Research on integrated and organic farming in the Netherlands

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As doubt about the perspectives of current agriculture is growing, interest in alternative systems of production is increasing. As a result, many new research activities have been started. Currently, most initiatives are taken in the field of plant production. In Europe, a Working Group of the International Organization for Biological Control (IOBC) is trying to develop integrated arable farming systems inspired by the aims and methods of Integrated Pest Management (IPM). The two oldest projects are the Lautenbach experimental farm near Stuttgart (West-Germany) and the Nagele experimental farm of the Ministry of Agriculture in the Netherlands.

On the latter farm integrated arable farming and organic mixed farming are being developed and compared with a conventional reference farm. Crop rotation, fertilization and crop protection on the 3 farming systems are described. Results of farming and research during the 1985-1987 period are summarized. Finally the perspectives of both alternative systems are discussed.

Objectives and significance of integrated and organic farming

The intensification of agriculture, based mainly on increasing inputs of fertilizers and pesticides, is considered as the major cause of a crisis. On the one hand, it is causing pollution of the environment, flattening of landscapes and decline of flora and fauna. On the other hand, it is leading to increasing agricultural surpluses which are forcing policy-makers to switch from a protective to a more market-oriented agricultural policy. Consequently, farmers all over the world have to face the snowball effect of falling prices, decreasing incomes and threatening unemployment. Integrated farming seems to be the only realistic strategy to control the still aggravating crisis, since it takes into account both ecological and socio-economical considerations. Briefly, its objectives at farm level are as follows:

1. A shift in emphasis from greater production to cost reduction and improvement of quality of both products and production ways, through substituting expensive and polluting inputs, especially fertilizers and pesticides, by both agricultural and ecological knowledge, (brain) labour and non-chemical husbandry techniques.
2. Encouragement and conservation of flora and fauna in and around fields to stabilize the agro-ecosystem as a major preventive measure against outbreaks of pests, weeds and diseases.

As main social effects of this integrated farming strategy can be expected:
a. Less pressure on profits of the agricultural holdings at increasing cost of production means and decreasing prices of products.
b. Less pollution of the environment.
c. More safety for public health.

Biological or organic farming may be considered as the most radical approach of these integrated objectives. On the long term it may also appear the most successful approach, provided the necessary technical and economic improvements can be made.

The experimental farm in Nagele

This national experimental farm for the development and comparison of alternative agricultural systems started in 1979. It is situated near the village of Nagele in the North East polder, 3 to 4 meters below sea level on heavy sandy marine clay (24% lutum). The size of the farm is 72 hectares. Three farming systems have been studied: Organic, Integrated and Conventional. The systems are run on a commercial basis by 1 manager and 4 co-workers. The organic farm is managed according to the biodynamic method, which is one of the organic systems practiced most in Western Europe today. It is a mixed farm of 22 hectares, with 20 dairy cows and a 10-year rotation including 50% fodder crops. Its main objective is to be self-supporting in fertilizers and fodder. No pesticides are allowed. The conventional farm which serves as a reference has as its main aim a maximum of financial return. The integrated farm should produce a satisfactory financial return but it also aims at a minimal input of fertilizers, pesticides and machinery, to avoid pollution of the environment and save non-renewable resources, so it may be characterized as an intermediate system.

The research on the farms has three objectives:

- development of the organic mixed farm and the integrated arable farm in theory and practice;
- evaluation of the results of the systems with respect to their specific aims
- comparison of the results of the systems with those of the conventional reference system.

Farming methods and techniques

Crop rotation
Appropriate crop rotation can be very effective to control pests, diseases and weeds and maintain soil fertility. In conventional agriculture, the chances

Dutch farming system experiment in Nagele. (Photo: Pieter Vereijken).

The organic farm: red clover/grass mowing pasture and white clover/grass grazing pasture with the Dutch-Frisian cows in the background. (Photo: Pieter Vereijken.)

for a good rotation have been strongly reduced, since most farmholdings in the Netherlands are small and farmers have to grow high yielding crops in an intensive way, facing increasing production costs and decreasing returns for their products.

For this reason the integrated system had the same crop rotation as the conventional system: potato - variable crop - sugar beet - winter wheat. The choice of crop for the variable year/field depended on the market situation. Since 1985, peas have been grown on one half of the field and onions and carrots on a quarter each. A longer rotation would have offered a better barrier against soilborne pests and diseases, but it would also have been less profitable than the current 4-year rotation.

