988900	5542300

Generalizing indicator of the work of tractors, is the integral work ratio (w.r.) of tractor, which is calculated using the formula (3):

$$W.R. = VTRa / VTRp = VTRa / G * D * OR, \quad (3)$$

where VTRa — actual volume of tractor work; VTRp — the volume of tractor work possible; G — Energy power ICC; D — number of calendar days of work; OR — rate of output per 1 kW per calendar day, usl.et.ga.

The smaller the tractor standing idle for a year, the day shift and the higher the production, the higher the actual amount of work will be closer to the technical possibilities, the higher the value of this ratio, the more efficient use tractors on the farm.

Table 8 shows that the company is effectively using 2 part ICC, hence, there are idle equipment. And the company recycles 1 tractor-rate change in the day. Thus, in the farms idle equipment, or it is not enough, therefore, it is necessary either to rent or to cooperate in relation to ICC services. Once we decided on the presence of technology, DTI analysis (Table 9), land area, the process of cultivation of agricultural crops, it is necessary to examine the wage rates for each type of work and the fuel consumption rate in the seedbed preparation and sowing of crops (Table 10). POL application rates are calculated on the basis of observations of chronometry and wage rates on the basis of the minimum wage.

Table 8

Analysis of MTP usage

Indicators	Enterprise 1	Enterprise 2
Field area, hectare	12915	1660
Availability of agricultural equipment: tractor	37	69
Volume of tractor work ,hectare	141800	30600
Worked by one tractor during a year:		
Machine days	287	255
Machine shifts	477	173
Machine hours	4388	1213
Coefficient of tractor usage, Cu	0,79	0,70
Coefficient of shifting, Csh	1,66	0,68
Averageshiftduration	9,2	7,0
Performance per tractor, hectare:		
Annual average	3832	443
Average daily	13,35	1,74
Average per shift	8,03	2,56
Average per hour	0.87	0,37
Integral coefficient of tractor park usage, Cp.u	0.88	0.35

Table 9

Consumption of petroleum products and the rate of wages in the seedbed and sowing crops

Type of work done	Tractor mark	Cupling mark	Performance norm, hectare	Consumption of petroleum per 1 hectare, liter	Rate of wage per 1 hectare, tengue
Cultivation	K-700	KPE-3,8	35,0	5,8	279
	DT-75	KPE-3,8	15,7	5,3	622
	T-4	KPE-3,8	34,2	4,0	285
Disking	DT-75	LDG-10	37,0	2,0	264
	T-4	LDG-10	40,0	2,4	244
		BDT-7	23,0	5,6	424
	K-700	BDT-7	26,7	7,1	366
Harrowing	K-700	BES-2,1	61,2	2,1	159
	DT-75	BES-2,1	43,0	2,0	227
ZigZag	T-4	BES-2,1	52,0	2,4	188
	K-700	SES-2,1	27,9	5,4	350
Sowing	K-701	SES-2,1	35,0	6,6	279
	DT-75	SES-2,1	21,2	3,5	460
	DT-75	EKK-6A	67,0	1,3	146
Soil rolling	MT3-80	EKK-6A	38,0	1,1	257
	K-700	PN-8-35	10,8	16,4	904
	DT-75	PN-4-35	6,0	10,5	1627

In order to decide on the beginning of the pre-cultivation period its necessary to view statistics on the timing of the start of the previous years, which are reflected in the Table 10

Table 10

The timing of the beginning of the pre-cultivation period in 2006–2015 years

Years	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Date	10.05	09.05	10.05	10.05	08.05	11.05	11.05	10.05	12.05	09.05

Statistics show that the average time of the beginning of cultivation falls on May 10 with a deviation equal to 1–2 days. During the spring field work shift is 10 hours, but this value is random, as there may be technical failure technique, stage technique to another location, etc. The KX two variants of work or machinery working an entire shift — 10 hours (qti), or spends 2 hours moving (qti') (Table 11). Now, consider the frequency and probability of occurrence and the values qtiqti' (Table 12).

