Development of solid manure technologies

Développement de technologies basées sur une gestion des déjections sous forme solide.

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Abstract

In Hungary there are a lot of problems caused by the huge amounts of slurry produced in large pig farms and partially in dairy cattle units. Development is needed to improve the applicability/effectiveness of solid manure technologies in animal keeping and to increase the proportion of good quality farmyard manure (FM) in the total production of animal waste.

The litter system have several well known advantages. Disadvantages of the system in the pig housing are the higher transportation and utilisation costs and the higher labour demand. The labour costs can be reduce using deep straw bedding system, which is widely spread in the keeping system of the dairy cows and beef cattle in Hungary. But the deep straw manure has poor quality, and the material costs are high because of the higher straw consumption To reduce the labour the bedding-slope floor system was adapted. The experimental barn has openings along the wall, the fattening pigs push the solid manure directly outside which is falling down to a longitudinal subsurface storage.

The first results of the system show :

- *the labour required is reduced significantly,*
- *the consumption of straw is 50-70 % lower comparing to the conventional system.*

The solid manure system is commonly used in the dairy cattle farming, mainly deep litter with straw. The problem is the lack of the correct storage facilities and the pure quality of the deep straw manure. We have planned a combined storage - maturing plant of solid and liquid manure.

It will also have facilities for composting of the manure surpluses. This demonstrational farm is situated on a water protected area.

Keywords: Solid manure, pig keeping, dairy cattle, composting.

Résumé

De nombreux problèmes se posent en Hongrie à cause des volumes considérables de lisiers de porcs produits en porcheries industrielles. Il est donc nécessaire de développer de nouvelles technologies de gestion sous forme solide de fumiers de bonne qualité.

Les systèmes sur litière présentent plusieurs avantages bien connus. Les inconvénients liés à ces systèmes sont la charge de travail. Le coût de la main d'oeuvre ncessaire peut être réduit en utilisant des litières profondes, ce qui est largement répandu en système bovin vaches laitières et bovin viande en Hongrie. Cependant, la litière profonde est de mauvaise qualité et les besoins importants en paille aggravent les coûts. Afin de réduire ces coûts, un système de litière inclinée a été développé. Le bâtiment expérimental est ouvert le long des parois, les porcs à l'engrais évacuent les déjections solides à l'extérieur et celles-ci sont collectées sur des aires de stockage.

Les premiers résultats témoignent que :

- le coût est réduit significativement,
- la consommation de paille est inférieure de 50 à 70% à celle du système conventionnel.

Dans le prolongement de ce travail, un système mixte de stockage-maturation des produits par compostage est prévu.

Mots-clés : déjections sous forme solide, élevage de porc, troupeau laitier, compostage.

1. Introduction

In the last decades - in the 60-s and 70-s - more large animal units was built in Hungary and in other Central and East European countries. These cattle and pig farms using "industrialised" closed production systems can work effectively and produce good quality food products, but they means heavy loading for the environment first of all because of the huge amount of manure. The waste management system must solve special problems from these units. The main problems by the system elements are as follows :

- Comfortable and labour save keeping technologies to have good production conditions for the animals.
- Mechanised or automatic systems for manure removal and transport to the storage. (At the big units there are good solutions only for the liquid manure systems).
- Safe storage to avoid harmful emissions (gases, odour, microorganisms) and to preserve nutrients during the required storage time (at least 3 months).

At the big units it needs huge and expensive storage facilities to store the manure. The slurry stores have big pollution potential if their storage's is broken. The reduction of the emissions is possible throw covering the storage, with needs extra investments.

At extreme huge units the amount of liquid manure do not make possible to store it during the required time. In this cage it must be cleaned and conducted to a recipient. This is possible only using more steps COD/BOD reduction techniques (phase separation, filtration, sedimentation or anaerobic/aerobic fermentation processes). The adaptation of the municipal waste water techniques do not gave acceptable results. The new requirements to conduct the waste waters to the surface waters cannot fulfil using these methods, that is why new developments are made to adapt low cost biological purification steps like wetlands.
Utilisation of manure in the coop production as a fertiliser in an environmentally friendly way counts the optimal way of the recycling of the nutrients, but it produce special problems, because of :

- the season for spreading the manure is limited
- the concentration of the nutrients in manure many cases is law
- the big plant needs huge acreage fields with different crops
- the big capacity machinery for transport and spreading is very expensive
- the organisation and the logistic system is complicated.

