The Recognition and Valuation of an Asset's Productivity in Business Accounting and Reporting

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Abstract:

In this article we have considered the problems of classification and recognition of a specific type of asset, namely cattle embryos, as well as analyzed the characteristic features of this type of asset. We also substantiated its recognition as a biological asset in accordance with IFRS 41 "Agriculture".

The possibility of applying the approach to embryos' valuation by means on fair value has been proved based on the convergence of selection calculations' methods and the income discounting method.

The calculations have shown that the evaluation of the embryos depends on conditions and patterns of their usage. The results of the study will allow more reasonably forming professional judgment in the primary recognition of the biological asset and its valuation at the reporting dates in the financial statements.

Keywords: IFRS 41 "Agriculture", dairy cattle embryos, business accounting, valuation, fair value of dairy cattle embryos, biological assets, selection calculations.

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1. Introduction

Modern technologies are associated not only with ensuring the animals' growing processes, but also with obtaining genetically most high-quality animals, which are able to significantly improve the genetic potential of the herd or population. Embryo transfer is a promising way to achieve this goal. But business accounting issues of such assets are practically not covered in the scientific literature.

2. Literature review

Whitingham (1974) a pioneer in the field of in vitro production of animal embryos, spoke about the positive role of embryo banks and the need for their development for genetics as a science, as well as for the purposes of breeding, as far back as in 1972 (Whittingham, 1974). Experts of the EU countries have estimated that the economic effect from the use of the modern approach, i.e. genomic breeding, per one servicing bull amounts to about 20 thousand Euros (Goddard and Hayes, 2007).

Unfortunately, traditional domestic selection was based on linear breeding, i.e. through the male parent (bulls). Long-term stagnation in breeding has led to the fact that 100% of domestic servicing bulls, according to the data of JSC "Moscowskoye", in terms of breeding, are animals of foreign breeding. However, it is obvious that the calf receives 50% of the genetic material from the mother cow, but mother cow's reproductive capacity is limited. One cow can give just one calf per year. Twins are extremely rare. Since the 1980-ies, in developed countries embryo transfer has been used as a way to speed up breeding through the mother cow. At that, 80% of all servicing bulls in the world, which give semen, were obtained through embryo transfer (Nikitkina *et al.,* 2011).

The complexity of this reproductive technology deters investors because of the high cost of equipment, and lack of specialists. Consumers in Russia are also cautious about this method, which is certainly a progressive way of conducting breeding work.

In general, the issues and approaches to determining the economic effect of breeding programs have been covered since the early 70-ies. Brascamp (1974) studied this problem through the example of raising beef cattle and proposed, in particular, to calculate discounted cash flows of income per one cow as an efficiency criterion. In 2017, the Russian business accounting standards were supplemented by amendments, which declared the priority of international financial reporting standard (IFRS) over domestic business accounting and reporting rules. In this connection, in our study we set the task to develop approaches to the recognition and evaluation of embryos in business accounting of dairy cattle breeding.

It should be noted that scientific articles that have emerged in recent years are related not only to the embryos' obtaining and transplantation processes, but also

devoted to the economic efficiency of these technologies. In particular, noteworthy are the works of Kaniyamattam (2017; 2018) which are dealing with the most profitable use of embryo donor cows. Based on stochastic modeling, the authors have proved the optimal model of business processes of the breeding company. Russian authors Abasheva and Lopatina (2017) also point out the positive effects of using embryo transplantation technology. According to them, the profitability of milk production based on this technology may double within 5 years.

Likhoman and Usenko (2016) note that in practice of the Russian agricultural companies, embryos' transfer technology is actually used, but it is necessary to raise the rate of embryos' survival, because it significantly affects the economic effect of reproductive technologies.

As for the issues of business accounting of animal embryos, their recognition and evaluation, we have not found such works published neither in Russian nor in English that confirms the relevance of research in this area, because scientific biotechnology has confidently emerged into the practice of cattle breeding. In addition, this is a very capacious business in terms of investment. Investors, breeding firms, and agricultural companies need unbiased information that allows making decisions with regard to this very specific asset, namely the embryo of an animal.

3. Research results and discussion

The first issue we investigated was the recognition of the embryo as an asset. To what kind of asset it can be attributed? We have put forward two hypotheses:

1) the embryo is a biological asset;
2) the embryo is a material (raw material) or stock obtained as a result of collection.

It is extremely important getting an answer to this question as it determines further approaches to business accounting and reporting. Table 1 presents the main definitions of standards, which allow adopting one of the hypotheses.

