The changes in milk production to new labour- and resource-saving capital-intensive technologies raise questions regarding determination of the economically and environmentally optimal animal concentration level in agriculture as a whole and on individual farms. Non-critical transfer of experiences from large farms (mega-farms) without taking into account regional aspects can create additional problems, which could considerably impair aspects of milk production, including its environmental safety.

Concentration of animals on large complexes with loose-housing systems (untied housing systems) and milking in milking parlours has a number of advantages in comparison with geographically dispersed cattle farms, in particular:

- Increased management efficiency.
- Reduced production costs (labour costs reduced 2.5-3-fold).
- Improved feed conversion efficiency, due to group feeding with the help of mixer-feed distributors, to 80 kg feed units per 100 kg of milk.
- Improved milk quality.

The competitiveness of production is increasing in terms of lower costs and better product safety. However, copying experiences from the most developed farms situated near big cities and concentrating the entire livestock on super-large complexes – mega-farms (1,200 milking cows and more) through farms having their livestock distributed between several dairy farms can lead to increased pollution load and environmental risks.

The increase in the dairy stocks in the Leningrad Oblast is mainly occurring in the form of agro-holdings at the present time. These commercial companies become larger, purchase new farms and usually concentrate their entire livestock in one mega-farm. Such tactics are most viable under the conditions of financial crisis, since they lead to minimum costs and since there are possibilities to buy farms with financial problems and incorporate these. However an organisational-economic concentration of agro-holdings is not always possible due to geographical distance.

The increase in environmental problems on farms (first of all water pollution by manure and slurry) becomes the determining factor of further livestock concentration. A high concentration of dairy cattle on the land leads to a sharp increase in manure output from the farm in connection with the change to new technologies. International studies of the agricultural load on the environment have revealed that a farm with 3,000 livestock units produces the same amount of waste as a city with 30,000 people (FGNU “Rosinformagrotech”, 2005).

In a national survey, no serious problems existed with storage of manure in an agricultural company with 1,000 cows kept on five different farms remote from each other,
using much bedding material. One farm with 200 cows kept on litter produced 4,000 tons of manure annually and 100 ha of nearby land was enough for efficient utilisation of manure and its consistency made it possible to transport and store the manure during the winter on nearby fields and then spread it before ploughing in spring time without harm to the environment. Construction of cattle houses (with mats) with local high concentrations of livestock, loose-housing, bedding-free systems of animal rearing and milking in milking parlours can produce a higher risk of pollution of groundwater and surface water due to mixing of rinsing water with manure, which increases the water content and the volume of manure 2-6-fold.

An area of 1,000 ha arable land is a necessary minimum amount to be able to spread 30,000 tons of manure. This increases the costs of transport and the number of work hours to spread the manure on the small-sized fields in the Leningrad Oblast. At the same time, the decrease in the dry matter content of the manure makes it impossible to store slurry in the field during winter.

An increased concentration of livestock is economically effective only when milk production is intensified. This is also connected to intensified feeding, which leads to an increase in environmental pollution for two reasons:

a) Animals with a high genetic productive potential produce more milk and consume more fodder and water, increasing the output of manure.

b) The composition of manure changes substantially with an increase in milk yield. The nitrogen concentration in manure increases from 0.35 to 0.50% with an increase in the protein content of the feed to allow the cow to increase its milk yield from 4,000 to 7,000 kg per year. A high protein content of milk leads to an increased need for calcium, nitrogen and phosphorus for the cow. A rise in the proportion of concentrate in the ration means that the overall nutrient content of the manure will increase. This will increase the problem of eutrophication of the Baltic Sea.

An increase in the volume of manure and changes in its composition lead to difficulties in storage and spreading. It is necessary to construct manure storage facilities with 6-10 months storage capacity considering the long winter period when spreading of manure is not possible. There is a problem of nitrogen losses in the form of ammonia from storage (especially open types). Such volatilisation pollutes not only the atmosphere but increases the environmental load to the drainage area of the Baltic Sea as precipitation and effluents.

Technologies aiming at decreasing production costs by concentration of livestock require appropriate capital-intensive technologies for storage and spreading of manure, i.e. significant investments are necessary which do not directly lead to a financial gain. The risks of equipment failures and leaking manure storage facilities increase
with a high concentration of livestock at one place. The consequences will be dire on farms in the event of a major event. The widespread river network in the Leningrad Oblast and the closeness of the Gulf of Finland aggravate this problem.

