

## From Maximum Yields to Sustainable Agriculture

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### 1. Introduction

Agriculture in West Europe and North America finds itself ecologically in a crisis situation. Agro-technical developments have resulted in very high production levels and in many cases overuse of energy inputs in the form of fertilizers and pesticides. These too high inputs have led to serious environmental contamination and will certainly continue to do so unless the distance between Best Technical Means and Best Economical Means is narrowed by government policy. The most pressing problems are currently soil and water pollution. In addition, farmers face economical problems as a result of overproduction and decreasing prices.

Therefore, in the Netherlands, a strong need was felt to explore alternatives to this maximum yield type of agriculture. More than ten years ago, the Dutch government decided to start a research project on "Development of Farming Systems (DFS)" on a modern experimental farm in the North-East Polder. The farm comprises three different units, designated as current, integrated, and organic Farm.

The objective of the current farm with a 17 ha farm size and a four-year rotation is to reach maximum economic returns, applying all modern technology with high inputs. The management works within the legally defined environmental constraints. The objective of the integrated farm is to develop a farming system designated as "integrated", which refers to an integration of purposes, especially reduction of inputs derived from non-renewable resources per unit of product -to avoid pollution- and maximize financial results within narrow environmental constraints and thus approaching those of the current farm. Size and rotation are similar to those of the current farm, so that comparisons can be made. The organic farm follows the principles of biodynamic farming, the major trend among the ecologically oriented farming systems in the Netherlands. Basic principles are rejection of the use of synthetic fertilizers and pesticides and restricted imports of manure and fodder. The farm was designed as a mixed farm of 22 ha, with a rotation of 10 years and about 20 dairy cows.

The research consists of a detailed description and analysis of the three farming systems, including two types of comparison:

- internal comparison; to see whether each farming system can meet its own objectives
- external comparison; to study the performance of the three farming systems relative to the surrounding area.

The internal comparison helps to analyse the various bottle-necks encountered and thus serves systems development. The external comparison may lead to conclusions on the economic viability,

the sustainability and the social implications of the three farming systems. To measure the performance, the variables to be measured and the methods of measuring were identified in advance.

## **2. Crop rotation and arable crop production**

The crop rotation of the organic farm proved to be adequate to maintain soil fertility without fertilizer use and to restrict weed competition. The crop rotations of the current and integrated farms are short and they contain mainly high yielding crops. They are risky with respect to soil-borne pathogens. In fact in both the current and the integrated system the crop rotations are too narrow, creating problems of soil soundness. A broader (1-6) crop rotation is needed, but for economic reasons, given farm size and farm structure difficult to implement. However it is the best preventive measure. Soil fertility can be maintained at high levels on both farms. Weed suppression by the crops in the rotations on the current and integrated farms is poor and the use of herbicides is still high, but may be replaced by thermal or mechanic methods. The organic and integrated farms shared on average low yields of potatoes. The major causes seem to be cultivar choice, damage by foliar diseases, and sub-optimum nutrient supply. Sugar beets performed excellent on the integrated farm. Their performance on the organic farm was not so good, possibly because of poor crop establishment and delayed canopy closure due to shortage of nitrogen. Winter wheat yields depend strongly on nitrogen availability and control of pests and diseases during the grain filling period. Therefore, it will be impossible to achieve high yields with organic farming. Yield stability and produce quality might be improved by further development of the system.

## **3. Nutrient supply and soil fertility**

Though a high degree of perfection was attained in nutrient management by recycling, the organic farm can only be sustained at the expense of range land fertility. On the organic farm, the phosphorus availability will go down in the long run and this will lead to a lower production. Drainage water quality of the current and integrated farms did not meet the EC standards for NO and the leaching losses of nitrogen in both farms gave rise to concern. The leaching losses in the organic farm were relatively small and the drainage water quality met the standard.

## **4. Control of pests, diseases and weeds**

The current farm uses far more pesticides than the other two farms and achieves high yields and good yield stability. But in the long run it may threaten environmental objectives. Natural enemies are least abundant on the current farm. In the near future, the integrated farm will be current. Though the tactics of the integrated farm seem to be risk-seeking, in strategic terms it is an extreme case of risk-avoidance. The weed management on the three farms resulted in acceptable weed levels. However, weed control was a difficult factor in the management of the DFS Farms. The number of weed plants was always lowest on the current farm and the number of species highest on the organic farm, the integrated farm being intermediate. On the organic farm, a massive input of labour for hand weeding could only be avoided by adapting the rotation scheme

and inserting leys.

## **5. Economic results and product quality**

Total costs per farm on the organic farm were recovered just over 50% by benefits from cash crop and dairy farming. The high labour costs and the low stocking rate preclude future profitability. But in the case of cash crops, low yields were compensated by high selling prices. On average, 95% of the costs of the integrated farm were compensated by returns, and 99% of those of the current farm. The increase in costs on the integrated farm was slower than on the current farm. Costs of fertilizers and pesticides on the integrated farm were considerably lower than on the current farm.

On the integrated farm the trend of benefit-cost ratio developed more favourably than on the current farm. In view of the trends in returns and costs of the integrated farm, more research on integrated farming is recommended, including the economic feasibility of large scale integrated farming.

## **References**

- Vereijken, P.H., 1989. Research on integrated arable farming and organic mixed farming in The Netherlands. Proc. Intern. Conf. on Sustainable Agricultural Systems. Univ. of Ohio, Columbus. Sept. 19-23, 1988.
- Zadoks, J.C. (ed.), 1989. Development of Farming Systems: evaluation of the five-year period 1980-1984. Pudoc, Wageningen, 90 pp.