Economic Estimation of Fertilizer Systems at Different Levels of Production Intensification

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Abstract

The objectives of this research were: a) to conduct the production and economic estimation of various fertilizer systems in the field crop rotation, considering production intensification levels and to choose rational fertilizer systems, which provide the increase of output volumes, improving of product's quality, producers' profitability, needed for implementation of expanded reproduction, and ecological safe; b) the formulation of the advices to agricultural producers on increasing economic efficiency of the field crops.

The main source of information was the results of the experimental investigations, carried off by the Department of Agrochemistry and Ecology of Verkhnevolzhsky Federal Agrarian Research Centre (Russia) in the field crop rotation. The base results: on the grey forest soils there was a trend of the reduction, in principle, of the economic efficiency of crop production technologies with increasing doses of mineral and organic fertilizers; the only exception is potato, in the cultivation of which the cost recovery steadily increased with increasing doses of fertilizers. We think at medium prospect, under the conditions of Verkhnevolzh region (Russia), the normal level of agricultural technologies in the production of grain crops is the most rational, for potato it is better to use intensive one. Fertilizer systems with mineral nitrogen (mineral and organic-mineral systems) contributed to the formation of grain with a higher content of crude protein. The useful of intensive technologies in the plant production is impossible without further development of the state support system for agricultural producers and the creation of processing facilities "in places".

Key words: Production Efficiency; Ecological-Economic Efficiency; Fertilizer System; Agrotechnology Management; Level of Intensification; Quality of Grain

Introduction

A realization on practice of ideas and principles of a construction of adaptive-landscape system of agriculture (directly associated with the decision of the state economic policy problems in agrarian branch) requires of the carrying of both production and economic estimation of different it's elements and subsystems concerning to certain agroecological kinds, types and groups of lands as well as concerning to specific conditions of the economic subject functioning.

Sufficiently widespread in the agrarian science investigations the method on estimation of efficiency of agricultural system's elements, in particular, on base of the returning of active ingredient of fertilizers by the crop harvest, represented by "grain units", doesn't allow to consider the value of costs, incurred by the producer, and income (loss) from production. At the same time, it is obviously that at market economy the state strategic tasks to ensure the food security of the country and regions cannot be solved without an achieving of sustainable profitable work of agricultural producers.

In fact, production efficiency, which is expressed in increasing the volume and improving the quality of agricultural products, often does not coincide with the economic one, because the increase in the yield is overlapped by a much higher rate of growth in production costs. On our opinion, this contradiction should be resolved at determination of technology strategy and tactics for each economic unit, taking into account its mission, short-term and long-term goals, role in the regional and state economy, participation in the state support programs, social situation, etc. At the resolution of this contradiction the main thing is to identify the priority of production or economic efficiency.

On our opinion, within the framework of agricultural organization the specialists should emphasize to ecological and economic efficiency, by which we understand the generation of rational income in compliance with officially established ecological standards, as the increase of income is the needed condition of sustainable function of enterprise and the source of means for solution of social and economic problems. However, production (productive) efficiency should dominate in some cases only, for example, when the organization is involved in the food providing for the realization of state (regional) social and other programs, as well as when the problem of production of high-quality (strong and valuable) grain is acute.

Regarding RF in whole now may say about the prevailing value of quality of agricultural products, compared with quantity. This statement may be justified, in particular, by that in last ears agricultural branch provided realization of "Doctrine of food security RF on 2010–2020" control indicators on main food kinds (grain, potato, sugar, plant oil and meat). However the increase of volumes of high-quality grain production (and on other agricultural products) isn't excluded from state agrarian policy tasks. It can be seen from extended to 2025 year "State Program of Agricultural Development and Regulation of Agricultural Products, row materials and food Markets" (Altuchov, 2017). It will allow increase export and the help for other countries. The matter of fact that the half of population of Earth feels food insecurity, 815 million of people in peace starve (Klimenko, Serdyuk, 2018).

Basing on above-described at the statement of research objectives (which will be formulated below), we took into account production, economic and quality (quality of product) aspects of research object estimation. Also the awareness of the need to solve ecological and social problems in the country have influenced on the statement of our research objectives. We believe agroeconomic science in this relationship should help by the designing of agrotechnologies of determined kinds and intensity levels, adapted to conditions of regions, economic subjects, fields, production sections, spots from viewpoint of economic, ecological and social efficiency. Similar problems are at agronomists and economists in all countries of the world. In this connection we present some data from recent economic literature.

Researchers of Mendel University in Brno (Czech Republic) (Kren, J. et al., 2017) studied relationships between yield of crops, input costs, gross margin and grain quality, as well as synergy phenomenon. It is proved that maximum input costs to the achievement of maximum yield do not provide an highest income. Besides it is identified that the higher the yield of wheat the lower the crude protein content and worse some other indicators of grain quality. In this article are suggested approaches for the achievement of optimum. This optimum is at a fairly high costs.

