

## **Crop yields in organic and conventional production – studies from the Öjebyn project**

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### **ABSTRACT**

In order to develop organic dairy production a system study called “The Öjebyn Project” was started in 1990. Öjebyn is a research station of The Swedish University of Agricultural Sciences in northern Sweden. There is 104 hectares of arable land; 58 hectares are grown organically and 46 hectares are grown conventionally. The feed produced on the farm was fed to around 50 dairy cows in each system. There has been a crop rotation of six years and a careful handling of farmyard manure and urine from the dairy cows. The crop yields have been recorded for twelve years as have the quality of each crop in terms of energy, protein and mineral content (P, K, Ca, and Mg). The difference in yield between the two systems has been changing over time. During the first three years there was a diminishing yield in the organic system, followed by a steady increase in yield. In the conventional system there was no such trend, on the contrary there was a tiny decreasing trend. Today’s conclusions about total crop yields from the systems would be quite opposite as if they were made six years ago. The organic system has throughout the study delivered crops with higher content of Ca, P and Mg but with a lower content of K. These differences in mineral concentrations affect the need of different mineral supply to the cows and at the end even the animal health.

*Keywords: system study; crop production; field balance; mineral nutrition*

### **INTRODUCTION**

The research station at Öjebyn has since 1944 belonged to the Swedish University of Agricultural Sciences. Öjebyn is located at longitude 21° 24' east and latitude 65° 21' north, five meters above sea level. The soils are fine sand and silt and give good yields of leys, barley and potatoes. Due to the high light-intensity during the summer months, vegetables of the highest quality are grown here. The research station has totally 170 hectares of arable land, (out of which 104 hectares are used in the Öjebyn project), two separate cowsheds that are similarly equipped for 50 cows each, two silo (400 m<sup>3</sup>), and six separate hay-dryers. The herd consists of 100 milking cows (Holstein-Friesian and some Swedish Polled Breed).

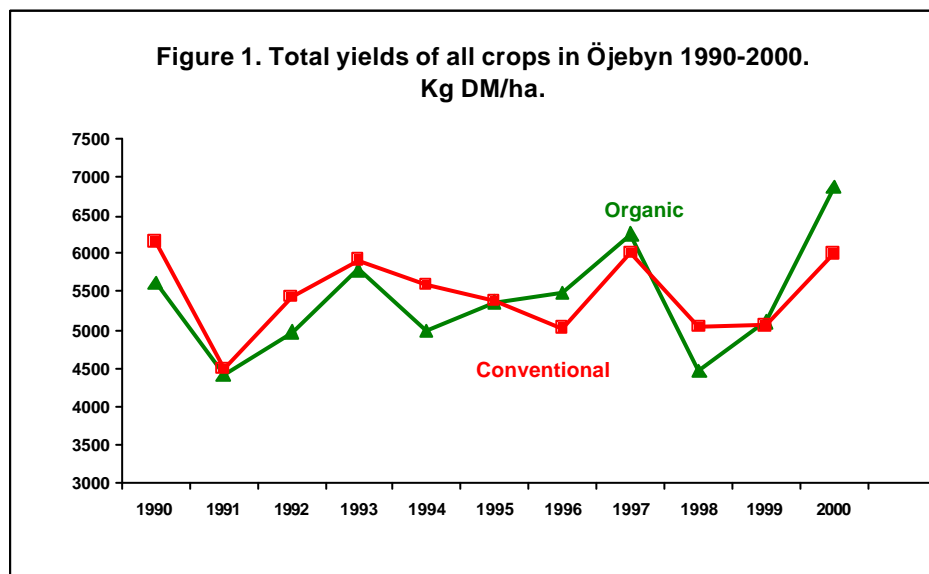
The aim of the project is to develop the organic food production in Sweden. A full-scale study comparing organic with conventional farming on 104 hectares of farmland is being undertaken. The project started in 1988 with the first conversion. The first recording of crop-yields was done in 1990 and the milk recording started in the autumn of the same year. We try to achieve a sustainable agriculture that is as considerate as possible towards the environment. Nutrients are recirculated within

the farm and nitrogen is obtained from the ability of the leguminouses to fix nitrogen. The most important plants for this purpose are clovers and peas. The herd is divided into two separate herds of about 50 milking cows in each. Feed is supplied from specific fields. Manure and urine are kept separately and returned to these respective fields. The project has in this year (2002) been run for twelve years, i.e. two complete six year crop rotations. The crops are; Reseed (Ley sown under green-crop as nurse crop), three years of ley, barley and seed-potatoes. On a small part of the fields in third year of ley (year 4) and with the seed-potatoes (year 6), vegetables have been grown as well.

## RESULTS

### Cultivation

Detailed results from this experiment have been reported previously (Jonsson 1997, 1999, 2001). The results presented here reflect the yields obtained during the eleven years after conversion to organic farming (1990-2000). The average figures for the total production from all crops during this period reveal that the organic production is 1% lower on a dry matter basis and 4% lower when considered on a metabolic energy basis. Therefore the organic crops have a somewhat lower energy content. However, there is a trend of increasing yields in the organic system while there is no such trend in the conventional system (see figure1). The yields from the reseed and the leys together are  $6357 \text{ kg dry matter ha}^{-1}$ . This is 6% lower than from the conventional system. However, the yield of organic barley ( $3789 \text{ kg ha}^{-1}$ ) is 5% higher than the conventional. The organic seed-potatoes have yielded 4% more  $\text{kg ha}^{-1}$  than the conventional potatoes.



