Development of a KPI system for pig farms based on the criteria for evaluating the efficiency of the enterprise

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Abstract. In the article we consider the main criteria for the effectiveness of the pig-breeding enterprise. We conducted a comparative analysis of the approaches considered by various authors and selected the most popular indicators, followed by an explanation of the significance and importance of each of them. A system of criteria for evaluating the effectiveness of a pig-breeding enterprise has been developed. The use of the following indicators is proposed: the number of piglets from one main sow (per farrow and per year); number of farrowing per year; average daily gain (in fattening and in the herd as a whole); feed conversion (for the herd, taking into account the costs of the parent herd and for fattening); profitability (loss ratio)%; age of livestock being slaughtered, days; and average live weight of sales, kg. It is proved that one of the organizational and economic mechanisms of enterprise performance management is the development of such a system of key performance indicators of personnel performance, which determines the dependence of the company's performance on the performance indicators of personnel. A system of key indicators of personnel efficiency is proposed, labor stimulation is determined to improve these indicators in this research, which ultimately leads to an increase in the efficiency of the enterprise as a whole.

1. Introduction
The goal must be measurable in order to achieve the goal or understand the rate of success. It is often naturally for enterprises to have many indicators that influence the measure of the outcome. We consider the main criteria for the effectiveness of the pig-breeding enterprise in the article. The literature analysis showed that authors usually do not justify why the set of estimated parameters has become exactly what is used today. We will conduct a comparative analysis of the approaches considered by various authors and select the most popular indicators, followed by an explanation of the significance and importance of each of them.

We will consider several ways to assess the effectiveness of pig-breeding enterprises based on different sets of indicators. Generally, we took into account both the experience of local researchers [1, 2, 3, 4, 5] and foreign researchers [6, 7, 8, 9, 10]. Some researchers write about KPI system for pig farms [9, 10]. There is a concept of key control indicators for the consumer, focused on the management of quality and health of pigs [11]. Key performance indicators can be used to monitor the efficiency of production, identify areas where improvements could be made, and monitor the effects of any management changes. Their use in the beef sector is increasing; however, there is limited evidence that performance indicators are most useful for overall enterprise success. [12]. We have learned application
experience KPI [9, 10, 11, 12, 13, 14] and we offer a KPI system for personnel based on the criteria for evaluating the efficiency of the enterprise.

2. Analysis of existing approaches to assessing the effectiveness of pig-breeding enterprises

In the article “The Efficiency of Industrial Pig Breeding”, Babiak estimates the efficiency of an individual enterprise on the efficiency of all pig-breeding enterprises of the Bryansk Region using the following indicators [1]:

- Number of piglets from one (main sow, (measured in heads)):
  - Per farrowing
  - Per year
  - Number of farrowing per year
  - Substitution of breeding stock, percentage
  - The average daily gain in live weight of pigs in growing and fattening, grams
  - Costs per 1 centner (cwt) of gain in live weight: feed, kg feed.
  - Labor, man-hours
  - Profitability (loss ratio), %
  - The mortality of pigs of all ages to the turnover of the herd, %
  - Duration of growing and fattening pigs to achieve a live weight of 100 kg, days
  - The slaughter-out-percentage, percentage
  - Thickness of bacon, mm
  - The output of lean meat from the carcass, %
  - The total number of personnel ensuring the efficient operation of the complex

For example, Tsoi L.M. notes that "an important factor in increasing the profitability of pork production is to reduce the unit resource-intensity of production" [2]. He analyses resources cost in pork production. "It is shown that feeds account for the specific share (over 60%) in resources structure. The technological processes of heating and ensuring of microclimate make up a significant share. Major directions of resource saving in pork production on a basis of modern innovative technologies are determined [3]".

