Waste management system in the brewing industry

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Abstract. Waste management implies such an organization of an enterprise economic activity in which, at the lowest possible level of environmental pollution, an organization creates the prerequisites for efficient utilization, reuse and imparting additional useful properties to waste in order to obtain an additional economic effect. In the Samara region, significant financial resources are spent annually on waste disposal activities, which could be used to increase production efficiency in industry and agriculture. Only current costs of environmental protection from 2011 to 2016 increased from 7.3 to 10.3 billion rubles or by 41.0%. In addition to this, investments in fixed assets related to environmental protection amounted to 2.3 billion rubles in 2011, up to 5.9 billion rubles - in 2014. Among the various types of pollution, solid waste ranks second (about 30%). In the brewing industry, the main type of waste is brewery mash, formed from grain residues. To properly dispose of it, a large area for storing waste is required, and the possibility of use in the future as an organic fertilizer. All this requires significant capital and disposal costs. At the same time, the brewer can be used as a high-quality feed. The article proposes a waste management system that provides for the interaction of the beer industry enterprises with pig-breeding complexes. Activities include the use of brewery mash as a valuable feed for the replacement of concentrated feed. As a replacement result, daily gains increase by 5-7%.

1. Introduction

In the current situation, the role of waste in the country's economy is very large. They are performing a dual function. On the one hand, waste is a brake on the industry and agriculture development, diverting considerable financial resources from the production process, which in another situation was an additional economic and investment reserve [7, 17-20]. For example, only in the Samara region, the current costs of environmental protection in 2016 amounted to a huge amount – 10,2 billion rubles. (table 1). Adding to it targeted investment costs, we get a forced annual reduction in the development potential of the region in the amount of 10 to 15 billion rubles. Among the various types of pollution, solid waste ranks second (about 30%) [1, 2].

Table 1. Current costs and investments in fixed capital aimed at environmental protection in the Samara region, mln. rub.

Indicator	2006	2011	2012	2013	2014	2015	2016
The current costs of environmental protection, total	5647,6	7294,2	7248,9	8306,7	8796,2	9561,5	10283,4
on the treatment of the wastes	722,9	806,4	1016,6	1285,8	2623,2	2990,6	3072,5
In % to the total volume	12,8	11,1	14,0	15,5	29,8	31,3	29,9
Investments in fixed assets, total	985,8	2298,4	2851,4	3592,8	5915,8	4792,1	2358,4
Total	6633,4	9592,6	10100,3	11899,5	14712	14353,6	12641,8

Note: calculated according to the data of the Russian Federation Federal State Statistics Service.

On the other hand, with the right approach, waste plays the role of an additional source of funds, a reserve for reducing the cost of production [9-11]. A striking example is the situation with the waste of the brewing industry. The main type of waste in beer production period - brewery mash. It is formed from the sediment remaining during cooking and sucking off the wort [14]. Consists of the grain remains of barley or other crops [6]. The chemical composition of the brewery mash are given in tables 2, 3, 4 [3-5].

Table 2. The total chemical composition of dry brewery mash

Name	% content
Crude protein	23,44
Crude fiber	14,3
Crude fat	7,73
Ash	2,5
Calcium	0,37
Phosphorus	0,5
Moisture	8,67
N-free extractive substances	43,34

Table 3. Content of basic microelements in dry brewery mash

Name	Contents
Calcium, %	0,37
Phosphorus, %	0,50
Manganese, mg / kg	52,0
Zinc, mg / kg	105,0
Iron, mg / kg	205,0
Copper, mg / kg	15,0

Table 4. Amino acid composition of dry brewery mash

Name	% content
Lysine	0,86
Histidine	0,66
Arginine	1,07
Aspartic acid	1,35
Threonine	0,77
Serine	0,89
glutamic acid	4,57
Proline	2,05

Glycine	0,79
Alanin	0,94
Cystine	0,46
Valin	1,06
Methionine	0,50
Isoleucine	0,79
Leucine	0,57
Tyrosine	0,61
Phenylalanine	1,23

2. Research methods

In the traditional approach, the beer pellet is either disposed of at the waste landfill or on a special site organic fertilizers are prepared from them [8]. To properly dispose of it, a large area for storing waste is required, and the possibility of use in the future as an organic fertilizer [15, 16]. All this requires significant capital and disposal costs. As shown by numerous studies and the existing practice of agricultural enterprises, the brewery mash, with appropriate organization of production and marketing of waste, can be a valuable feed for almost all groups of farm animals [21-26]. The main obstacle for this is the short shelf life of a wet brewery mash [12, 13].