Large number of science work (within of array we studied) are devoted to issues of the use in practice of the intensive, extensive, precision and organic agriculture. Further we are going to determine the difference and similarity between these terms, their advantages and disadvantages, but now it is important for us as agricultural systems look like from an environmental, social and economic view points. The review of international literature showed that organic (including biodynamic) agriculture (Klimenko, 2018; Cakirly, 2018; Beluhova, 2017; Agapieva, 2014) is predominantly not less profitable than "conventional" one. It is despite higher laboriousness and lower yields by higher sale prices and consumer demand for organic products. The social effect is expressed both in the improvement of environment and in providing of greater biodiversity (Agapieva, Koprivlensky, 2014, p. 69).

Features of organic, biological and biodynamic agriculture are expressed clearly enough in the articles of the Bulgarian and German authors (Beluhova – Uzunova, Atanasov, 2017; Agapieva, Koprivlensky, 2014; Cakirly et al., 2018). Here the main is that biological (biodynamic) farming systems are more about ecology, quality of food, human's health, landscape etc. (Beluhova – Uzunova, Atanasov, 2017). Works of these authors are related to enough highly fertile soils. However in our country organic agriculture can't be used widely because soils are nutrition elements poor on large acreage.

The essence of organic (biological) agriculture is described, in particular, in the article (Klimenko, Serdyuk, 2018). It is rejection from the use of mineral fertilizers and pesticides, that provides output of ecologically clean products, implementation of business activity on principles of natural ecosystem imitation; the use of organic fertilizers and biological means of plant protection.

Biological plant growing is alternative to traditional (for developed countries) intensive type of agriculture. Authors, working in intensive agriculture field, sometimes do not focus attention to it's environment effect (Sofyina, 2018; Ilyina, 2017; Thompson et al., 2018; Stoces et al., 2018; Muncan M., 2017). Individual scientist have courage to say: "Since intensification determines the efficiency of reproduction by its functioning leading scientists speak about the primacy of intensification as a process and the secondary of effectiveness as a result" (Ilyina, I., 2017), thus expressing contempt for the effectiveness of the intensification itself, including ecological efficiency.

Besides at the recent literature the sources on the study of precision agriculture problems (as variant of intensive one) are presented widely enough (Stoces et al., 2018; Thompson et al., 2018; Wegener et al., 2019).

Data of the other science works present negative consequences of intensive agriculture, as well as measures to prevent them (Hong - wei, HU. et al., 2015]. For example, Russian researches demonstrated this damage in the numbers and set the problem of the choice: "… or to applicate intensive technologies with the use chemical means, allowing to increase volumes of agricultural products output and in the same time continuing to deteriorate environment and hurt to people's health, or to move to biological (ecological) plant growing" (Klimenko, Serdyuk, 2018). However, on our opinion, it is unacceptably to choose the direction so categorical. In this connection the question about the possibility of the compromise variant between these "or" – options occur. We have in view rational variants, in which a reasonable, rational, scientifically-based use of chemical fertilizers, plant protection products, and other preparations will help to obtain a production (quantitative and qualitative) and commercial results that suit for the agricultural producer and the society, while not disturbing the ecological balance.

Hence a statement of our research objectives and work hypothesis follows.

Work hypothesis: rational variants for conditions of Verkhnevolzh region are agrotechnologies of normal (moderate) level of production intensification for most agricultural producers.

Research objectives are: a) to conduct the production and economic estimation of various fertilizer systems in the field crop rotation, considering production intensification levels and to choose rational fertilizer systems, which provide the increase of output volumes, improving of product's quality, producers' profitability, needed for implementation of expanded reproduction, and ecological safe; b) the formulation of the advices to agricultural producers on increasing economic efficiency of the field crops.

The production and economic estimation of various fertilizer systems in the field crop rotation in composition with the full technological cycle of production, considering it's intensification levels and ecological effect and product's quality; as well as the formulation of the advices to agricultural producers on increasing economic efficiency of the field crops.

The achievement of these research objectives is a beginning stage of the create of agrotechnology management system on region and economic subject's levels.

Conditions, materials and methods

The work was made on results of the experimental investigations, carried off by the Department of Agrochemistry and Ecology of the Vladimir Research Agricultural Institution (currently Verkhnevolzhsky Federal Agrarian Research Centre) in three rotations of the field crop rotation (Okorkov, V. et al., 2017, 2018). At the first and the second rotations of crop rotation between grain crops and perennial grass was potato (grain grass-tilled crop rotation), in the third rotation it was excluded and the crop rotation was transformed to grain grass one.