Table 1: Definitions of IFRS

Criterion	The embryo is a biological asset	The embryo is a material [2]
Definition of IFRS	The IFRS 41 "Agriculture" lacks the definition of embryo.	The IFRS 2 "Inventories " lacks the definition of embryo
Definition of an appropriate accounting standard	Biological assets are plants or live animals. Transformation process creates growth, anatomical degradation of living cells of	Inventories should be assessed based on the lower of two values: by cost value or by net selling

	production or those that cause qualitative or quantitative change in the biological asset. A harvest is a removal leading to the termination of vital processes of a biological asset.	price

As for the modern status of this issue, we have come to the conclusion that this aspect has been very little studied. Discussions on the concept of the embryo are usually taking place in relation to human embryos. And they revolve around the issue of whether the human embryo is a living organism. Here, of course, we do not discuss the issue of whether the human embryo is a human. This is definitely beyond the subject of our research. The authors agree that here the key point is the ability to function independently and be unique.

The IFRS 41 "Agriculture" does not include an exhaustive list of biological assets. And our research has shown that there are different kinds of biological assets that are not included in IFRS, though can be the objects of agricultural activity. Modern technology requires an expanded interpretation of the definitions formulated in IFRS 41, not based on formal reading, but rather based on the professional judgment. Such an approach, in our opinion, allows including mycelium, algae plantations, and bacterial cultures (colonies) in the biological assets (Shadrina, 2017; Nechaev and Antipina, 2016).

Embryos of animals obtained in consequence of stimulation of multiple valuation function within 7 days are biologically transformed independently, but under human control. Specialists in embryology study and create special nutrient media for 30 years, experimenting with temperature conditions, etc. (Eyestone and First, 1989). Thus, the asset is controlled by the person or the company. After embryo transfer, its functioning depends on the mother cow's body (nutrition, oxygen exchange, etc.).

Proceeding from this standpoint, we believe that the embryo of an animal does not differ from the human embryo. The processes of embryogenesis are absolutely identical. Therefore, the embryo of the animal can be considered as a biological asset in the period of its being outside the organism of the animal recipient. The process of obtaining embryos can be carried out using two technologies – *in vivo* or *in vitro* (Table 2).

Also, modern biotechnologies allow obtaining sexed embryos, i.e. embryos with a predetermined sex. For dairy cattle breeding, embryos with a set of sex chromosomes XX are preferred, while for example, in raising beef cattle male embryos (with XY chromosomes) are preferred. Sexing semen requires the use of expensive equipment. Besides, the consumption of semen increases twice. However, Likhoman and Usenko, (2016) argue that sexed semen is a significant factor in

obtaining economic benefits from embryo transfer (Japparova and Rupeika-Apoga, 2017).

Table 2: *Technologies – in vivo or in vitro*

	Ovulation stimulation	Obtaining sexed semen or ordinary semen					Freezing and storage	Defrosting and transplantation
in vivo			Insemination of donor cows	Preparation of recipient heifers	Embryo production by flushing	Fresh embryo transfer		
in vitro			Receiving ovicells from donor cows	Fertilization of ovicells	Preparation of recipient heifers	Embryo cultivation and transfer		

Thus, at some point in time, including the reporting date, the agricultural company may have certain number (n) of frozen embryos. We understand that the freezing process "suspends" the vital functions of the animal, but this is not identical to the termination of the process. Consequently, the embryo is a living organism of the animal, which is at an early stage of development and has the entire set of genes, which determine its value and uniqueness, in both genetic and economic sense. The embryo of an animal, in our opinion, can be recognized as a biological asset. It is the expression (manifestation in traits) of genes that determines the economic benefits of the asset in the future and is the main reason for investing in reproductive technologies or the purchase of embryos.

4. Research methods

a. *The convergence of selection calculation methods and discounting method to determine the fair value of embryos*

In the absence of a market of active cow embryos we make use of the cash flows discounting method in relation to the embryos of animals, because these biological assets do not finish their existence, rather turn into heifers and cows, and then are able to produce again new biological assets and give products. Against this background we have investigated the possibility of using selection calculations for the purpose of determining the fair value of the cattle embryo (Dudova, 2009).

Determination of fair value by discounted cost is based on the assumption that the potential investor (buyer) will not pay an amount greater than the present value of future cash flows; in turn, the seller will not sell at a price lower than the present value of projected future income. In consequence of this balance, the parties will agree on a market price equal to the present value of future earnings (Albekov *et al.,* 2017; Grima 2012).

The approach based on discounting of cash flows generated by the asset requires calculating the amounts of benefits. Benefits from the use of embryos in breeding are stipulated by the reduction of time for the shift of mean value of the partitioning feature of the herd after breeding. The intensity of directed breeding is determined by the breeding pressure, i.e. the percentage of cows to be replaced in the herd (Shadrina, 2003; Kachkova *et al.,* 2018). Traditional breeding methods are limited by the number of herd replacements with high productivity of parents. Even advanced farms cannot replace more than 20% of animals per year. At that, the breeding differential is not large, as most of it is due to the selection trend caused by the productivity of male parent due to artificial insemination. Also, more intense breeding pressure due to replacement of cows with heifers born from transplanted embryos, will allow reducing such an indicator as the generation interval.