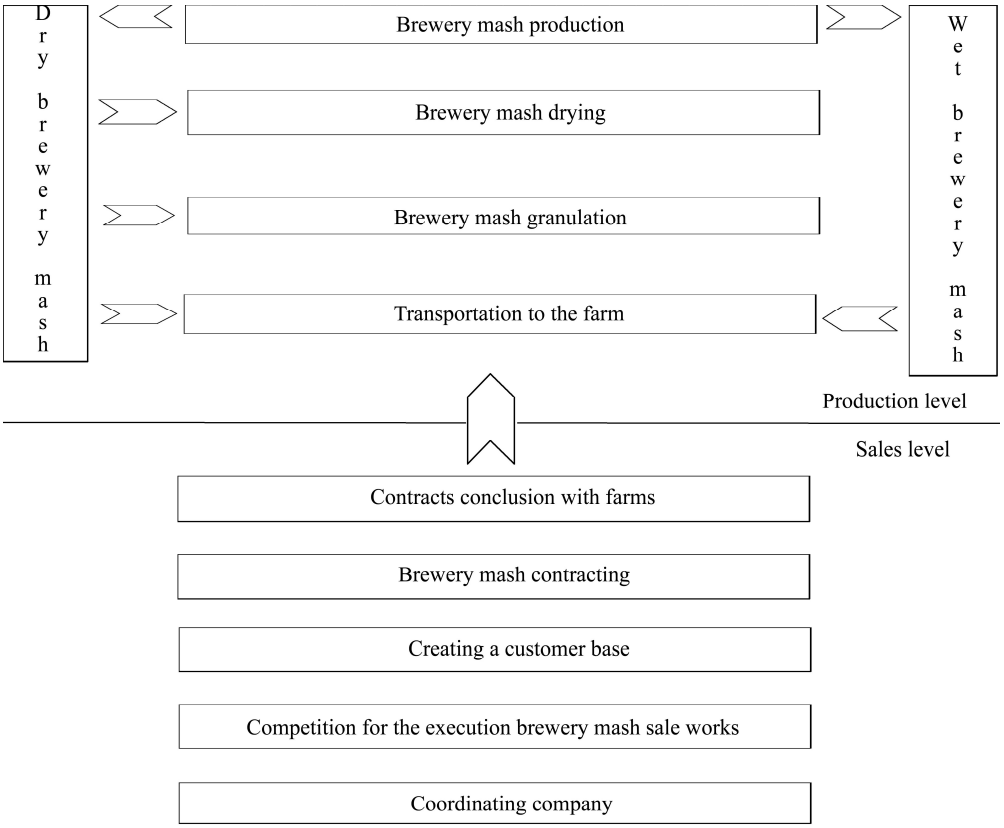

Figure 1. Elements of the waste management system in a brewing company (for example, brewery mash)

In the Samara region, the following waste management scheme is used to reduce the cost of waste disposal and obtaining additional economic effect at breweries. (Fig. 1) The system is based on two main elements: the construction of production for drying and granulation brewery mash, due to which the period of possible brewery mash use increases dramatically, the possibility of transporting the product improves, the possibility of using brewery mash as a component of compound feeds appears

(production level); transfer to the outsourcing function for the implementation of the brewery mash, which reduces the risks for the implementation of the product (sales level). The coordinating company is determined by the results of an annual competition, which allows the brewing company to effectively monitor the work and fulfill the contract conditions. Such an organization of the production process and its maintenance ensures the implementation of dry and wet brewery mash with little or no inventory at the enterprise, saving on the construction of warehouses and their maintenance.