The main production indicators for comparing their effectiveness are the following:

- Live-born piglets from a sow on one farrowing, heads
- Piglets weaned from sow in one farrow, heads
- Mortality (total to offspring), %
- Age of the livestock being slaughtered, days
- The average daily gain in fattening, grams
- Feed conversion in fattening
- The average live weight for sale, kg
- Increase in live weight per sow, kg
- Sold pigs per year from one sow, heads

"The economic efficiency of pig production is directly dependent on technological efficiency in this industry. [4]" The criterion is the use of scientifically based resource-saving technology for the production of pork, providing high productivity, preservation and optimal feed conversion with the rational fattening period.

M.V. Bazylev, V.V. Bukas, E.A. Levkin, in their article “Efficiency of pork production on an industrial basis due to the intensification of pig feeding”, noted that “... intensification of industrial pig farming is possible only through the use of a complex of factors determining the efficiency of the industry. The most important of these is the balanced feeding of animals at all stages of pork production.
The economic efficiency of intensification is due to both minimization of cash costs per unit of output and an increase in the added value of the final product. [5]” In view of the foregoing, they propose the following indicators for assessing the economic efficiency of measures to intensify production at pig enterprises:

- The pigs age upon sale, days
- Live weight of pigs upon sale, kg
- The average daily gain in live weight of fattening pigs, grams
- Feed consumption per 1 pig for fattening, kg
- Costs of feed for pigs for fattening, thousand rubles
- The cost of growing for one pig, thousand rubles
- Cost of 1 centner (cwt) live weight, thousand rubles
- The average selling price of pork for 1 kg, thousand rubles
- Profit per 1 centner (cwt) of pork, thousand rubles
- Profitability, % (percentage)

The R&D article on the topic: “Improving the competitiveness of the pig breeding cluster on the example of the Belgorod region” is noted that profitability primarily depends on the productivity of pigs (while large enterprises have a positive effect on the scale of production), the following indicators are considered as an assessment of it:

- Number of farrowing from one sow per year
- Prolificacy of sows, heads
- The number of piglets at birth per 1 sow per year, heads
- Level of emergency farrowing, %
- The level of empty-sow after insemination, %
- The duration of the lactating period, days.
- The average live weight of 1 pig in 60 days, kg
- The average daily gain in piglets during the growing period, gr
- The average daily gain of fattening piglets, gr
- The average live weight of 1 piglet when removing from fattening, kg
- Amount of feed for the production of 1 kg of pork (in live weight), feed units, total
- Amount of feed per 1 kg of growth of fattening pigs, feed units
- Technological waste, % no more than:
  - Lactating piglets
  - Growers
  - Fattening piglets

Galanopoulos et al. [6] look at the enterprise performance through resource efficiency that might be used for improving overall productivity and, ultimately, its profitability. The authors propose the conversion of all costs (for capital, labor, feeding, etc.) and results (gross income) into average costs per sow for providing a clearer picture of productivity. At the same time, larger enterprises seem more technically efficient than small ones.

Thus, the initial performance indicators are reduced to the calculation of the following indicators per 1 sow: feed costs, salary and capital.

C. F. M. de Lange et al. [7] propose building a pork production management system based on the Pig Growth Model. Using knowledge about the nutritional value of substances, the dependence of pig growth on these substances, and the environmental impact of an animal, we can propose a model for the growth of pigs. Studying what-if scenarios helps in developing pig-breeding programs. The used – models in the industrial production of pork must take into account the biological processes of pig growth.
and must be flexible so that they can be easily oriented to the needs and special conditions related to specific breeding units. It is necessary to have sufficiently accurate data of all processes for the correct application of pig growth models in practice. For example, it would be useful to know the upper limit of body protein deposition for pigs can achieve under practical conditions, from the dependence of feed intake on the various stages of growth, and the presence of alternative feeding strategies are able to be explored. Pig growth models can be a valuable tool for helping producers to increase their pork production efficiency. In this case, the main indicators for measuring pork production efficiency, the authors propose the following indicators: the average daily gain (gr), Feed conversion, the slaughter-out-percentage (%), profitability (%).

A.E. Lines [8] notes, like many other scientists, larger enterprises use resources more efficient and, as a rule, are more profitable. A larger size leads to reducing production costs by declining share of overhead costs. At the same time, he considers the main indicators of the effectiveness for pig breeding are:

- the number of pigs from one main sow per year
- feed conversion
- capital costs.