In our study, we found it appropriate to apply a synergistic approach, combining selection calculations and methods for determining the fair value of biological assets by discounting technique, in order to verify its validity in the practice of business accounting and financial reporting. Besides, the technology of embryo production and transplantation was also studied, and some quantitative characteristics were used in financial calculations. We calculated the breeding differentials and the effect of breeding in traditional breeding and (*in vitro*) embryo transfer based on milk production, namely the yield of milk.

1. Selection differential (with respect to mother cows) was the difference between the average values of the partitioning feature of animals selected for reproduction (nucleus) and the initial population (herd before selection). It was determined by the formula:

$$Sd = \overline{X\,b} - \vec{X}_c \tag{1}$$

where Sd was the selection differential by mother cow; $\vec{X}_b$ was the mean value of selectable feature of animals of nucleus or embryos' donors; $\vec{X}_c$ was the mean value of selectable feature of the original herd.

2. The selection differential by male parents (Ss) was determined taking into account the fact that donor bulls were evaluated by the quality of the offsprings.

$$Ss = 2 \times (\overline{D} - \overline{C}) \tag{2}$$

where $\overline{D}$ was the average productivity of daughters of the estimated producer; $\overline{C}$ was the average productivity indicator of the peers of daughters of the servicing bull. In our model, we were based on data from the embryos' maps of the Breeding and Genetic Center, in which the average differential of bulls was quite high, equal to 500 kg.

3. The total effect of breeding per generation, taking into account the selection differential by bulls and mother cows, was determined by the formula:

$$SE = \frac{Sd \times h2 + Ss}{2} \tag{3}$$

where h2 was the coefficient of heredity of the partitioning feature (for example, milk yield);

In the calculations, h2 with respect to the yield of milk was taken equal to 0.32. Coefficient 2 showed that the descendant received half of the inheritance from the male parent and half from the mother cow. Thus, the effect of selection is directly proportional to the selection differential and the heritability estimate of the considered trait, and is inversely proportional to the interval between generations. The effect of selection for the year, taking into account the interval of digenesis, was determined by the formula:

$$SEy = \frac{Sd \times h2 + Ss}{2L} \tag{4}$$

where L was the intergenerational interval expressed in the years.

The intergenerational interval is the period from the birth of an animal to the birth of its first offspring used for breeding. The use of embryo transplantation technology accelerates digenesis, thereby increasing the value of the indicator of breeding effect of a generation per year. At traditional breeding methods, intergenerational interval is about 5 years or more, because offsprings of both sexes are obtained. Further, the bull-calves are culled.

b. The initial conditions for the simulation

The dairy farm has 100 cows in the herd with an average productivity of 5,500 kg of milk per year, while the average productivity of the nucleus is 7,700 kg. The farmer has used the traditional artificial insemination with the bull's semen with a selection differential equal to plus 500 kg. The herd replacement is no more than 20% per year.

It was decided to purchase frozen sexed embryos (♀) in order to intensify breeding and increase milk productivity of the herd. Productivity of embryo donors (cows) was 10,500 kg. At the reporting date they were frozen. The farmer expected to use them during two years to update the herd. In our model, we did not assume extended reproduction of the herd. To determine discounted cash flows, we had developed a multiscenario breeding model to verify the hypothesis that the value of a biological asset was determined not only by its genes, but also by the conditions of its use.

5. Results and discussion

The table presents the calculations according to three breeding scenarios. The first scenario involves the use of own replacement heifers and the annual replacement of 20% of the livestock, which is the maximum achievable rate.

The second scenario involves the transplantation of sexed (XX) embryos and the assumption that 20 successful pregnancies require 40 embryos. That is, the survival index is 0.5. After calving, the recipient cows (surrogate mother cows) are culled.

The third scenario assumes replacement of cows in the herd by 40% by obtaining offsprings from surrogate cows with their subsequent culling. The calculations of the 3rd scenario have been divided into two parts, because we took into account the fact that the acceleration of the digenesis would affect the calculations of the selection differential (Table 3).