As a contrast, the mixed character of the organic system offers excellent opportunities for a diversified and sound rotation. Perennial pastures with grass and clover suppress weeds, restore the soil structure and increase the organic matter and nitrogen content of the soil. Moreover, a high proportion of grassland in the rotation reduces the cropping frequencies of the marketable crops such as potatoes and cereals. As a result, the pressure of soilborne pests and diseases is kept to a minimum. At the moment the rotation is: potato - winter wheat - half carrot, half fodder beet - pea - 2-year mowing pasture (alfalfa, red clover, English rye grass) - onion - winter wheat - 3-year pasture (white clover/grass mixture). This crop sequence was specifically based on alternating positive and negative influences on the structure and the nitrogen reserves of the soil.

Fertilization
As is usual in Dutch arable farming, on the conventional farm fertilization was mainly of a mineral nature. Organic manure, preferably solid chicken manure was applied only to the wheat stubble land to supply organic matter. On the integrated farm, fertilization was mainly organic and mineral fertilizers were only used in a complementary way. In this system crops were moderately supplied with N in order to avoid abundant leaf development and - as a result - high disease susceptibility. Liquid chicken manure was applied right before the sowing of sugar beet and the planting of potatoes, and immediately ploughed under in order to achieve a maximum N-effect. In conventional agriculture, green manure is applied to improve soil structure. On the integrated and organic farms, green manure crops were also grown to fix the nitrate which had been left behind by the main crop or which has mineralized after harvest. Thus, green manure crops served as a means of prevention of nitrate leaching. On the organic farm, only organic manure from our own farm was used. Clover was the main source of N in the farm cycle. After being consumed as protein by the dairy cattle, N was collected in the loose-housing as stable manure. Together with the other nutrients, N was distributed over the various crops, as required. Because products were sold, soil reserves of P and K were gradually depleted. This was compensated for by purchasing straw and roughage and some concentrates.

Crop protection
In conventional agriculture, crop protection is chiefly of a chemical nature. Whereas on the integrated farm, pesticides were used only as a last resort. Chemicals that are known to be highly toxic, persistent or mobile were avoided. Weeds, diseases and pests were controlled mainly by means of resistant varieties, lowering of the N-dressing, mechanical weed control, use of appropriate sowing times and sowing distances, etc. On the organic farm ample rotation was indispensable for the prevention of weeds, pests and diseases, because chemical control was prohibited. In both experimental systems, some loss in yield caused by weeds, pests and diseases was accepted.

Results of farming and research

Economics and environment represent the two main criteria for the social acceptability of the three production systems. The inputs of fertilizers and pesticides were important indicators of the environmental impact. The economic viability was especially indicated by net surplus and labour returns. Because of considerable changes in the management of the systems since 1984, only the latest results are presented (1985-1987).

Total returns of the organic farm appear to be considerably higher, as a consequence of high premiums on standard product prices. Marketable organic crops clearly have higher returns than grassland and fodder crops. However, the total production cost was much higher than on the conventional and integrated arable farms, especially in labour, buildings and cattle/fodder, which renders by far the lowest net surplus. In spite of this, labour returns on the organic farm were highest, although insufficient compared to labour returns outside the agricultural sector. The integrated farm hardly differed from the conventional system in total returns and total operation costs (labour, contract work, machines). However, the integrated farm gave considerable savings of expenses in fertilizers and pesticides. As a result, the integrated farm achieved a 500 guilders (ca. U.S. $250.-)/ha higher net surplus. The three farms hardly differed in intensity of soil use (Standard Holding Units/ha). Labour productivity of the organic farm however, was less than half of that of the two other farms (Standard Holding Units/Labour Unit).

On the integrated farm, an important shift has taken place from mineral to organic fertilization (Table 1). Compared to the inputs on the conventional farm, total inputs of K and N were less and the total input of P was the same. On the organic farm, a very large quantity of K was brought into circulation by fodder crops and cows. However, P and N fertilization was by far the lowest here. N-availability was clearly the main limiting factor for production on the organic farm, as appears from yield comparison between experimental plots in the pastures with and without clovers. From the results, it has been concluded that biological N-fixation was the main source of N-input in the organic system.