Table 11

Tractor work during pre cultivation

Indicators	Date (May — month)															Total trac/ day
	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Quantity of tractors worked 10 hours (qti)	16	18	16	20	19	19	18	15	16	16	13	12	12	8	5	223
Quantity of tractors worked 5 hours (qti’)	-	-	2	3	4	4	6	7	5	5	4	5	-	5	-	50
Total amount of tractors (W)	16	18	18	23	23	23	24	22	21	21	17	17	12	13	5	273

Table 12

The frequency of appearance of q_t

q_t	5	8	12	13	15	16	18	19	20
Frequency Mq_t	1	1	2	1	1	5	2	2	1
Pq_t	0,067	0,067	0,133	0,067	0,067	0,334	0,133	0,133	0,067

From Table 12 we can see that in one day can refuse two and more tractors. The failure rate is shown in Table 13. There is a possibility that the tractor may refuse and, in spite of the fact that before the start of the field work took place all the equipment overhaul, the phenomenon happened in practice. Table 14 shows the production of equipment failures during cultivation.

Table 13

The frequency of appearance of q_{ti}'

q_t'	2	3	4	5	6	7
Mq_t'	-	1	3	4	2	1
Pq_t'	-	0,091	0,273	0,364	0,182	0,091

Table 14

Meantime between failures

Indicators	Date						Total amount of failures for the cultivation period
	11.05	13.05	15.05	16.05	19.05	23.05	
Amount of refused tractors(r_i)	1	1	1	1	1	1	7
Interval between failures, days(l_i)	0	2	2	1	3	4	-

According to Table 15, the distribution frequency of the failed equipment is subject to the normal distribution law. When, as defined with the failed equipment, it is necessary to generate a period of repair of equipment, and to determine the precedence SMO MTM.

Table 15

The frequency of the number of tractors failures

Indicators	Enterpise 1	Enterprise 2
r_i	1	2
Mr_i	5	1
Pr_i	0,833	0,167

A simulation model of mass service solves problems, which is characterized by a stream of input requirements, serving stations, devices, formed a queue and output stream that can contain both catered and non-catered requirements. Orders to the requirement to be an application for the repair of equipment (Table 16).

Table 16

Equipment repair time during cultivation

Indicator	Number of failed tractor						
	1	2	3	4	5	6	7
Repair, days	1	2	1	1	1	1	2

Following initial data were assigned to a machine simulation experiment:
N — total number of simulations;
Stotal — total area plowing, ha;
j — number of stations, (j = 1, k);
i — the number of tractors, (i = 1, n);
V — average speed tractor *km* / *h*;
L — width, km;
Sj — area of the *j*-th area, ha;
*T*1 — beginning plowing;
*T*2 — the time of failure of the tractor;
*T*3 — MTM services time;
t — time interval, t = 1 hour;
R — the time limit for the end of the cultivation;
Cpetr — the cost of fuel and lubricants, tenge / ha;
Cw — labor costs, tenge / ha;
Cr — repair costs, tenge / ha.

The following indicators for all types of technology used for the entire period were obtained at the output of simulation experiment:

PR — Performance, ha / hour;

Co — overall cost, tenge / ha;

Tokon — end time of cultivation.

The proposed measures to optimize key business processes integrated agricultural production will increase their effectiveness. The economic effect totaled 21,945,880.1 tenge in the horizontal component of the integration of a year.

In general, the integration in integrated effect manifested as a synergistic effect:

– effect conglomerate, which means that an increase in the number of enterprises allocates risk between them, thus reducing it to share each.
– Sales effect — it benefits the sales organization from the point of view of marketing, advertising, collective distribution as marketing opportunities of the combined company with the correct formulation of the case must be increased;

Scientific and production effect is to maximize the use of production capacity, staff resources, reducing transaction, fiscal, marketing and administrative costs as well as total cost of R & D and IT costs associated with obtaining information and errors in decision-making due to inadequate and / or insufficiently treated and meaningful information;

– effect investment — is to multiply the effect of the investment opportunities of each individual company, in addition, the creation of associations opens up additional opportunities for leveraging public investment on favorable conditions and external, including foreign investments under the state guarantees;
– effect management and is the effect that occurs when the proper construction of corporate management. This includes vertical management structures, and formal training and communication, and cross-communication informal communication managers of different levels and areas of the same corporation.