Calculation was made on each culture and on crop rotation in whole as well as on each rotation of crop rotation and on 8 fertilizer systems, conditionally related to three levels of production intensification:

I. Extensive level (E): 1) no fertilizer; 2) organic fertilizer (40 t/ha);

II. Normal level (N): 3) organic fertilizer (80 t/ha); 4) complete mineral fertilizer $N_{40}P_{40}K_{40}$; 5) organic fertilizer (40 t/ha) + $N_{40}P_{40}K_{40}$; 6) organic fertilizer (60 t/ha) + $N_{40}P_{40}K_{40}$;

III. Intensive level (I): 7) organic fertilizer (60 t/ha) + $N_{80}P_{80}K_{80}$; 8) organic fertilizer (80 t/ha) + $N_{80}P_{80}K_{80.}$

Besides in work the Plans of production and financial activity for 2017 on some agricultural organizations were used (SPK "Rassvet" of Ivanovo region and ZAO "Suvorovskoe" of Vladimir region).

During the analysis of the carried out estimation results and formulation of advices to the production, we used following methods: comparative analysis, economic-statistical and graphic methods, production leverage technique, relative "indicators – points" technique. For the economic estimation of fertilizer systems, we used the methods of cost accounting and calculation of production cost value: "on variable costs" (Voronova, E., 2013) and "direct-costing" (Rozhkova, N., 2018), adopted in management accounting. For the calculation the exclusive software tool for computer "HOST – 2.3" was used (No. 2015610045 of the certificate of state registration in FIPS).

Economic estimation of experimental variants was carried out on bases of following indicators: labor expenses (in man-hours) per 1 centner of products and per 1 hectare of sowing area; direct conditionally-variable costs (further – "variable costs") on production at calculation per 1 hectare of area and 1 centner of products; conditional net income in calculation per 1 hectare; the cost recovery by revenues from sales of products (in rubles per 1 ruble of costs).

Under the conditional net income, we implied the gap between the value of all manufactured products, expressed in 2017 sales prices, and variable costs of its production. It is the marginal income on economical essence, which the commodity producers can distribute to profit and renovation Fund, which serves as a source of fixed assets renewal. The direct variable costs include: wages of workers with the tax deductions, expenses of fuel and lubricant materials, seeds, fertilizer, plant protection means, containers, tools, unforeseen current expenses. Cost recovery was determined by the results of division product's value to variable costs sum, expressed in monetary terms. It was calculated at three variants: at the average economic situation, at favorable economic situation (realization prices are higher by 10%, than average those), at not favorable situation (prices by 30% below). All indicators were calculated for the full technological cycle of crop production.

After the analysis of estimate indicators dynamics on eight variants of experiment three variants were allocated. They conditionally can be attributed to different levels of agroproduction intensification on classification, designed by (V. Kiryushin, 2000), for analysis of fertilizer systems efficiency in according to intensity levels. Some conditionality related to fact that technological scheme of experiment implies the invariability of "seeds", "plant protection products", "treatment of soil" factors on intensity levels, and only fertilizer factor varies. "Seeds", "plant protection means", "treatment of soil" factors are stated at conditionally normal (moderate) level. The application of herbicides is implied at all levels of intensification. Such approach, on our opinion, allows to estimate exactly the efficiency of fertilizer systems in composition of the full technological cycle at others equal conditions.

After the calculation of efficiency indicators, on the base of mathematical relationships between a production volume, costs and product's price (production leverage technique), the size of yield, required in order to cost recovery at intensive level of production remained the same, as it is in the extensive one, was determined. Such calculation was made on example of spring wheat and barley. These cultures were selected because under spring wheat the whole crop rotation's norm of organic fertilizer is introduced, this means, that value of organic fertilizer is introduced to net cost of this culture wholly; but value of organic fertilizer is not included in net cost of barley, only the after effect of organic fertilizer take place as factor of yield formation at barley production.

In this connection, the cost recovery at the extensive level of production was accepted as conditionally stable one. The correspondence between the cost recovery of variable costs and level of profitability, calculated on full production net cost, was determined on the basis of the share of the technic renovation expenses and overhead expenses in the total sum of costs for the plant growing, which was accepted as amount of 33% according to Production and finance plans of SPK "Rassvet" (Ivanovo region) and ZAO "Suvorovskoe" (Vladimir region).

The final stage of the work was the production and economic estimation of fertilizer systems at the same crop rotation on example of spring wheat, taking into account the quality of grain (the share content of crude gluten and crude protein). In the calculation we used the data on plastic sorts of this culture Lada and MiS (2005–2007) and Priokskaya and MiS (2009–2010) as well as intensive sort Ladya (2017). In this case the following estimated indicators were used: crop capacity, percentage of gluten and protein, protein yield per unit area, variable production costs per 1centner of protein, cost recovery from product sales.