On the organic farm, relatively little nitrate is leached, as appears from analysis of the average drain water contents (Table 1). Nitrate leaching on the integrated farm remained equal to the conventional farm, notwithstanding its principally organic form of N-supply. Apparently, the resulting higher degree of N-mineralization after harvest was

recovered successfully by green manure crops. In fact, the drainwater of the organic farm was so clean that it could also meet the requirements of the European Community-guidelines for the maximum admissible nitrate content of drinking water (5,6mg NO3-N/1 = 25mg NO3/l).

On the conventional farm 9.2 pesticide treatments per field were applied and on the integrated farm only 3.5 per field. If the use of chemical means per year is expressed in kg per ha active ingredient, the difference is still greater: 10.4 versus 4.6 and even 53.1 versus 4.6, if routine fumigation of the soil against potato cyst eelworm on the conventional farm is included.

Experimental introduction of integrated agriculture

From the experimental results the conclusion may be drawn that drastic reduction of the usage of fertilizers and pesticides by means of integrated farm management is attractive from an environmental point of view. The resulting cost reductions may also offer sufficient compensation for lower yields and may even bring a higher profit. As increasing costs of production and especially decreasing prices of agricultural products put profits under pressure, it becomes attractive to convert to integrated management. Considering the saturation of markets and the growing amount of restrictions through environmental legislation, research on integrated farming should be extended, through experimental introduction of the system into practice. This would imply the testing of the prototype-system developed in Nagele by experienced and commercial arable farmers, in order to attain technically and economically feasible farming scenarios. Undoubtedly this will also lead to the improvement and broadening of the current integrated cropping programmes, promoted by the great variety of practices in attitude and skill of farmers, nature and size of holdings, soil types, crop rotations etc. Two other experimental farms for the development of integrated arable farming started in 1986 and 1989 in the peaty sand and light sand districts respectively.

Perspectives on organic farming

The net output of the organic mixed farm has increased steadily since 1985, when low profit fodder crops were replaced by high profit vegetables and milk production was raised to a higher level through supplementary purchase of concentrates. Consequently, an acceptable income can be expected in the next few years. This can be achieved on the condition that, a 25% (milk, meat) to 100% (grain, vegetables) higher price level be obtained for the organic products compared to the conventional market, in order to make up for the higher investments in capital and labour. This need of high premiums however, appears to be too high a threshold for the majority of farmers and consumers up till now. This does not mean that organic farming is doomed to play a marginal role. In areas with sensitive ecological characteristics and also in water collection areas, organic farming may play an important role because of its minimal introduction of nutrients and its rejection of chemical pest control. Therefore, organic farming in these areas deserves financial support from public funds. Finally, an increasing demand for organic products is occurring on the European market, inspired by growing concerns for man and his environment and for the well-being of animals. Sooner or later this may lead to a break-through of organic farming into the conventional practices of farm production, trade and consumption.

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Photo's: Pieter Vereijken

	Conventional	Integrated	Organic
K as fertilizer	75	20	-
K in organic manure	70	95	155
Total	145	115	155
P as fertilizer	15	-	-
P in organic manure	40	55	20
Total	55	55	20
N as fertilizer	140	60	-
N in organic manure	75	125	115
Total	215	185	115
NO3-N in drainwater	12,4	12,2	5,0

Table 1. Fertilization (kg ha-1) and nitrate-nitrogen content of the drainage water (NO3-N in mg l-1) in the 3 systems averaged for 1984-1986.

	Conventional	Integrated
Results per ha in Dutch guilders		
1. Total returns	6190	6250
2. Labour cost*	2310	2280
3. Contract work	1020	1020
4. Equipment and machinery	1560	1630
5. Total operation cost (2. to 4.)	4890	4930
6. Land and buildings	1290	1290
7. Fertilizers	450	290
8. Seeds	690	790
9. Pesticides	690	260
10. Other costs	610	610
11. Total cost (5. to 10.)	8620	8170
12. Net surplus (1. minus 11.)	-2430	-1920
13. Labour returns (12. plus 2.)	- 120	360
Technical and economic data		
14. Cultivated land (ha)	17	17
15. Number of labour units	0.7	0.7
16. Standard holding units (S.H.U.) per ha	105	105
17. S.H.U. per labour unit	149	152

* 27 guilders/hour was the norm gross reward for the farmer's own labour in Dutch agriculture during 1985-1987.

Table 2. Average economic results of the integrated and conventional farming systems during 1985-1987 (US$ 1.00 = Dutch guilders 2.00).