CJ Stalder [9] uses the following pig production indicators in reports:

- The average daily gain, gr
- Feed conversion
- Age of livestock for slaughter, days
- Average live weight of sale, kg

Taylor-Pickard, J. A., and P. Spring notes that, “apart from price and feed costs there are a number of key performance indicators (KPI) that affect profitability of any pork business and these are whole herd feed efficiency and volume (pigs sold/sow/year and carcass weight). [10]”

3. The proposed system of criteria for assessing the effectiveness of pig production
Summarizing the opinions of the analyzed authors [1, 2, 3, 4, 5, 6, 7, 8, 9, 10], it should be noted that most of them associate the effectiveness of pig production in general with the efficient use of resources. However, most authors use the same set of indicators:

- number of piglets from one main sow
- from one farrow
- in year
- farrowing rate per year
- Average daily gain
- For fattening
- Totally in the herd as a whole
- Feed conversion
- In the herd, taking into account the costs of the parent herd
- Fattening
- Profitability (loss ratio) %
- age of livestock for slaughter, days
- average live weight of piglets for sale, kg

The resulting set of indicators covers various aspects of the pig enterprises work and is proposed as a set of indicators for assessing performance.
Thus, a system of criteria for evaluating the effectiveness of a pig-breeding enterprise has been developed. The use of the following indicators is proposed: the number of piglets from one main sow (per farrow and per year); number of farrowing per year; average daily gain (in fattening and in the herd as a whole); feed conversion (for the herd, taking into account the costs of the parent herd and for fattening); profitability (loss ratio)%; age of livestock being slaughtered, days; average live weight of sales, kg.

4. Development of a KPI system in pig-breeding enterprises, taking into account the criteria for evaluating the effectiveness of the enterprise

Management in animal husbandry is the choice of a specific farming method from a number of alternative production methods, taking into account the differences in breeding and nutrition systems, genetics, feed and feeding programs, keeping conditions, etc. [15].

Optimization of management processes most often reduced to solving the problem of optimal feeding (i.e., determining the composition of ingredients, the percentage of vitamins and minerals, etc.) and optimizing the genetic material (genotypes obtained from the breeding herd or from the finishers) and the method insemination, as ways to improve the quality characteristics of the herd. The enterprise productivity will depend on these production factors, which will affect economic efficiency. Nowadays, the complexity of animal husbandry systems in rapidly changing circumstances is widely considered. High competition does not allow to be restricted by the extensive growth of production; it has to pay attention to the efficiency of farm management and continuously engage in intensification of production.

Company policy should include a system of motivation and incentive for labor. The right system will help for the enterprise to achieve its goals. For this, the dependence of the characteristics of the enterprise state on the characteristics of the results of the employees’ activities should be determined.

Consider the standard incentive system in the enterprise. Often, employee salaries include salaries and bonuses. Bonuses in this case are a stimulating bonus. A correct, competent incentive system should be consistent with the goals of the enterprise as a whole, and then each employee will be interested in achieving the goals of the enterprise. The complexity of creating an effective system of labor incentives is associated with the need to solve three problems:

- to determine such indicators of employee labor efficiency that contribute to the improvement of the necessary indicators of enterprise efficiency, the indicators should have planned values
- to achieve understanding by employees of the dependence of labor efficiency indicators on their actions,
- to create a system for assessing and recording the achievement by employees of these indicators and a bonus system.

A typical Russian bonus system based on one enterprise is considered in this research. Prior to the beginning of 2018, Vostochny LLC has historically developed a bonus system for employees aimed at completing the process, rather than achieving a specific result. However, despite of the existence of an incentive system, most employees did not know about the specific bonus indicators for which they received bonuses, as any awareness-raising activities were not, also any specific bonus indicators were not specified in the payroll sheets. In addition to the salary and the district coefficient, the company had a number of bonuses:

- Award from the fund of the department head
- Award to managers, specialists and employees for key business results
- Award for labor intensity indicator
- Award to managers, chief specialists for financial results of economic activity.