On the results of investigation the ranked rows were identified on each indicator and on all variants of experiment. This estimation has included 17 variants: 1) no fertilizer; 2) background (lime); 3) $P_{40}K_{40}$; 4) $N_{40}P_{40}K_{40}$; 5) $N_{80}P_{80}K_{80}$; 6) M (manure) 40t/ha; 7) M (manure) 60t/ha; 8) M 80t/ha; 9) M 40t/ha + $P_{40}K_{40}$; 10) M 40 t/ha + $N_{40}P_{40}K_{40}$; 11) M 40t/ha + $N_{80}P_{80}K_{80}$; 12) M 60t/ha + $P_{40}K_{40}$; 13) M 60t/ha + $N_{40}P_{40}K_{40}$; 14) M 60t/ha + $N_{80}P_{80}K_{80}$; 15) M 80t/ha + $P_{40}K_{40}$; 16) M 80t/ha + $N_{40}P_{40}K_{40}$; 17) M 80t/ha + $N_{80}P_{80}K_{80}$.

In order to at the choice of rational fertilizer system it was possible to consider such two heterogeneous indicators as protein yield and cost recovery, we used the method of estimation by relative indicators – points. On each indicator for the basis (100 points) we took the variant with the minimal value. For other variants the quantity of points we determined by the division of value of corresponding indicator to its minimal value with the next multiplication on 100. Then we summarized the quantity of points on each fertilizer system and determined its place from max sum of points until minimal sum.

On basis of carried out analysis the findings and suggestions were formulated for agricultural producers, working in Vladimir region as well as in Verkhnevolzh region in whole.

Results and discussion

The analysis of indicators of production and economic estimation of different fertilizer systems on 7-field crop rotation in whole in it's the third rotation (Table 1) testified, that variable production costs per hectare of crop rotation's area increased by 2.6 times from the first variant (no fertilizer) to last one (maximal dose of organic and mineral fertilizer). In this case average crop capacity on crop rotation, expressed in grain unit, increased by 1.4 times only. For this reason, the economic efficiency of production was steadily declined on increasing doses of fertilizers. The conditional net income (marginal income) at middle economic situation decreased from 10431 rub./ha to 8608 rub./ha (by 17.5%), in this case the cost recovery by revenues from products was sharply decreased from 2.73 rub./rub. in the first variant to 1.55 rub./rub. in last one (by 43.2%). In whole the "no fertilizers" variant proved to be the most economically efficient. The statistic explanation of this phenomenon consists in that the crop capacity is increased on the power or hyperbolic function (not linear dependence) with increasing fertilizer doses despite the increasing of the free nutrient's reserves (Okorkov, V., 2017, p. 42, 43).

The results of study of the estimated indicators dynamics, concerning to separate agriculture crops, testified that the trends of the economic efficiency changing on the experiment variants on different cultures are somewhat different. So for spring wheat the "no fertilizer" variant proved to be the most economically efficient (cost recovery 3.04 rub./rub.); for winter wheat the best variant is organic fertilizer system "80t/ha manure" (cost recovery 3.24 rub./rub.). The potato culture was

Table 1. The production and economic estimation of fertilizer systems at cultivation of crops in the field crop rotation

Indicators*	1) No fertilizer	Organic		4) Mineral, $N_{40}P_{40}K_{40}$	Organic-mineral			
		2) 40 t (Э)**	3) 80 t		5) 40 t + NPK	6) 60 t + NPK (N)**	7) 60 t + 2NPK	8) 80 t + 2NPK (I)**
1	2	3	4	5	6	7	8	9
1. Organic fertilizer, t/ha	-	40	80	-	40	60	60	80
2. Mineral fertilizer, active substance, kg/ha***				$N_{40}P_{40}K_4$	$N_{40}P_{40}K_4$	$N_{40}P_{40}K_4$	$N_{80}P_{80}K_{80}$	$N_{80}P_{80}K_{80}$
3. Ammonium nitrate, kg/ha				116	116	116	232	232
4. Superphosphate double, kg/he				80	80	80	160	160
5. Potassium chloride, kg/ha				80	80	80	160	160
6. Basis fuel expense, kg/ha	47,2	52,6	56,0	51,2	56,3	57,3	57,7	59,4
7. Labor expense, man*hour/ha	5,3	6,2	6,8	6,1	6,8	7,1	7,21	7,5
8. Herbicides, rub./hectare	412,1	412,1	412,1	412,1	412,1	412,1	412,1	412,1
9. Seeds expense, rub./hectare	2797,7	2797,7	2797,7	2797,7	2797,7	2797,7	2797,7	2797,7
10. Expenses per hectare, rub.	6021,1	6949,4	7750,0	10213,0	11098,0	11471,0	15134,0	15531,0
11. Crop capacity, thousand grain unit/hectare	3,02	3,38	3,53	3,97	4,09	4,10	4,39	4,36
12. Conditional net income, rub/ha	10431	11571	11570	11634	11400	11133	9162	8608
13. Cost recovery in dependence on economic situation, rub./rub.: average,	2,73	2,66	2,49	2,14	2,03	1,97	1,61	1,55
14. Favorable,	3,01	2,93	2,74	2,35	2,23	2,17	1,77	1,71
15. Not favorable	1,91	1,87	1,75	1,50	1,42	1,38	1,12	1,09

