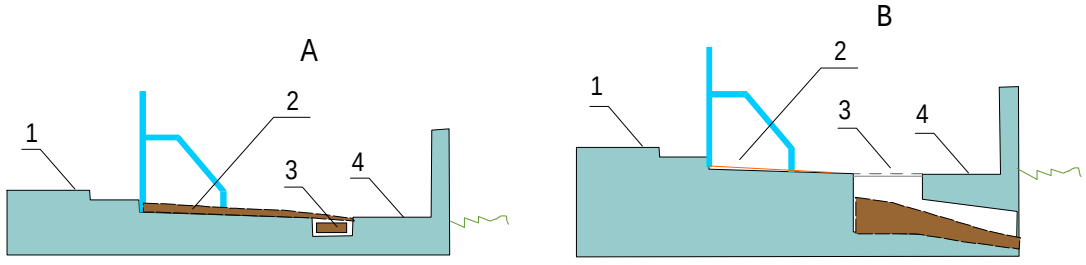
6. STORAGE AND APPLICATION OF ANIMAL MANURE

6.1. CONSTRUCTION OF BARN

6.1
Animals have to be reared and kept under such conditions that are not harmful for animals. Rearing and housing conditions have to be chosen with regard to peculiarities of animal species and breed.[1,2] Animal husbandry systems and types, the size of barns are designed according to the branch and specialisation of a farm. The chosen animal keeping system has to ensure good animal health and high productivity, low expenditure of fodder, labour, low monetary costs, qualitative production and to protect environment from pollution with production wastes.[3]

Buildings for livestock housing have to be economical; their dimensions have to correspond to the requirements of technological processes. Building constructions and interior engineering facilities have to ensure proper microclimate. The floor in the places of livestock housing has to be non-slippery, even, of low heat permeability in the lying place, waterproof, resistant to urine and disinfecting fluids.

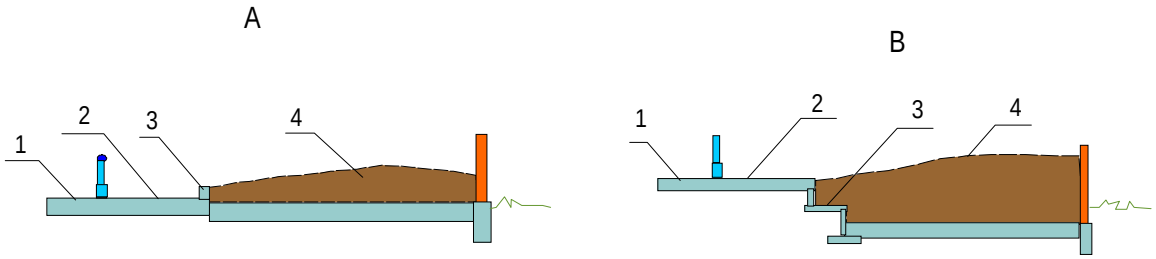
Floor slope can not be more than 6 % in passageways, 2 % in kennels and stalls, 5 % in standing places of fatling animals; floor slope in lying places in simple loose housing littered barn may be up to 10 %. Schemes of the different barn systems are given in Figures 6.1. – 6.3.



1- feeding passage; 2- bed;
3-dung plate transporter for manure removal;
4- service passage

1- feeding passage; 2- stall with rubber mat;
3- grids with underlying slurry channel;
4- service passage

Fig. 6.1. Standing place for cow in stanchion barns: A- with bedding; B- without bedding

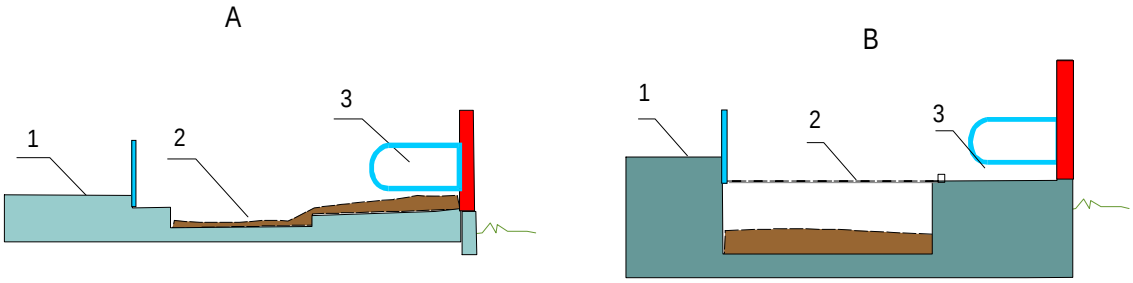


1- feeding passage; 2- service passage
3- manager; 4- manure (lying area)