Data of the recorded harvest during the second crop rotation (table 1) show the trend of increasing yield in the organic system. The chemical composition of the crops shows a low content of metabolizable energy in the reseeds and a higher content of crude protein. The organic leys have a lower content of metabolizable energy (ME) and crude protein, which can be caused by a later harvest time. The leys are harvested twice and it has been logical to start harvesting the conventional

leys before the organic ones as the higher clover content in the organic leys has caused the later start of harvest. During 1996-2000 the clover content of the organic leys has been 30%, while only 18% in the conventional system. The clover develops slower and the grasses faster in springtime in both systems but because of the availability of soluble N in the conventional system the harvest date tends to be earlier. The slower start to the organic system results in later first and second harvests. In reality it means that the total growing season becomes longer in the organic system and might be one reason to the higher ley production in the organic system.

Table 1. Metabolizable energy and chemical composition and quota K/(Ca+Mg) in organic and conventional crops, 1996-2000.

Crop	ME (MJ/kg DM)	CP (g/kgDM)	Ca (g/kgDM)	P (g/kgDM)	K (g/kgDM)	Mg (g/kgDM)	K/Ca+Mg
Organic reseed	10,0	17,9	6,8	3,1	25,7	1,9	2,9
Conv. reseed	9,8	13,3	7,3	3,3	31,2	1,9	3,4
Organic ley	10,5	12,3	6,6	2,7	24,1	1,9	2,8
Conv. ley	10,8	14,5	6,0	2,5	28,4	1,9	3,6
Organic barley	13,4	14,3	0,5	4,4	6,2	1,2	3,5
Conv. barley	13,4	14,3	0,5	4,5	6,3	1,2	3,6
Organic potato	13,1	10,1	0,8	2,5	24,8	1,3	12,2
Conv. potato	13,1	9,7	0,7	2,7	27,2	1,1	14,8

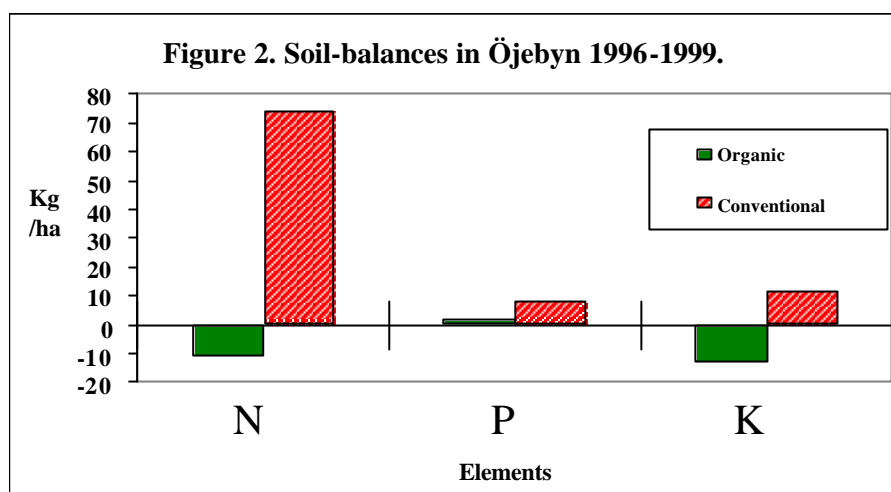
There are differences in mineral content between the two systems. In the organic crops there are lower concentrations of potassium (K) and usually higher concentrations of calcium (Ca) and magnesium (Mg). From an animal production point of view it is advisable to have a lower quota of K/(Ca+Mg) in the ration. This quota is lower in all organic crops. Bengtsson *et al.* (1999) and Öborn *et al.* (2001) also found differences in mineral content between the systems. Gustafson *et al.* (2001) discusses the fluxes of minerals and how it affects the sustainability of the whole farm. The mineral content affects the health situation of the herd and even minerals like cadmium (Cd) and zinc (Zn) are important. Bengtsson *et al.* (1999) have studied the fluxes of Cd and Zn in the systems of Öjebyn and Olsson *et al.* (2001) have reported quality differences in products from the dairy cows in the two systems.

### Field-balances

Field-balances have been done for the first six years (1990-1995). Similar field-balances have been done for the following four years 1990-1999, (see figure 2). The input consists of nutrients from manure, urine and lime. In the conventional system there is also the input from chemical fertilisers. The output are entirely what has been harvested and brought from the fields. For nitrogen (N), phosphorus (P) and potassium (K) there has always been a surplus of nutrients in this system (75; 18; 18 kg ha<sup>-1</sup> respectively). This surplus has been decreasing due to the lower amounts of chemical fertilisers that have been added during the last years (74; 8; 12 kg ha<sup>-1</sup> respectively).

In the organic system there has always been a small surplus of phosphorus (P), which originates from the input of concentrates and mineral feeds to the dairy cows. There is a shortage of nitrogen (N) ranging from 15 - 11 kg N ha<sup>-1</sup>. The shortage of potassium (K) ranges from 27- 13 kg K ha<sup>-1</sup>. The shortage of N is supposed to be met by the fixing of N in clover. The clover-content was 26% as an average in all leys during the first six years. Calculations show that there is a need of a clover

content in the leys of 30-35% in order to balance N in the organic system in Öjebyn. During this period (1996-1999) there has been an average clover content of 30% for all organic leys. The N-fixing in the conventional system causes a surplus of 18 kg N ha<sup>-1</sup>.



The shortage of K (13 kg ha<sup>-1</sup>) in the organic system has led to studies on weathering of K by Öborn et al. (2001). It is proved that there is weathering going on in these soils that contributes 15±5 kg K ha<sup>-1</sup>.

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