In the total amount of the wage fund, the salary was about 40% of the total amount of payments, respectively, for the remaining lines, the total payments amounted to about 60%.
A bonus from the fund of the unit head is a certain amount of money that was distributed directly by the head of each unit (site) at his own discretion, without explanation. Some managers distributed the amount equally among all employees, but often each one allocated “favorites” to whom he paid more than the rest. The presence of the unit head of its premium fund on the objective side is explained as follows.

Firstly, the immediate supervisor knows better the specific employee, his effectiveness, and secondly, for the manager it is an additional tool for managing the employee through the stimulation of his work.

The award to managers, specialists and employees for the main results of economic activity is exactly that part of the award that was paid for the achievement of certain production indicators. Below we will examine these indicators in more detail and make sure that in most cases, employees could not influence the performance / non-fulfillment of these indicators by their own efforts. How, when and why precisely these indicators were adopted remains unknown, and by and large is no longer relevant. It is only important to note that the majority of employees (as shown by the results of the survey) did not know the indicators, and especially the target values of these indicators, for which they should have been awarded a bonus. Alas, this system did not stimulate the employees of the enterprise to perform their work duties more efficiently.

The bonus for the indicator of labor intensity - as the manager’s fund, this part of the bonus could be redistributed among the employees of the unit by their leader, on the base of additional work. In the case, one of the employees did not leave. For example, if a loader was on vacation in January, then over the days of his vacation part of his bonus was redistributed among the rest of the unit’s employees and was called “labor intensity”. The difference from the leader’s fund was that the FR is one “common boiler”, which the manager distributed as he wanted, regardless of merit. Intensity - this is part of the bonus for a particular employee, which this employee could be deprived in case of vacation / absenteeism / refusal to come to work. If in fact there were no complaints about the employee’s work, then they could not be deprived of labor intensity.

Premiums for managers and chief specialists for financial results of economic activity. Since the financial results of the enterprise are a commercial secret, such information is not for disclosure, often it cannot be double-checked by the recipient of the award.

The existing system of labor incentives required constant accounting and control, in connection with which the heads of divisions (site managers), direction directors, and the manager, who calculated, checked, double-checked, agreed and approved these figures, were involved in this process. Even with the objective need for changes to the labor incentive system, and especially its simplification, the established organizational and managerial structure of the enterprise is not always interested in changes and can defend the old, established system (so as not to be left without work).

As a result, the essence of changes in the system of labor incentives should be reduced to changes in bonus indicators, so that people understand how to influence the achievement of specific indicators, they begin to understand these indicators and their values. Also, during optimization of the incentive system, an indicator of the cost of pig production was introduced to all employees, without exception, and the indicators introduced became economically significant in reducing the cost of production in general.

The changes introduced should be accompanied by explanatory work, and even better so that the incentive system was created with their direct participation. Introduced employee performance indicators should be specific, measurable, achievable and clearly defined in time. Also, each employee should be able to personally influence them through his actions.

During the implementation of the new system, the following actions were taken:

- Introduced an indicator of the cost of pig production for all employees at all levels. The economic feasibility of such a change is obvious. The goal of any commercial enterprise is to make a profit, and taking into account the fact that the selling price is an external factor (income depends on the price), the company can change profit by changing costs (expenses depend on cost).
The feed conversion indicator as an indicator of labor efficiency was excluded for all employees. In fact, in daily work, personnel cannot control feed conversion, just as they cannot, for example, manage the actual (honest) number of live births. The conversion depends on the loss of feed (proper adjustment of the feeders) - which is monitored at the enterprise with periodic walks (so that the feed does not wake up). Then, in fact, the conversion depends on many quality indicators of the feed, both on its composition (recipe set) and on the quality of the preparation (mixing quality, particle size distribution). In theory, the person responsible for determining the required composition (recipe) of feed is at the enterprise. However, the actual composition of the feed may differ from the necessary, as many factors affect this, including: the quality of mixing, the quality of the feedstock, etc. Therefore, the conversion was excluded as an indicator.