* *we have presented the estimated indicators on factors of production mainly in natural units, excepting cases, when it is not correct to conduct the averaging them in this form on crop rotation in whole, in last case these indicators are gave in the monetary terms;*

** *the conditionally taken level of intensification;*

*** *for the used fallow*

the most responsive to fertilizers. In concern to it the best results are noted at the most expensive variant with maximal doses of organic and mineral fertilizers (cost recovery 3.17 rub./rub.). For potato the steady positive dynamics of economic efficiency indicators took place.

The analysis of the results of economic estimation of the production costs structure indicated that the share of wages, fuel and lubricants, seeds, plant protection products reduced from the first fertilizer system to the eighth, but the share of fertilizer significantly increased (from 8,2% to 56% or almost by 7 times).

The dynamics of cost recovery was different on rotations. For example, at the first rotation of crop rotation the organic-mineral system on "M60 + N40P40K40" scheme provided the highest efficiency (cost recovery 2.57 rub./rub.); at the second rotation – mineral system "N40P40K40" (cost recovery 2.43 rub./rub.). At the third rotation, as was noticed, the constant reduction of cost recovery occurred from the variant with the crop growing on background of natural soil fertility to organic-mineral system with the maximal doses of fertilizer "M80 + N80P80K80" (from 2,73 rub./rub. to 1,55 rub./rub.). Such differences mainly were due to the presence of potatoes in the first and second rotations and the its absence in the third rotation. Potato is more responsive to the increasing of fertilizer doses, than grain crops as well as its realization price is higher (prices 2017).

The analysis of economic efficiency of fertilizer system on conditionally accepted the levels of production intensification proved general trend of it's constant declining at the strengthening of intensification. So cost recovery at extensive level equal 2.66 rub./rub., at normal – 1.97 rub.rub., and at intensive level – only 1.55 rub. per 1 rub. of revenue from sales of products (Table 1). In this case the labor expenses per 1hecture of crop area at intensive level was increased per 21% in comparison to extensive one, variable costs – per 124%, and conditional net income was decreased per 26%.

In connection with that the trend of the reduce of economic efficiency indicators at introduction of organic and mineral fertilizers and the increasing its doses (that does not meet of science and technical progress requirements) was obtained, the interest is presented by calculation, demonstrating at what yield the cost recovery will not be lower, than it is at extensive production level. Graph, built on results of this calculation, shows

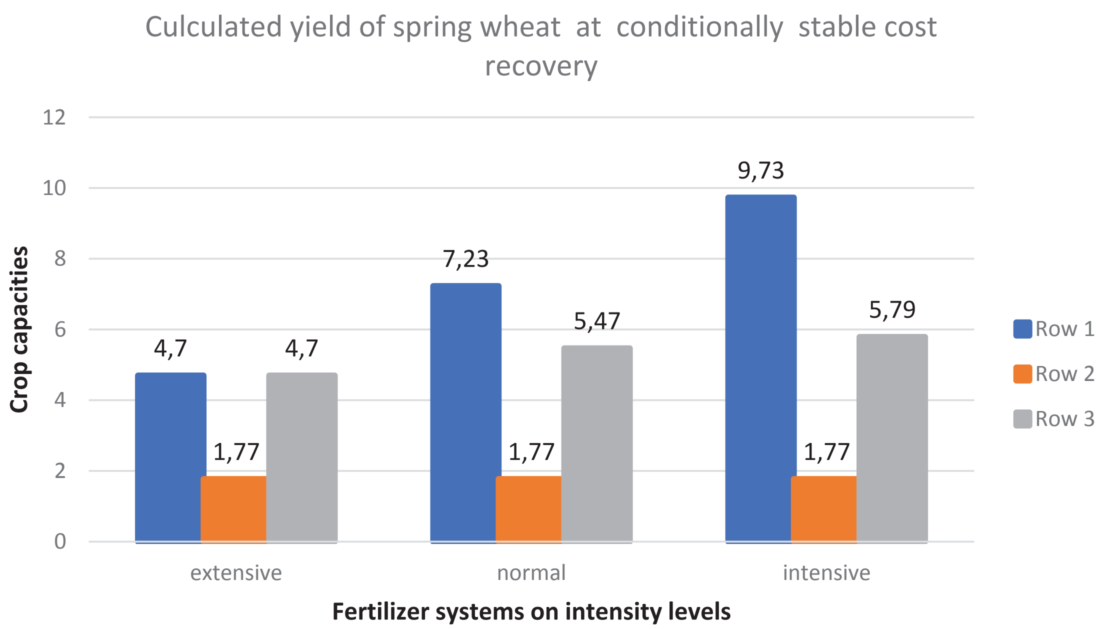

Fig. 1. The real and necessary crop capacities of spring wheat at conditionally stable cost recovery