Because of the about mentioned characteristics, there is en need of new solutions to avoid the production of liquid manure using labour saving bedding systems.

2. Pig keeping technologies

Owing to the favourable natural conditions animal husbandry and the pig production within it had always a great importance in the agricultural section in Hungary. As a result of a governmental programme for developing the pig production, increasing of the pig stock was considerable by the early '80-s. Nearly 290 of large-scale pig farms were completed by that time.

Twenty seven percent of these farms have 3,000 - 4,000 places for fattening pigs, while about 20 % of the total farms have 10,000 or more fattening places. At the same time the individual or private pig-keepers were predominant. Private farmers and individual pig keepers had more that 50 % of the total number of the sows.

Characteristics of the keeping technologies as follows :

Seventy eight percent of the pig houses built with part-slatted floors. Hydraulic manure removal systems were applied in 80 % of the breeding houses while in 87 % of the fattening ones. 45 % of the farms run without any slurry handling system. By the year of 1985 about 4,5 % of the pig farms had built-in mechanical manure

removers. Rate of the pig farms using hydraulic manure removal technologies was 94 %.

Diluted slurry was irrigated on the surface of arable land around the farms in 54 %, while 40 % of the pig farms used slurry tankers. Volume of slurry was about 16 million m^3.

Compared the data of the "top-period" of 1985-86 the pig production - was strongly reduced after the political-economical changes up to 40 % in 1994. In the last years goes slowly up again.

3. Fattening experiments on sloping floor with straw bedding

We found, that development is needed to improve the applicability/effectiveness of solid manure technologies in animal keeping and to increase the proportion of good quality farmyard manure (FYM) in the total production of animal waste.

The litter system have several well known advantages :

- no slurry problem,
- higher level of thermal comfort and welfare of animals,
- lower odour emission, less stress for animals,
- utilisation of the cheap wheat straw produced by the crop production,
- the good quality FYM is an important source of organic carbon in the soils.

Disadvantages of the system in the pig housing are the higher transportation and utilisation costs and the higher labour demand.
The litter and labour saving pig fattening experiments were started at a private pig farm of Mr E. Tugyi, Újlengyel village, in the second half of August, 1997. The owner has 60 ha of arable land. On the 50 % of it he produces cereals (triticale); on 30 % maize, and on 12 % of it sunflower seeds.

Cereals are used for feeding fattening pigs. Weaning of the pigs take place after about 56 days at 15 kg live weight. Fattening lasts about 5 months. Fattenings at about 110 kg l.w. are slaughtered on a private slaughterhouse. Number of fattenings per year is about 500-550 head.

The experimental pens were constructed and built on the basis of the German experiences, taking into consideration the Hungarian conditions. In the same house there are two experimental pens with 15 places in each and one control pen with 30 places. Fattening in the experimental pens are feeded from four combined self-feeders, while the stock of the control pen from traditional feeders.

Data Sheet is made to collect the results and experiences of the experiments.

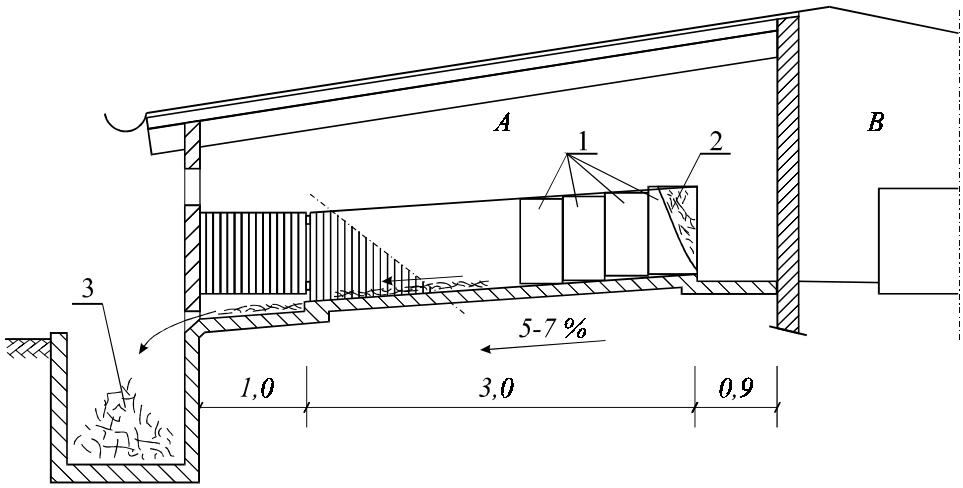
First group of fattenings was ready by the middle of January, this year.