1- feeding passage; 2- manure service;
3- manager; 4- manure (lying area)

Fig.6.2. Floor in littered loose barns: A- semideep litter; B- deep litter

[1] Republic of Lithuania. Law on animal care, housing and use. 1997 11 06 VIII-500. V.
[2] Rules on pig housing confirmed by the State Veterinary Service 1998 12 31 by the order No. 4-359.
[3] Rules on technological design of animal buildings, confirmed by LRAF and LRBU ministries 1997 07 11 order No. 640/247



1- feeding passage; 2- service passage;
3- cubicle (lying area)

1- feeding passage; 2- slat floor;
3- cubicle (lying area)

Fig. 6.3. Barn floor for loose cubicle barns: A- with bedding; B- with less or without bedding

It is not favourable to keep cows in barn during summer. Calves should stay in individual pens up to 2-4 weeks old and in well-littered group pens up to 4 months old. It is recommended to keep poultry loosely on deep litter, not in coops. In livestock barns priority should be given for technologies that use litter.

Technologies of slurry management save expenditures for human labour and machinery work but they are very expensive and nitrogen losses in manure storage are bigger than in littered, especially in deep littered, barns. In deep littered barns expenditures for human labour and machinery work are also saved, besides that separate manure storage is not needed, cheap cold barns of light constructions may be built when animals are kept loosely. It is more difficult for farmer to take care of every animal individually though.

The conventional in Lithuania tied-littered cattle technologies require more expenditure for labour, but they provide sufficiently dry and warm lair, reduce nitrogen losses during manure storage, air humidity in the barn, concentration of hazardous gasses, and the sufficient amount of high quality manure is obtained. Even if a farmer puts more work to compare with other manure handling technologies it is so far simpler for him to take care of cattle in this way and to make individual feeding ration. Recommended litter utilisation rates are given in Table 6.1.

Table 6.1. Bedding utilisation rates

Animal	Animal housing type	Bedding input kg/day*	
		straw	peat
Mature cattle	Tied Loose with bedding Loose in cubicles Loose in combi-cubicles	2,5 5,0-8,0 0,3 1,5	4,0 3,0-5,0 1,0 2,0
Calf under 6 months	In individual pens In group pens Loose in cubicles	1,5 1,5 0,2	- 3,0 0,6
Cattle yearling 6-18 months	Tied Loose with bedding Loose in cubicles	2,0 3,0-4,0 0,3	2,0 6,0-8,0 0,8
Beef cow with calf	Loose with bedding	5,0-6,0	8,0-10,0
Fatling pig	In shallow pigsty On deep litter	0,15 3,0	0,25 4,5
Sow with piglets	In shallow pigsty	1,4	
Sheep	With bedding	0,3-1,0	
Hens and replacement pullets from 19 weeks	With bedding	0,05	
Geese and replacements	With bedding	0,10	
Turkeys	With bedding	0,05	

**Humidity of straw used for litter - 15%, humidity of peat - 45%. Rate of litter has to be increased if its humidity is higher.*

Watering places have to be made of non-hazardous for animals and waterproof material, tidy in order to prevent water leakage and increased humidity in the air and manure. Designing cattle yard, there should be foreseen a collection of rainwater from the yard and a separate outflow preventing mixing of rainwater with urine.

6.2
Animals should be fed only with valuable feed at officially determined feeding norms based on animals need.

The total nitrogen loss in the farm reduces when animal feeding is well balanced. Valuable ration for animals and poultry have to be made taking into consideration nutritive value of feed. It is desirable that the nutritive value of feed available on a farm would be analysed at least 1-2 times per year in a laboratory.

During preparation of feeding plans and ration it is recommended to consult with specialists from Lithuanian Agricultural Advisory Service, regional agricultural departments and science and education institutions.

Formation of ammonium, hydrogen sulphide and other gasses hazardous for animal and human health depends on animal species, feed composition, the amount of litter, age of animals, frequency of manure removal from the barn, air temperature in the barn and other microclimate indices. The warmer it is in the barn, the more intensive activity of bacteria and the more ammonia is formed and released into environment. When applying more litter and removing manure more often, the formation of hazardous gasses reduces. Release of ammonia depends on livestock housing type too. Nitrogen losses may reach 12-15 % and more if livestock is kept on slat floor. Microclimate of the barn is strongly dependent on ventilation system. Some natural barn ventilation systems are shown in Fig. 6.4.