Row 1 – necessary crop capacity, t/he; Row 2 – conditionally accepted stable cost recovery, rub./rub.; Row 3 – real crop capacity, t/ha that for the keeping of the cost recovery of variable expenses at spring wheat growing on level 2.1 rub./rub., that corresponds to level of production profitability about 77% (considering all elements of expenses, including technic renovation and overhead expenses), crop capacity at normal level should be 7,23 t/he; at intensive one – 9.73 t/ha. The most gap between the values of real and necessary for the achievement of conditional profitability the crop capacity takes place in the intensive variant and it is 3.94 t/ha or 68%.

For oat with reseeding of perennial grasses the crop capacity, necessary for the keeping of conditional cost recovery at intensive level was closer to real crop capacity, because fertilizers were not introduced directly under this crop and the expenses of fertilizers was not influent net cost. However, and for oat the gap between values of real and necessary crop capacity was almost 30%.

Calculated values of crop capacity on responding levels of intensification cannot be achieve in practice in Verkhnevolzh region. For the substantiation of this statement we are going to refer to data of (Voloshchuk, A., 2004). In monography under his editorship at the development of the classification of agricultural technologies on intensity levels, adopted to the conditions of Vladimir opolye region, the crop capacity of grain crops is about 3–4 t/ha response to normal level, 4–6 t/ha – intensive level. This is at involvement of all production intensification factors, not only the fertilizer factor. Because the calculated crop capacity cannot be achieve in practice in conditions of Vladimir opolye and Verhnevolzh regions, on our opinion, specialists should use the others approaches for the increasing of agrotechnologes efficiency, in particular, those, which was formulated as suggestions for agroproducers, made in the conclusion of article (Table 3).

On results of production and economic estimation of fertilizer systems on spring wheat (sorts Priokskaya and MiS), considering quality of grain, it was discovered, that on yield of crude protein per 1hectate of area the organic-mineral fertilizer systems with high doses of manure (60 and 80 t/ha) and whole mineral fertilizer with double doses NPK (active substance 80 kg/ha) were at the1st and the 2nd places in ranked row (Figure 2). The organic-mineral fertilizer system

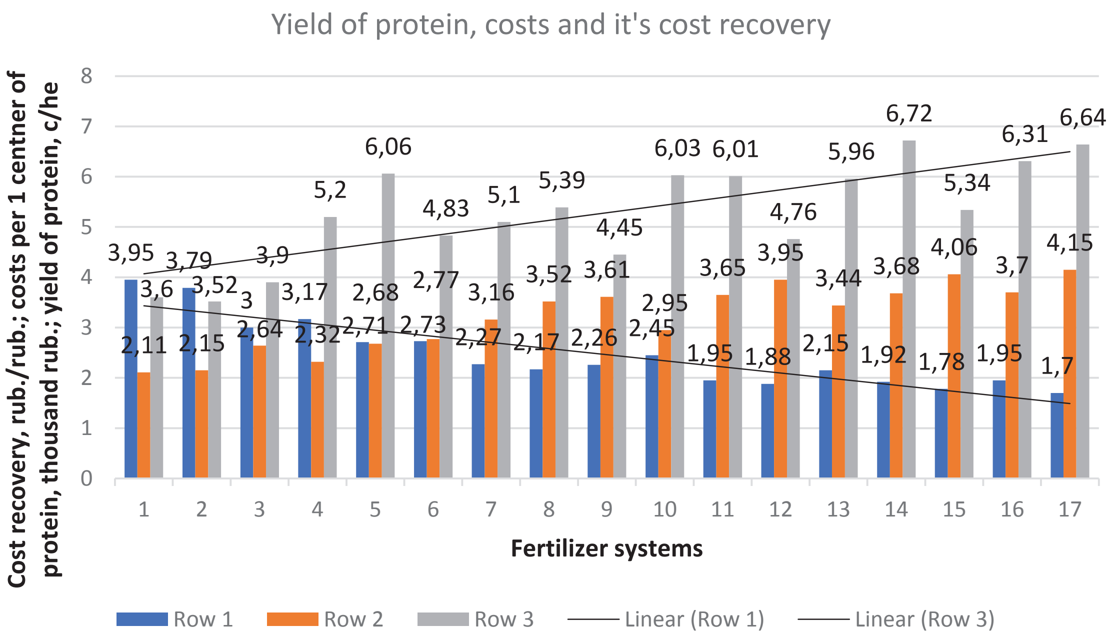

Fig. 2. Yield of crude protein, production costs and cost recovery in fertilizer systems on spring wheat (sorts Priokskaya and MiS), 2009–2010 years