More than 70% of the arable land of the Leningrad Oblast is covered by perennial grasses to provide milk production with cheap forage. This index exceeds 90% on some farms. This grassland is only re-seeded once every 5-7 years, which decreases the possibilities of applying slurry unless special equipment is obtained so this operation can be performed in growing perennial grass crops. Thus, the area of nearby fields suitable for spreading slurry with existing equipment and technologies (surface application) is very limited, which increases the time needed for spreading (exceeded agronomic time limits) and the transport costs. A sample calculation is given in Table 18.1. The time is calculated for one machine surface-spraying a tank of 11 tonnes on 100 ha arable land. The time needed for the preparation, loading and spreading does not depend on the distance and is taken as a constant (4, 2.1 and 7 minutes respectively).

In the Leningrad Oblast more land is needed for spreading of manure/slurry in connection with high livestock densities. This makes the transport distance longer in combination with the small-sized fields of the Leningrad Oblast, which increases the total spreading time and requires more machines with higher tractive power. Super-large tankers lead to unacceptable compaction of soil and destruction of soil structure in non-chernozem soils with a high soil water content.

Spreaders for organic fertilisers can only be used during a limited time period of the year, but significant investments are required with a long payback time period. The possibilities of getting credit are limited for many farms due to deterioration of their financial conditions against the background of the economic crisis. The diversion of cash resources from turnover is not possible, which leads to the fact that many farms ignore the environmental aspects of production and increase pollution of the environment.

### Conclusions

The pollution load to the environment of the Baltic Sea catchment area may be substantially increased as a result of increasing local concentration of livestock during the change to loose-housing systems of stock-keeping with milking in milking parlours, an increase in animal productivity and an intensification of feeding. It is necessary to take into account environmental problems connected with high livestock density when making a decision on this level in the individual agricultural company and on separate farms of this company.

It is necessary to take into consideration experience from the Scandinavian countries while developing a scientific approach to the correlation of savings from the economy of scale and alternative costs connected with livestock density. This experience shows the possibility of decreasing the costs of milk production on farms with

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**Table 18.1. Time required for manure spreading by a tank with a spreading aggregate with trailing hoses.**

<table>
<thead>
<tr>
<th>Type of work</th>
<th>3 km</th>
<th>5 km</th>
<th>7 km</th>
<th>9 km</th>
<th>11 km</th>
<th>13 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport, minutes</td>
<td>33</td>
<td>55</td>
<td>77</td>
<td>99</td>
<td>121</td>
<td>143</td>
</tr>
<tr>
<td>Other work</td>
<td>13.1</td>
<td>13.1</td>
<td>13.1</td>
<td>13.1</td>
<td>13.1</td>
<td>13.1</td>
</tr>
<tr>
<td>Total</td>
<td>46.1</td>
<td>68.1</td>
<td>90.1</td>
<td>112.1</td>
<td>134.1</td>
<td>156.1</td>
</tr>
<tr>
<td>Transport time, %</td>
<td>71.6</td>
<td>80.8</td>
<td>85.8</td>
<td>88.3</td>
<td>90.3</td>
<td>91.6</td>
</tr>
<tr>
<td>Productivity, ha/hour</td>
<td>0.36</td>
<td>0.24</td>
<td>0.18</td>
<td>0.15</td>
<td>0.12</td>
<td>0.11</td>
</tr>
<tr>
<td>Working days</td>
<td>28</td>
<td>41</td>
<td>55</td>
<td>68</td>
<td>81</td>
<td>95</td>
</tr>
</tbody>
</table>

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**Figure 18.3. 11 tonnes manure spreader in JSC “Udarnik”, Leningrad Oblast. Photo: M.A. Ponomarev.**

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*Recycling of Nutrients*
100-200 cows including the use of modern computer technologies (milking robots, automated control systems with telecommunication) without harmful effects on the environment.
References


Chapter 18


Chapter 19


NTP 17-99. The norms of technological projects of the systems for manure removal and preparation to utilization.


Chapter 20

EU directive on sewage sludge (Directive 86/278/EEC)


Chapter 21