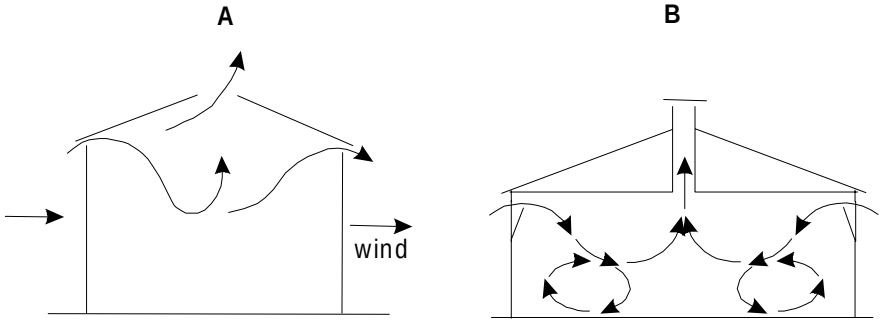


Fig. 6.4. Ventilation systems of natural traction

In bigger farms it is recommended to collect farmyard manure (littered manure) and slurry (non-littered manure) in barns by pivotal transporters and push to manure storage via underground pipe. Then fresh manure gets always under older manure that is already covered by crust; therefore, evaporation of ammonia and other gasses reduces, flies multiply in the manure storage less.

6.2. STORAGE OF ORGANIC FERTILISERS

6.3
In the farms having more than 10 animal units there should be manure storage of sufficient capacity in order to reduce nutrient losses and preserve environment.[4,5]

[4] HELCOM 1992 February 6. Recommendation 13/7. Reduction of ammonia emissions from manure storage.
[5] Environmental requirements for manure and sewage handling on farms LAND 33-99. – V., 1999.

Depending on animal keeping system, at the barn there is arranged storage of solid manure with liquid manure reservoir or storage of slurry, and sometimes equipment of manure composting, dewatering and biogas evaporation. The solid manure storage with urine reservoir and slurry removal systems are given in Figures 5.2, 5.3 and 6.5.

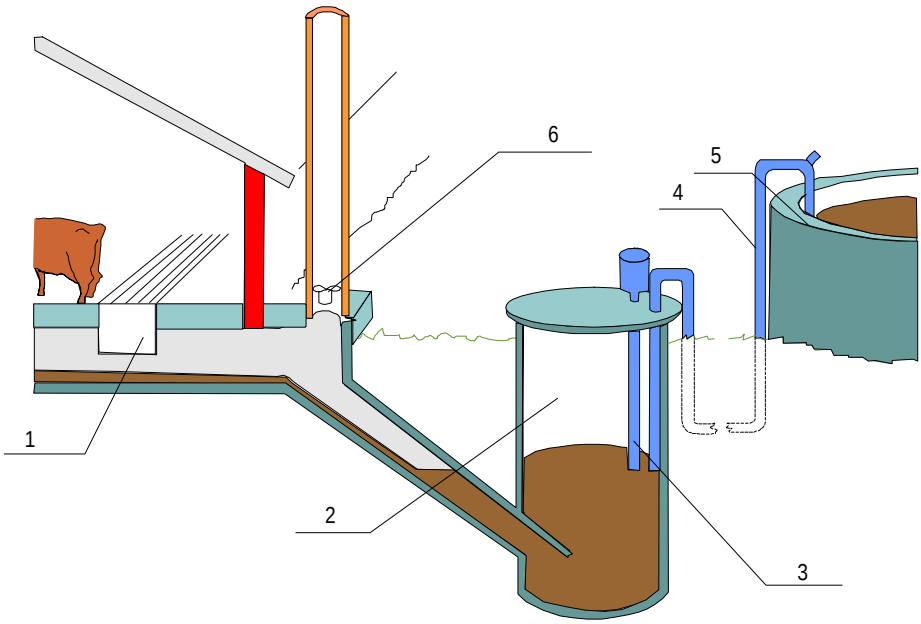


Fig. 6.5. Slurry removal system: 1 – slurry channel; 2 - pit for pumping over; 3 - pump; 4 - rising pipe of slurry; 5 - slurry reservoir; 6 - ventilator

Intermediate semi-solid manure is kept in storage of dung yard. If a farm does not have a manure storage and the matter is co-ordinated with the Regional environmental department of Environmental Ministry or if there are less than 10 AU, the solid manure may be temporarily collected in field heaps following these recommendations:

- on elevated places in order to prevent flooding during periods of flood and rain;
- enclosed the site with a ground dam of 50 cm;
- prior to stocking of the site, pour 50-cm height substratum of air-dry peat or 70 cm substratum of chopped straw, leaves in order to absorb liquid manure;
- store manure covered with film or with 20-cm thick layer of peat, chopped straw.