Row 1 – the cost recovery by revenues from products, rub./rub.; Row 2 – direct variable costs per 1 centner of protein, thousand rub.; Row 3 – yield of crude protein, centner/ha

"M_{80} + $N_{40}P_{40}K_{40}$" took the 3rd place. However, on expenses per 1 centner of crude protein and cost recovery the first two places belonged to variants "no fertilizer" and "background (lime)", and the 3rd – mineral system "$N_{40}P_{40}K_{40}$". At such signification gap between the results it is very difficult to do the choice of optimal fertilizer system.

So in order to at the choice of rational fertilizer system it was possible to consider at the same time such two heterogeneous indicators as protein yield per unit area and cost recovery, we used the method of estimation by relative indicators – points. The results of point estimation on two indicators (yield of protein and cost recovery) proved that the variants with whole mineral fertilizer and organic-mineral systems were moved to higher positions (places) in comparison with the estimation on the cost recovery only (Table 2).

So "$N_{40}P_{40}K_{40}$" variant was moved from the 3rd to the 2nd place, "$N_{80}P_{80}K_{80}$" – from the 6th to the 3rd one. At this case the schemes, concerning to organic system and the "without mineral nitrogen" schemes (phosphorus-potassium) were moved to lower places. From these data we may do the conclusion that fertilizer systems, containing mineral nitrogen (mineral and organic-mineral systems), contribute to the formation of grain with higher yield of crude protein. These data prove with economical point of view the conclusions, made by agronomy scientists early (Okorkov, V., 2018, pp. 22-32). It is interesting the variant with highest yield of crude protein per 1 hectare on complex point estimation was only at the 6th place, but the 1st place still was took by "no fertilizer" variant, which is the least expensive, that not meet the agroecological requirements and requirements of science and technical progress. The high crop ca-

Table 2. Point estimation of production and economic efficiency of fertilizer systems on spring wheat (sorts Priokskaya and MiS)

Fertilizer system	Yield of protein per hectare		Cost recovery		Sum of points	Place on sum of points	Place on cost recovery
	cent-ners	points	rub./rub.	points			
1	2	3	4	5	6	7	8
1. No fertilizer	3,6	102,3	3,95	232,4	334,7	1	1
2. Background (lime)	3,52	100	3,79	222,9	322,9	4	2
3. $P_{40}K_{40}$	3,9	110,8	3,0	176,5	287,3	11	4
4. $N_{40}P_{40}K_{40}$	5,2	147,7	3,17	186,5	334,2	2	3
5. $N_{80}P_{80}K_{80}$	6,06	172,2	2,71	159,4	331,6	3	6
6. M_{40} (E)*	4,83	137,2	2,73	160,6	297,8	**7**	5
7. M_{60}	5,1	144,9	2,27	133,5	278,4	14	8
8. M_{80}	5,39	153,1	2,17	127,7	280,8	13	10
9. M_{40} + $P_{40}K_{40}$	4,45	126,4	2,26	132,9	259,3	15	9
10. M_{40} + $N_{40}P_{40}K_{40}$	6,03	171,3	2,45	144,1	315,4	5	7
11. M_{40} + $N_{80}P_{80}K_{80}$	6,01	170,7	1,95	114,7	285,4	12	12
12. M_{60} + $P_{40}K_{40}$	4,76	135,2	1,88	110,6	245,8	17	15
13. M_{60} + $N_{40}P_{40}K_{40}$N)*	5,96	169,3	2,15	126,5	295,8	8	11
14. M_{60} + N $_{80}P_{80}K_{80}$	6,72	190,9	1,92	112,9	303,8	6	14
15. M_{80} + $P_{40}K_{40}$	5,34	151,7	1,78	104,7	256,4	16	16
16. M_{80} + N $_{40}P_{40}K_{40}$	6,31	179,3	1,95	114,7	294	9	13
17. M_{80} + $N_{80}P_{80}K_{80}$ (I)*	6,64	188,6	1,7	100	288,6	10	17

**conditionally accepted the level of intensification* pacities in crop rotation and high yield of crude protein in determined variants (for example 672 kg/he) reflect the high culture of agriculture and potential of soil at medium – and long-term prospect (Okorkov, V., 2018).