According to the first experiences, the average daily weight gain was about 800 g. Straw litter consumption will be about 0.1-0.2 kg/place, day that is favourable. Labour requirements take place only at filling up the feeders and the straw grid.

The experimental barn has openings along the wall, the fattening pigs push the solid manure directly outside which is falling down to a longitudinal subsurface storage. In this way the dosage, move, spread and removal of the bedding - manure mixture (solid farmyard manure) is made by the animals, without any labour consumption.

The capacity of the storage is about 1 m^3/animal. It means, that the transport of the farmyard manure is needed only once in a month.

The diagram of the experimental barn is shown on the Fig. 1.



A. Experimental pens, B. Control pen.
1) Combined self feeders, 2) Straw guid, 3) Manure collecting pit.

Figure 1
Constructing the experimental pens of sloping floor with straw bedding

4. Housing systems for dairy cows

In toady's cattle husbandry, three main types of housing systems for dairy cows are distinguished: loose housing, tie stalls and free stalls. Table 1 gives an inventory of those housing system, based upon their waste management characteristics.

Waste management characteristics				
Housing system	**Collection system**	**Type of waste**	**Removal technique**	**Storage**
Free stall with :	shallow pit	slurry	gravity/pump/tanker	outside

* slatted floor	deep pit	slurry	-	inside
* concrete floor	deep pit non	slurry slurry	- flushing/scraping	inside outside
Loose	straw bed concrete floor	manure + straw slurry	hand; tractor hand; tractor	outside outside
Tie stall	shallow gutter deep channel	* faeces +straw * urine slurry slurry	hand; scraping gravity - pump/tanker	outside in-/outside inside outside

Table 1
Housing systems for dairy cows and its waste management characteristics.

Nowadays, in Hungary most dairy farms have loose stall houses with wheat straw bedding. Storage is needed for storing the slurry produced in the milking house and from the waiting area, together with the washing water. From the farmyard manure storage comes out urine and polluted water witch must be conducted to the storage too.

For the comfort and health of the animals very important the use of good stored, dry straw. The big proportion of the cereals in the plant production gives possibility for using bedding and recycling the organic material into the soil.

These systems are those is which manure can be collected, stored, transported, and utilised in a solid form. This necessitates scraping of the manure and minimising the quantity of the manure and minimising the quantity of water which comes into contact with it. In some climates it may require addition of other material to absorb moisture to get the manure into a solid form.

Floors or alleys can be scraped prior to flushing. The or alleys can be scraped prior to flushing. The or alleys manure then is handled as a solid for spreading on cropland or for exporting from the farm. If dry scraping is used in conjunction with flushing, then size and cost of the spray field will be reduced. It is recommended that provision be made for dry scraping and flushing in the modification of existing facilities or in design of new facilities.

If export of the nutrients from a dairy is required, then composting can convert manure into a much less odorous and more acceptable material for spreading on cropland or for marketing to the public. Many owners/operators of large dairy farms are becoming interested in composting for 3 reasons: (1) it is a method of exporting nutrients from the farm and obtaining some economic return , (2) it eliminates or minimises the size of large spray fields and cropping systems, and (3) it gives a better form of fertiliser to use it in organic farming.