One of the possibilities for utilization of waste from the brewing industry is cooperation with pig farms in the region to reduce the fattening pigs cost.

A significant role in the formation of the economic result and cost play feed. At the pig-breeding complex, pigs were fed during the fattening period according to standard recipes provided by the production technology. In the first period of fattening (from 38 to 68 kg), the animals were fed SK-6 feed, in the second period (from 68 to 112 kg) SK-7 feed. 1 kg of such feed contained 1.10-1.17 fodder units, 154-136 g of crude protein and 129-115 g of digestible protein, respectively. In the current environment, the cost of feed in the pork production cost structure is 65-75%. Therefore, it is necessary to look for new types of feed, which will either reduce costs by reducing the cost of 1 fodder unit.

In order to reduce the cost of feed for feeding pigs for fattening, a recipe for feed PC-55 was developed. In 1 kg of feed brand PC-55 contains 0,07 fodder units and 5 g of crude protein less than in the feed CK-6.

The specialists of the pig-breeding industry were given the task of maximally reducing the cost of preparing mixed feeds. This solves the problem of not only reducing costs, but also compliance with the supplied feed formulation. It was decided to work out the replacement of the grain group with a brewery mash, which is formed as a waste of beer production. Fresh brewery mash has a light or slightly chocolate color. It contains mostly insoluble sediment with residues of barley, rice and oatmeal. When fresh, it contains 20,3-20,5% of dry matter and an average of 0,23 fodder units. An experiment was put on replacing part of the feed with a brewery mash in a ratio of 1:10 - 1-2 kg of brewery mash per 100-200 g of feed of recipe PK-55.

Production experience was carried out for two months. For this purpose, four experimental and two control groups of local animals obtained from crossing a yorkshire breed with boars producing landrace breed were formed at the fattening zone of the pig-breeding complex.

The experimental groups I and II and the control group I included animals with a living weight from 45 to 48 kg, the experimental groups III and IV and the second control group included gilt with a living weight of 55-60 kg. The schooling of pigs to the brewery mash was carried out gradually over the course of one week, starting from 0,2 kg per head per day. Feeding pigs of the experimental and control groups was carried out 2 times a day with liquid feed of 75% moisture with a temperature of 30-35 ° C. The control groups were fed according to the norms of feeding for these groups of animals, pigs I and III of the experimental groups 200 g of feed were replaced with 1 kg of fresh brewery mash, II and IV experimental groups instead of 200 g of feed were fed 2 kg of brewery mash. Entering fresh brewery mash into the diet did not have a negative impact on the feed palatability. The remains of brewery mash in the feeders one hour after feeding in all experimental groups was not observed. The state of health in animals of the experimental groups was similar to the controls, and no deviations from normal physiological indications were established. The results are shown in table 5.

Table 5. The results of production experience in the use of brewer mash

Group of animals (feeding rate)	Experimental group ± to control,%	
	1 month	2 months
A group of animals weighing 45-48 kg		
Experienced I (replacement of 200 g of feed for 1 kg of brewery mash)	-0,03	+0,07
Experienced II (replacement of 200 g of feed for 2 kg of brewery mash)	+5,2	+5,2
A group of animals by weight category 55-60 kg		

Experienced III (replacement of 100 g of feed for 1 kg of brewery mash)	+4,8	+3,8
Experienced IV (replacement of 100 g of feed for 2 kg of brewery mash)	+7,4	+6,9

3. Conclusion

As can be seen from the data in the table, a 1:20 replacement provides almost the same gain with the control group. The recommended replacement of 1:10 (100 g per 1 kg of brewery mash or 200 g of feed by 2 kg) increases the monthly weight gain by 5-7%.

The introduction of a new feeding scheme will require minimal cost. To create a point for receiving a brewery mash, storing it and mixing it with a fattening compound feed of a standard recipe will require an investment of 200 thousand rubles.

The creation of the proposed waste management system at the beer industry enterprises will significantly reduce the amount of waste, remove the unpleasant smell from the decaying brewery mash, and increase the profitability of the enterprise as a whole. Attracting a special company for the sale of dry brewery mash will reduce the entrepreneurial risks of the project.

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