6.4
Manure storage should be of such size that manure would be spread only when the plants can utilise nutrients. The minimum level to be required should be 6 months storage capacity. Urine and slurry stores should be covered or handled by a method that efficiently reduces ammonia emissions.[6]

The volume of solid manure, liquid manure and slurry from the storage per 1 month per animal is given in Annex 6.1. An example for calculation of the necessary storage capacity of manure is seen in Annex 6.2 (solid manure), 6.3 (liquid manure) and 6.4 (slurry). The calculations take into account the number of different types of animals on the farm, specific storage type, productivity levels as well as the information about the amount of manure per animal per year ex storage as appears from Annex 6.1.

[6] HELCOM 1998 March 26. Recommendation 19/6. Amendments to Annex III of the Helsinki Convention concerning regulations on prevention of pollution from agriculture.

Exceptions:

- if animals are stored in deep barn where manure is taken away 1-2 times per year and brought directly to the field, the manure storage by the barn is not necessary;
- if animals are stored in semi-deep barn with manure passage that is cleaned every day, dung-yard is allocated for storing of the manure from the passage only. When calculating storage capacity it should be considered that 75% of livestock faeces fall on the manure path (i.e. about 32 kg per animal unit);
- if there is a compost site for organic wastes on the fields, manure storage by the barn may be absent. But then a dung-yard site for temporal storing (10 days) of manure should be installed at the barn. Manure for temporary storing should contain at least 20% of dry matter.

6.5
When selecting a place for manure storage, as for every other production building of livestock-farm, the distance to dwelling houses, water bodies and roads is determined under the guidance of existing normative.[7]

Manure storage by the livestock farm is arranged as possible farther from milking parlour, animal husbandry processing shop and leeward from dwelling buildings. Open dung-yard for slurry is built 15 m behind the barn.

All manure removal, collection and processing systems are insulated reliably and land surface is formed so that urine would not get into ground and surface waters and the waters to the manure systems.

Solid manure storage. The cheapest and most simple storage is overground three-walled, two-walled and one-walled (sometimes four-walled at small barns) storage when its sole is elevated 5-10 cm above the ground or deepened only by 50 cm. Height of breast-walls is till 1.5 m. The sole of storage for manure with high amount of straw may have a concrete ridge instead of one or some of the breast walls; the ridge should be not lower than 5-cm height in order to withhold urine inside the storage and prevent from rainwater coming from the territory of the farm.

When dung-yard is open, urine mixed with rainwater leaks from manure during rain or snow. Covered concrete reservoir is installed for storing of the leaked urine mixed with rainwater; the depth of the reservoir is 2-4 m. Dirty water from the barn yard is directed to the same reservoir. Data from Annex 6.1 is used for calculation of the volumes of dung-yard and slurry reservoir. Additional 0.3 m^3 of wastewater per cow per month should be added for cleaning of milking equipment and 0.15 m^3 per pig per month for cleaning of pigsty. Calculation examples for 6 months storage capacity of solid manure pad and liquid manure reservoir are given in annexes 6.2 and 6.3.

The storage sole and territory around the storage are done with a slope so that urine flows only to the pit and rainwater or snow water from the territory of livestock-farm does not flow to the manure storage.

The breast walls of manure storage are made of assembled blocks, monolithic concrete, logs or planks. When the walls are wooden, gutter for collection of urine has to enclose the storage from outside.

When it is foreseen that heavy machinery would drive over the sole of the manure storage, the sole should be made of B 25 and B 75 class concrete or reinforced-concrete. In other case the sole may be cobbled and then additionally covered by not thinner than 5 cm layer of concrete. Waterproof concrete suits best. If the sole is permeable, 0.2-mm width waterproof film has to be stretched under or inside of the concrete layer.

[7] Special conditions of forest and land use. (Lithuanian) LRG 1992 05 12 resolution No. 343.

The manure heap made in the dung-yard is covered by a half-meter straw layer, peat or tent. Ammonia emissions are reduced in this way.

Slurry storage. Slurry is stored in deepened or overground leak-proof storage that has a storage capacity of at least 6 months. The volume of slurry for one animal is determined from the data given in Annex 6.1.

Calculation example of the volume of slurry reservoir is given in Annex 6.4.

The deepened manure storage is moulded out of concrete, assembled out of reinforced-concrete elements; the overground storage is concrete or metal. Slurry is directed to the bottom of manure storage so that straws would remain always on the top. If slurry storage is open, 15-30% of nitrogen evaporates during storage. These nitrogen losses pollute environment. The reservoir has to be covered in order to reduce ammonia emissions. If covered with tarpaulin or film, emissions reduce by 60-80%, with non-burned ceramsit 90% and with chopped straw 40-50%.