The existence of a conversion indicator can lead to harmful behavior of employees, for example, fattening pigs can be artificially limited in feed so as not to overuse compound feed and to fulfill the conversion indicator. At the same time, the growth rate slows down and, interestingly, the conversion from such an action only increases (worsens). However, ordinary operators, not understanding the intricacies of all processes, did not understand the harmfulness of such behavior.

The indicator was removed the number of live-born piglets (for all, including inseminators) - because this indicator depends on many factors that are practically uncontrollable in the daily work of people. For example, from the genetics of sows, or from the quality of compound feed (content in it of the necessary level of vitamins / minerals, lack of mycotoxins). Compound feed is brought "as is", and employees are not able to influence its quality, nor can they evaluate the quality of the feed (this requires complex laboratory analysis).

Introduced the indicator plan for the number of inseminations for inseminators - this indicator is extremely important to ensure the rhythmic receipt of piglets, and it is important not only to make a certain number of inseminations per month, but to do it evenly for a month. A week (7 days) was taken as a quantum. It was determined that every 7 days in the East it is necessary to inseminate at least 320 and not more than 340 sows and repair pigs. If in each of the 4 weeks of the month the number of inseminations fell within the established range, the indicator was considered fulfilled. In case of failure only within 1 week per month - the indicator is partially fulfilled. Two or more “misses”, and the indicator is not fulfilled. In pig farming, the number of inseminations can be controlled. During the first 8 days after weaning, 85-90% of sows come into the hunt (and inseminate). Knowing the daily number of weaned pigs, we can accurately predict the number of inseminations of sows.

With the correct organization of the work of stimulation and registration of sexual hunting with rhinoceros, it is also possible to predict the number of animals accurately that will go hunting in a given period. In the event of a shortage, it is required to timely carry out additional stimulation of the reinserts, as well as some other measures leading to an increase in the number of animals in the hunt that can be fruitfully inseminated.

In the farrowing area previously there was an indicator of the safety of piglets. At the same time, part of live-born piglets (small and weak), instead of giving them special care and proper attention, simply gave up for slaughter. It did not go to death. Piglets could be slaughtered for both newborns and weaners. This was called “special slaughter through the slaughterhouse. Thus, the enterprise was deprived of a certain number of piglets (about 7%), and the piglets surrendered "by eye", all those that seemed to employees weak or lagging behind in growth. Of course, some (small) part of the handed over piglets for canned food - really were potentially weak. But in most cases, employees simply reinsured, leaving themselves the best livestock so that it would be easier to work in the future, while there would be less mortality. As practice has shown, after the delivery of piglets for canned food was prohibited, and the employees were motivated to properly care for weak piglets, the mortality rate for growing was even reduced, despite the fact that the number of taken pigs per 1 spawned sow increased by 0.8 piglets.
In addition to the foregoing, the safety index in a large pig complex, subject to a small deal with conscience, is quite easy to adjust by reducing the number of live-born piglets. The death of piglets in farrowing occurs mostly in the first 3-5 days. During this period, the piglets are still small and weak. The head of the site (the person responsible for posting the offspring and writing off the case) can easily reduce the number of piglets born by an nth number, while reducing the number of dead piglets in the documents by the same nth number. Thus, the total number of live piglets on the site will converge with the accounting documents, the mortality rate will not exceed the required set values, and the number of live-born piglets will be reduced. To check and track these frauds is possible, but very problematic, because it’s not necessary to do this every day. Given the large volumes of the East, it is enough to choose 1-2 days a week to knock out the numbers.