Thus, the effective development of the agro-industrial complex of Kazakhstan in terms of competitive pressures and external social and economic threats is not possible without introducing new forms of systemic organizational solutions based on the principles of integration and cooperation.

References

1 *Яновская О.А.* Корпоративное управление: учебник. — Алматы: Экономика, 2005. — 320 с.

2 *Есиркепов Т.А., Мусабаев Н.О.* Агропромышленная интеграция: теория и практика. — Алматы: Кульжахан, 2001. — 116 с.

3 *Бабич А.А.* Животноводство: проблема кормов. — М.: Знание, 1997 — 64 с.

4 *Кабдулшарипова А.М.* Экономико-математическая модель оптимизации производства в сельскохозяйственных предприятиях // Поиск. — 2007. — № 2. — С. 65.

А.М. Кабдулшарипова, С.Н. Суйеубаева, Г.И. Джемпеисова

Деңгейлес-біріктірілген жүйеде ауылшаруашылық өнімді өндіру және өңдеуді оңтайландыру

Әлеуметтік-экономикалық қатерлер мен бәсекелестік қысым жағдайында Қазақстанның агроөнеркәсіптік кешенінің тиімді дамуы интеграция және кооперация қағидаларына негізделген ұйымдастырушылық шешімдердің жаңа жүйелік формаларын енгізусіз мүмкін емес. Мақалада ауылшаруашылық өнімді өндіруді деңгейлес біріктіру қажеттілігі негізделді. Мал шаруашылық кешенінің мал азығын өндіру үрдістерін оңтайландыру және бидайды өндірудің бизнес-үрдісінің деңгейлес-біріктірілген үлгісі ұсынылды. Негізгі технологиялық процесті оңтайландыру, соның ішінде мақсаты мал шаруашылығын минералды, өсімдікті және жануар текті әр түрлі азықтармен қамтамасыз ету болып табылатын мал азығын өндіру бойынша есептеулер жүргізілген. Имитациялық үлгілеудің негізінде бидайды өндірудің бизнес-үрдісінің деңгейлес-біріктірілген үлгісі есептелген. Түзу сызықты программалаудың симплекстік әдісінің көмегімен оңтайландыру есептері негізінде оңтайлы жоспарға қол жеткізілді. Біріктірілген жүйеде ауылшаруашылық өнімін өндіру аграрлық сектордың дағдарыстан шығуының тиімді шешімі болып табылады.

А.М. Кабдулшарипова, С.Н. Суйеубаева, Г.И. Джемпеисова

Оптимизация производства и переработки сельхозпродукции в горизонтально-интегрированной системе

Эффективное развитие агропромышленного комплекса Казахстана в условиях конкурентного давления и внешних социально-экономических угроз не представляется возможным без внедрения новых системных форм организационных решений, базирующихся на принципах интеграции и кооперации. В статье обоснована необходимость горизонтальной интеграции производства сельскохозяйственной продукции. Проведены расчеты по оптимизации основного технологического процесса, а именно кормопроизводства, целью которого является обеспеченность животноводства разнообразными кормами — минерального, растительного и животного происхождения. На основе имитационного моделирования рассчитана модель горизонтально-интегрированного бизнес-процесса производства зерна. В результате оптимизационных расчетов с применением симплексного метода линейного программирования получен оптимальный план. Интегрированное производство сельскохозяйственной продукции является эффективным решением выхода из кризиса аграрного сектора экономики.

References

1 Yanovskaya O.A. *Corporate Governance: textbook*, Almaty: Ekonomika, 2005, 320 p.
2 Esirkepov T.A., Musabaev N.O. *Agroindustrial integration of theory and practice*, Almaty: Kulzhahan, 2001, 116 p.
3 Babich A.A. *Livestock feed problem*, Moscow: Znanie, 1997, 64 p.
4 Kabdulsharipova A.M. *Poisk*, 2007, 2, p. 65.