Table 3: *Indicators of breeding scenarios*

Indicator	1st scenario	2nd scenario	3rd scenario	
	The self-replacement of the herd (replacement of 20% of the livestock)	Transplantation of sexed embryos (replacement of 20% of livestock)	Transplantation of sexed embryos (replacement of 40% of livestock) First generation	Transplantation of sexed embryos (replacement of 40% of livestock) Second generation
Milk productivity, average by herd per year, kg	5,500	5,500	5,500	6,006
Productivity of the best cows (mother cows of embryos), kg	7,700	10,500	10,500	10,500
Selection differential of mother cows (Sd)	2,200	5,000	5,000	4,494
Selection differential of male parents (Ss)	500	500	500	500
Heritability estimate (h2) (according to Kushner 0.30-0.42)	0.32	0.32	0.32	0.32
Selection effect (SE), kg	363	506	506	480
Intergenerational	5.0	4.5	2.8	2.8

interval, (L), years				
The breeding effect for the year (SEy), kg	72.5	112.4	180.7	171.5
Number of cows in the herd	100	100	100	100
The breeding effect for the year per herd (SUMM SEy), kg	7,253	11,244	18,071	17,146
Milk price of basic year (Pm), ruble per 1 kg	24	24	24	24
Economic income from breeding (FV1), rubles	174,067	269,867	433,714	411,508
Purchase price of 1 embryo (Pe), rubles	x	16,000	16,000	16,000
Survival rate of embryos	x	0.5	0.5	0.5
Number of embryos purchased for transplantation, pieces	-	40	80	80
Total cost of embryos (Total C)	-	700,000	1,400,000	1,400,000
The cost of embryos' transplantation, synchronization of sexual cycles, etc. (per 1 transplantation) (Cte)	x	3,000	3,000	3,000

Thus, in the third year, the average productivity of the herd will grow up to 6,006 kg of milk. Therefore, selection differential of mother cows will decrease and the effect of breeding will slow down to 171 kg.

Calculations objectively prove that during embryo transplantation and selection pressure of 20 or 40%, the growth of productivity per year per head will amount to 180 and 112 kg, compared to 77 kg at conventional artificial insemination. Given the

productive life of the cow born from the embryo, its net income is much higher due to sizeable growth of productivity.

The assessment of the embryo as an asset should reflect the future return on the asset. The calculation of discounted net income by scenarios is shown in Tables 4 and 5. As a discount rate, we used a risk-free rate (5%) plus a risk premium (5% + 0.4% = 5.4%).

Table 4: *Calculation of the fair value of embryos for breeding according to the 2nd scenario*

Indicators	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	Total
Income from cows culled from the herd of recipient cows (FV0), thousand rubles		1,012						1,012
Income from the sale of milk obtained as a result of the selection trend in productivity (FV1), thousand rubles	-		188.9*	269.9	269.9	269.9	269.9	1,268
Income from reduction of unit cost at productivity growth (FV2), thousand rubles			28.3	40.5	40.5	40.5	40.5	190.3

	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	Total
The cost of the embryos' acquisition, transfer, and storage	700							700
Net income (NV), thousand rubles	-700	1,012	217	310	310	310	310	1,771
Net present value (PV), thousand rubles	-700	911	186	251	239	226	215	1,328

The fair value of 1 embryo is 33,192 rubles = 1,327,675 / 40

Table 5: *Calculation of the fair value of embryos for breeding according to the 3rd scenario*

Indicators	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	Total
Income from cows culled from the herd of recipient cows (FV0), thousand rubles		2,024						2,024
Income from the sale of milk obtained as a result of the selection trend in productivity (FV1), thousand rubles			303.6*	433.7	433.7	411.5	411.5	1,994
Income from reduction of unit cost at productivity growth (FV2), thousand rubles		-	45.5	65.1	65.1	61.7	61.7	299.1

The cost of the embryos' acquisition, transfer, and storage	1,400							1,400
Net income (NV), thousand rubles	-1,400	2,024	349	499	499	473	473	2,917
Net present value (PV), thousand rubles	-1,400	1,822	298	404	383	345	327	2,180

Revenues are determined taking into account the coefficient of 0.7, which characterizes the incomplete year of productivity, because the lactation in heifers starts from 26th-27th month of life. The fair value of 1 embryo is 27,254 rubles = 2,180,342 / 80 (see Table 6).

Table 6: *Evaluation results of the biological asset*

Scenarios	Evaluation of 1 embryo at actual cost, Ruble / USD	Evaluation of 1 embryo at fair value, Ruble / USD
2nd scenario	16,000 / 258	33,192 / 535
3rd scenario	16,000 / 258	27,254 / 440

6. Conclusion

Valuation of the biological asset (embryo or their homogeneous population) should be carried out both at the time of initial recognition, and at the end of each reporting period. After all, the fair value of biological assets can change. The above calculations have shown that the embryo's valuation in the reports depends not only and not so much on its price, but on how to use it. Exactly the use generates economic benefits.

Also, a very important conclusion can be drawn with regard to the environment where the embryos of cows are used in dairy cattle breeding. If a farmer has bought or received embryos from highly productive donor cows on his own, and his herd is also highly productive, then it is not worth for him expecting for high milk yields. This is confirmed by presented calculations of the selection differential. The fair value of such embryos will be much lower than those in the environment with the average milk yields (for example, in the agricultural firm). Thus, the selection laws and calculations can be quite applicable for the estimation of the net income, subject to discounting, in order to determine the fair value of the concerned biological asset.

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