Chemical and biological measures reduce formation of harmful gasses during storage. Oxidising and bacteriological measures, such as lime and preparation 'Sentil', inhibit activity of micro-organisms and at the same time reduce formation of ammonia, hydrogen sulphide, carbon dioxide, mercaptan and scatol type gasses. It is possible to use superphosphate, ceolites, bentonite and other substances that are able to bind harmful gasses. Biologically active substances (deodoraze, preparation 'Odor kell') have ferments or specific microbial cultures and therefore bind and eliminate harmful substances formed in manure. Special preparations added to slurry not only reduce ammonia evaporation and mitigate pumping but also preserve crops from burning caused by the applied slurry and improve the hygienic state of it. The slurry has to be well mixed before pumping out of the reservoir.

Manure storage in the vulnerable zones. It is allowed to build manure storage in the zones where barns are allowed. But the storage has to be insulated from leaching and built in such a way that breaches would be easily noticed and eliminated. Building of deepened manure storage or slurry reservoir in karst region is allowed after geological investigations. In flooded territories it is not allowed to build the deepened manure storage and slurry reservoir.

Around slurry storage such dike is made that all manure flown out during possible accident would fit in the area enclosed by the dike.

6.3. FORAGE PRODUCTION

6.6
Effluent evolved during silage production should be collected to reservoirs of slurry or urine.[8]

One of the most perspective feedstuffs for livestock is silage. It may be produced in different ways: in trenches, clamps, bales, etc. Silage may be produced out of non-wilted and wilted grass, leguminous and cereal mixture, maize, beet tops, etc.

Silage effluent ('silage juice') evolved during production is one of the most hazardous and poisonous pollutants. Even the small amount of it causes big negative effect on water body as it reduces the amount of oxygen in water very quickly. The amount of evolved silage effluent depends on moisture of plants used for ensilage. If grasses are used for silage it is always recommended to wilt them at least to 27-28% of dry matter (i.e. about 24 hours) until silage juice do not evolve any more. If maize, leguminous and cereals mixtures are used for silage they have to be cut at milky-wax stage (i.e. when plants have about 27-28% of dry matter). Silage effluent mostly evolves in first two days after ensilage. If ensilage takes place during rain, even more effluent appears.

[8]EU Council Directive concerning the protection of waters against pollution caused by nitrates from agricultural sector (91/676/EEC).

Table 6.2. Calculation of silage effluent amount

Crops for ensilage	Dry matter %	Amount of effluent in liters from 1 m^3 of silage
Non-wilted grass	12.5	350
Non-wilted grass	15.0	250
Non-wilted grass	17.5	175
Wilted grass	20.5	100
Wilted grass	25.0	35
Wilted grass	30.0	0
Mixture of oats and vetches	14-22	300-120
Maize	18-28	210-0
Beet tops	12-15	500-350

The main requirements for silage production:

- If silage is produced in trenches or clamps, the reservoirs for collection of silage effluent have to be arranged. The capacity of the reservoir has to be 200 l of effluent for one m^3 of silage, i.e. 20 m^3 reservoir for 100 m^3 of silage.
- Silage effluent can cause corrosion of metal and concrete. The effluent can easily percolate through sole of the pit if it is unsuitable. The sole of the pit has to be impermeable to fluids, covered by concrete or asphalt.
- By walls of the trench there have to be canals that would be used by silage effluent to flow to the reservoir.
- Silage trenches can not be built in protective zone of a water body.[9]
- The sole of silage trenches has to be with slope to sides and to front. In the front of the trench there has to be a canal directed to the reservoir.
- If silage is stored in a clamp, the canal has to be dug out around the whole clamp.
- The reservoirs for silage effluent have to be made out of a material that is resistant to corrosion and single, i.e. without joints (seams).
- Silage effluent can be collected in slurry reservoir if the latter is made out of materials resistant to corrosion and is well ventilated. It is not possible to mix silage effluent with slurry in closed underground reservoirs and inside buildings, because the formed poisonous gasses may be very dangerous.
- It is recommended to spread a small straw layer on the bottom of silage trench that would absorb a part of the effluent.
- If silage is made in bales, the bales have to be kept at least 10 meters apart from water bodies, wells and draining facilities.
- Silage effluent can be used as fertiliser and watered on the fields, but it has to be necessarily diluted with water 1:1 and used at a rate not higher than 50 m^3/ha.

[9]Special conditions of forest and land use. (Lithuanian) LRG 1992 05 12 resolution No. 343.