The impact of conversion to ecological recycling agriculture (ERA) on farm nitrogen budgets and production levels

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Implications

The data used in this study is collected under BERAS Implementation project from ERA-farms in Finland in 2010 to 2012 (three years averages) and from three different production lines on ERA farms: beef, egg and milk. The data indicates the production level, the products sold and feed and other supplements purchased on the farm each year. Accordingly it has been calculated A) how much area B) how much other inputs (e.g. nitrogen and phosphorus) is needed to maintain the production level. Based on these calculations it makes possible to estimate how much of these nutrients are recycled on the farm, how much of the used nitrogen is based on biological nitrogen fixation and how much non-renewable resources have been needed. This makes it possible to calculate the output-input ratio of nitrogen.

Three case examples (*):

1. A beef and lamb production ERA-farm produces yearly 1100 kg N in products, which means 12 kg N /ha, without buying any N outside of the farm. If this same farm was conventionally driven, it would produce 1400 kg N /year in products, but it should have to buy 6500 kg N in fertilizers. This would mean that the nitrogen balance would be 63 kg /ha negative.

2. An ERA farm with 10 000 laying hens and 55 ha own fields. The production level is 140 000 kg eggs annually, which contains 2500 kg of nitrogen. This amount of hens requires 490 tons of cereal-pea mixture, of which 115 tons are produced on the farm. The total production area of 305 ha does not include the area required to produce feed concentrate (70 tons, which contains 3850 kg N), but 110 ha green manure area for the crop rotation. The total production of N is -1350 kg N /year and - 4,5 kg N /ha. Conventional farms get average yields of 3200 kg cereals /ha for which they need 153 ha cereal area as well as 70 tons of concentrate in order to feed 10 000 hens. But on these 153 ha is used average 80 kg of nitrogen/ha, which makes 12 250 kg N /year. Including the concentrate, the farm balance is 98 kg N/ha is negative on egg production.

3. An ERA farm with milk production has 61 ha of own field area and 70 lactating cows and young cattle, altogether 100 animal units. Milk production farm works in co-operation with three organic plant production farms, which have 150 ha fields. This means 211 ha of field area are needed yearly for feed production. The farm produces 22690 kg meat and 636000 kg milk, which contains nitrogen 700 kg in meat and 3500 kg in milk annually. The incoming nitrogen flows in the form of feed additives are 2300 kg yearly. Net N-production is 1900 kg N, which is 9 kg N /ha yearly. If the mentioned farm would be a conventional farm, it would need only 150 ha arable land to get all needed hay and cereal and also pastures. However, conventional milk farms in Finland use approximately 130 kg N /ha and it is 19500 kg N to 150 ha area and besides that same amount concentrate as is used on this ERA-farm. So the nitrogen balance should be negative.

Background and objectives

There is increasing concern about the dependence of agricultural food production on mineral fertilizers (especially N and P) and other agrochemicals, because these inputs are

associated with significant negative environmental impacts, reduce the sustainability of crop production systems and negatively affect future food security (Bartlett 1998, Cordell 2009, Tilman 2002). Ecological Recycling Agriculture (ERA) is organic agriculture based on local and renewable resources with an integration of animal and crop production (Granstedt et al 2008). This way a large part of the nutrient uptake in the fodder production is effectively recycled. This in effect means that each farm (or farms in close proximity) strives to be self-sufficient in fodder production (min 80 % own fodder) which in turn limits animal density and ensures a more even distribution of animals to most farms.

As in organic production generally no artificial fertilizers and pesticides are used in ERA model. However, it provides a system in which the recycling of nutrients is more effective, either within one/a farm or as a result of co-operation of a few farms located nearby. Consequently the input-output ratio is better in balance compared to conventional farms (Granstedt et al 2008).

Key results and discussions

The study of the three ERA-farms demonstrates, that the ERA-model enables a better input-output balance in N compared with conventional farming methods. It has however to be considered that implementing the ERA-model the field areas have to be larger than in conventional production, if the meat production and consumption stays at the present level. Another important factor is NUE (nitrogen use efficiency), which demonstrates the synchrony between N supply and crop demand (Cassmann 2002). The farm cases indicate that ERA-farms could have quite high NUE values because the yields are quite high in relation to the low inputs.

ERA-farms are using only recycling organic fertilizers, which are made from manure and crop residues in the farm. They increase the inherent fertility of soils, when used repeatedly over many years. Future food security is likely to depend on reducing the reliance on mineral fertilizer inputs yet maintaining and/or increasing current levels of productivity in crop production, because the production of mineral fertilizers relies on non-renewable resources. The main strategy available to replace mineral fertilizer use is to recycle a larger proportion of nutrients which are removed from soils as crops and livestock products back into agricultural soils. This will have to be based on the efficient recycling of agricultural, food processing and domestic organic waste.

(*) Conventional farm figures are statistical averages from Tike, Information Centre of the Ministry of Agriculture and Forestry In Finland

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