In mid-2017, they were adjusted so that safety levels were at 93% - this is a very high% for the farrowing area. For example, even on the best, new farms with a very healthy livestock population, 91% is considered a very good indicator. This is provided if all the figures are true. Therefore, as a result of the reform of the labor incentive system, instead of 2 indicators that do not meet the goals of the enterprise (the number of live births asked and the safety of piglets), 1 indicator was introduced that combines both indicators, and at the same time is consistent with the production goals of the enterprise - the number taken piglets per 1 farrowing sow. Thus, on the one hand, they were forced to register all farrowings (since the number of farrowings directly affects % of economic fertility, for which a premium of the insemination section is awarded). On the other hand, it was as if they were allowed not to register the born piglets, they were allowed to kill the "weak", but they explained to people that you still get the prize (or not) for the number of piglets taken. And if you undergo euthanasia of a weak piglet, or if you don’t give it proper care, then it certainly won’t live up to weaning, and if it is well taken care of, then there is every chance that it will survive and grow, accordingly, it will put you a ruble in the bonus piggy bank. In this case, no one will scold you for death. In fact, “weak” piglets very often survived, with due care. Moreover, care had to be taken only in the first 1-3 days, then the “weak” piglet became almost indistinguishable from all the others, not weak, and sometimes overtook its cousins in growth rate. At the same time, we began to control and encourage honest accounting in every possible way, presented the achievement of the number of live-born piglets as the pride of the team.

- Instead of the average weight of 1 weaned piglet, the indicator introduced the total weight of the weaned nest. Those. if earlier it was profitable to take 10 large piglets (8 kg each, for example, and get a bonus for an average weight of 8 kg) and send 2 piglets 5 kg each for canned food, then after entering the indicator, the total weight of the removed piglets per nest - each piglet taken (even small) began to add weight to the general piggy bank, thereby we also stimulated people to provide proper care to weak piglets.

- In the areas of growing and fattening, it was decided to replace the average daily gain by the average weight of the transferred (sold) pigs. At first glance it may seem that they changed the awl for soap, but in reality this is not so. If earlier employees could prepare a section for 10-15 days (wash, repair equipment, disinfect) and this did not affect the weight gain, now, reducing the time for preparing the sections, it became possible to keep animals longer, thereby providing them with an additional set of live weight with each extra day. Thus, the action of people was coordinated with the ultimate goal of the enterprise - that is the sale of increased kilograms of meat.

If earlier one often had to hear a million reasons why it is impossible to prepare a section faster than 10 days, then as a result of the changes, preparing a section for rearing began to take 2-3 days, and for fattening 4-6 days.

Unchanged in the rearing and fattening were left indicators on the safety of livestock. We changed only the values of the indicators depending on the season, epizootic situation and some other factors. At
the same time, we first completely prohibited any sort of culling (either we raise a normal conditional pig, or we subject the animal to euthanasia and record it in the case) - so that people promptly identify and treat sick animals. But after in the issue of culling, we rolled back, because there were many sores, and euthanasia added significant numbers to the case. This, in turn, turned out to be a “red rag” for the state and security services of COMOS. We returned the culling by setting stringent criteria of culling, balancing between the culling amount and the percentage case.

For greater manageability in the East, all indicators began to be tracked weekly, although at the same time, the payment of premiums was for the total monthly results. This made it possible, on the one hand, not to violate the managerial traditions of the enterprise, and on the other, to achieve greater flexibility and to notice changes in a timely manner, and, if necessary, to carry out corrective actions faster.

When developing an incentive system, the response of personnel to the introduction of such a system should take into account. If the system is complex or difficult for rechecking, the staff will not understand by what actions they can change their incentive allowance.

5. Conclusions
A system of criteria for the evaluating effectiveness of a pig-breeding enterprise has been developed. The use of the following indicators is proposed: the number of piglets from one main sow (per farrow and per year); number of farrowing per year; average daily gain (in fattening and in the herd as a whole); feed conversion (for the herd, taking into account the costs of the parent herd and for fattening); profitability (loss ratio)%; age of livestock being slaughtered, days; and average live weight of sales, kg.

Thus, it has been proved that one of the organizational and economic mechanisms for management of the enterprise effectiveness is the development of such a system of key performance indicators for personnel, which determines the dependence of the enterprise effectiveness on staff performance indicators.

A system of key indicators of personnel efficiency was proposed in the work, and also a labor stimulation was determined for improving of these indicators, which ultimately leads to an increase in the efficiency of the enterprise as a whole in the work.

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