5. The Hungarian Project to Develop a Pilot Farm

The dairy farm Matra near Batonyterenye (North East of the Capital) is located on a small river, the Zagyva, which is a branch of the river Tisza, that drains into the Danube. The Tisza basin area covers 40% of the Hungarian Republic territory. The farm is located near the boarder with Slovakia. It is one of the 150 dairy farms in the Tisza catchment area, which are of similar in size (200-400 animals). Because of its location and it represents an average farm, it is chosen as one of the focus points in the Strategic Action Plan for the Danube basin and has nationally a high priority and the government want to use it in future as a pilot-farm.

The cows are kept in a shed with an open system lay-out under deep litter regime. The stables are cleaned twice a year. The manure is taken out and put very near to the sheds.

The corridor to the feedline and the open space outside is cleaned once a week.
The liquid manure is collected in 3 pits, pumped under vacuum to one tanker. Than it is spread regularly over nearby (situated 150 meter from the farm) grass-lands one flat of 30 hectares and 150 hectares of lands which have a slope.

When it rains, water leaks from these solid manure heaps and also from the barn and runs into to the nearby river.

The animals at the farm produce per year 3,000 tons of manure. This includes 240 tons of straw (2.6 Kg/day/animal).

1,100 tons of manure are produced during the grazing period, and about half of this remain in the fields.

Urine, annually in the fields 350 m^3 and at the farm 1,850 m^3, of which 600 m^3 remain in the straw and 1,250 m^3 of the liquid flows into one of the three pits

From the milking parlour, there is an additional 3,000 m^3 of water per year used for cleaning, which goes into one of the pits.

6. The proposal

The farm agrees with the proposal which originates from the Ministry of Agriculture.

These investments total (counted on prices January 1997 and without tax) 68 million HUF and they can be divided into the costs of building and construction, planning and technical supervising and machinery and equipment.
Constructions:

Five different constructions will have to be built.

- To store the solid manure, an open construction is required with an isolated floor of 20 meter by 50 meter and 2.5 meter high. The estimated total cost required for that investment is 10.0 Million HUF.

- For the storage of the liquid manure a concrete tank is required of 900 m^3.

The estimated cost of that storage is 8.0 million HUF

- For one third of the solid manure a composting plant is required of 3.0 million HUF.
- For the storage of straw, needed for the deep litter, a building is needed of
  18.0 million HUF
- Drainage system, for draining directly the rain which has fallen on the open space of the cows to convey it into the concrete tank. Total cost 4.5 million HUF

Machinery and Equipment :

The following machinery and kinds of equipment is needed for the handling of the manure.

- A straw bail opener and cutter of 1.6 million HUF
- Slurry mixer and pipes to transport the slurry from the pits to the liquid storage tank. 1.8 million HUF
- Compost mixer (tractor driven), 2.5 million HUF
- Pipes, tubes and pump to pump 50% of the liquid manure to the nearby fields. 2.7 million HUF
- To transport solid manure to the fields, 2 car and 1 self driven loader, 7.5 million HUF
- For the transport of the other 50% of the liquid manure on other fields two vacuum takers, 2.4 million HUF.
- Finally to decrease the water use, two washers, one for the milking equipment 1.4 million HUF and the second to clean the milk cooler, 0.5 million HUF.

7. Conclusions

The using of the bedding by the keeping of pig and dairy cattle has great importance in Hungary, because the most serious problems are originated from the large animal units, producing liquid manure.
The bedding on sloped floor by the pigs seems to be fruitful technology. The results of the system show :

- the labour required is reduced significantly,
- the consumption of straw is 50-70 % lower comparing to the conventional system.

The solid manure system is commonly used in the dairy cattle farming, mainly deep litter with straw. The problem is the lack of the correct storage facilities and the pure quality of the deep straw manure. We have planned a combined storage - maturing plant of solid and liquid manure.

It will also have facilities for composting of the manure surpluses. This demonstrational farm is situated on a water protected area.

The investments and running costs of the demostration farm are high compared with the level of the profit achievable on dairy farms. It means that the state must subsidise the projects witch are needed to solve the environmental problems on the existing farms. The new subsidising possibilities of the Agricultural Found are open for this purpose first this year.

The Hungarian government is preparing now a new wider program in connection the Phare Program to help the animal farms in the environmental investments.

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