According to the sorts of spring wheat Lada and MIS (2005–2007), the results of the point estimation were approximately the same as for the sorts Priokskaya and MIS (2009–2010), the reason, in our opinion, is that these are sorts of the

Table 3. The findings and suggestions on increasing economic efficiency of agricultural technologies in plant growing

Findings	Suggestions	Notices
1	2	3
1. The reduction (in principal) of economic efficiency of crop production technologies at the increasing of doses of mineral and organic fertilizers.	1.1. At the conditions of Verkhnevolzh region the produces should use mainly the agrotechnologies of normal level during about 3 years. The inexpediency of wide application of intensive technologies at the moment can be justified not only by economic inefficiency. It may be justified by that now in state the problem of further increasing of grain production volumes do not exist (on results of realization of the Food security Doctrine, accepted until 2020 year [Medvedev, D., 2016.]), it is more important to provide profitable work of agricultural producers and improve the quality of grain.	For agricultural producers
	1.2. The specialists should work out the technological multiformity (multi-level) in crop production branch on example of Republic Tatarstan [Amirov, M. et al., 2014], this is a reasonable ratio between agrotechnologies of different technological formations (levels): the 3rd (basis technologies), the 4th (intensive), the 5th (high) and the 6th (biotechnologies).	For region government authorities along with FSSI “Verkhnevolzhsky FARC”
2. Exception from last finding is potato, for which the cost recovery by revenue from product’s sales steadily increases with an increasing fertilizer burden per unit of sowing area.	It is recommended: expansion of the planting area of potatoes, organization of grain grass-plough crop rotations. Market expediency consists in that agricultural organizations and farms have open realization channels despite the provision of the Vladimir region population by potato of own production by 185%]. Main channel is Moscow (food potato) as well as farms (quality seed potato) [Regions of Russia, 2017].	For agricultural producers
3. It is necessary to increase economic efficiency of agrotechnologies at normal and intensive production levels.	The organization of grain processing “in places” - the formation of mini-plants on mixed fodder, groats and cereal flakes production. In our opinion, here is a suitable organizational and legal form “consumer cooperative”. It will allow agricultural producers to enter to the consumer market without intermediaries, will except the problems with realization of product and the loss of economic benefit, which is inevitable at the conclusion of contracts with outside private investors.	For agricultural producers
4. The gradual transformation from more chare of low technological levels to more development of higher technological levels is necessary, but it is impossible without the added state support.	4.1. For agricultural producers, developing intensive technologies (a limited number of “pilot” enterprises in region is implied), the amount of the subsidy on not connected support in the field of crop production should be increase in value, proportional to the relation between costs of intensive technology and extensive one during period at least 4 years. In our opinion the suggested directions on the development of state support of agricultural producers not contradict to the requirements WTO, which limit measures of state support by frameworks of “green basket” [Garina, E., 2014]. 4.2. Compensation of part of the costs incurred by agricultural producers to payment for services, provided by processing companies.	For Federal and regional legislative and executive authorities

same type – plastic. In the concerning to intensive sort Ladya the results were differed. The optimum was mineral system of fertilizer with maximal dose. On the second place was “M_{40} + $N_{80}P_{80}K_{80}$”. On the last places (as well as on plastic sorts) were the variants without mineral nitrogen and without fertilizer in general. In relation to the direct influence of fertilizer on product’s quality: wheat of the 3th class was obtained on background of organic-mineral fertilizer system, in the first; at mineral system of fertilizer with maximal dose, in the second; at organic fertilizer system with maximal dose 80 t/he, in the third. The grain of lower classes (the 4th and the 5th) – at schemes without mineral nitrogen, without fertilizer and at organic system with low dose of manure.

On the basis conducted analyses the findings and suggestions for agricultural producers and government authorities was formulated (Table 3).

Conclusion

Conducted production and economic estimation of agricultural technologies with the different fertilizer systems at different levels of production intensification, considering quality of product, allowed to formulate findings and suggestions to agricultural producers, region government authorities etc. on increasing economic efficiency of crop production at the increasing of intensity level (Table 3). The most general finding, on our opinion, is: the most efficient level of intensification at grain growing is normal (moderate) in Verkhnevolzh region (Russia) with organo-mineral fertilizer system (manure 40–60 t/ha, one time per crop rotation + $N_{40}P_{40}K_{40}$). Such scheme provide about 4 t/ha grain units crop capacity, quite high quality of grain, quite high cost recovery, the support of soil fertility and environment. The most important suggestions, on our opinion, are: the expansion of the planting area of potatoes, the organization of grain processing “in places” with the formation of the consumer co-operatives, the choice of a few “pilot” enterprises in region for the implementation of the intensive technologies in them on science base, the development of state support.

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