DEVELOPMENTS AND RESEARCH ACTIVITIES IN CROP HUSBANDRY - FROM A DANISH POINT OF VIEW

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1. Introduction and overview

This paper gives a brief description of the situation in Danish crop husbandry with emphasis on future trends and started research activities. Although based on Danish experiences, it is belived that the picture may be representative for the present and future situation in many other industrially developed countries as well.

After giving some background information on Danish plant production, four main challenges to crop husbandry are discussed concerning:

- agriculture and the environment,
- production surplus,
- reduction of production costs, and
- consumer preferences, e.g. in relation to product quality.

These challenges are induced by political and/or economic factors, and they are some of the consequences of the public's growing interest in the production methods applied in intensive plant production.

The paper outlines possible ways to go in plant husbandry to meet those challenges. Research initiatives, the role of new technologies and the importance of a close linking between research, advisory service and farmers are highlighted.

2. Background

The total agricultural land of Denmark was at a maximum of about 3.2 million ha at the end of the 1930'es. Since then the agricultural land has decreased to about 2.8 million ha. Since 1970, the decrease has averaged to a little more than 0.2 % annually, caused by primarily house building, public purposes, e.g. road systems, and growing areas with forest. During the same period there has been a strong decrease in the number of farms and a corresponding increase in the average farm size. In 1987 the number of farms was about 86,000 out of which about 40,000 were full-time farms. The average fram size is about 32 ha. This structural development is expected to continue, and year 2000 the total number of farm units is expected to be about 62,000 with an average size of about 44 ha.

The arable area by type of crop is shown in the table underneath:

56.0	Cereals
5.1	Pulses
7.8	Root crops
8.2	Seeds for industrial use
1.6	Seeds for sowing
12.5	Grass and green fodder in rotation
1.1	Horticultural products
0.1	Other crops (including fallow)
7.6	Permanent grassland
100 %	

Source: Danish Statistical Office, numbers for 1986.

Within the cereals group the predominat crop is barley occupying about 68 % of the total area with cereals.

The input intensity in plant husbandry has increased over the last 30 years. The total consumption of nitrogen in commercial fertilizers has increased from about 124,000 tons in 1960 to 382,000 tons in 1986 with a maximum of 412,000 tons in 1984. Similarly, there has been an increase in the average number of treatments of the arable land with pesticide application. This factor reached its

maximum in 1984 with an average number of treatments of about 3.5 per year. The number has decreased, however, to about 2.6 treatments per year in 1986.

3. Four main challenges

Agriculture and the environment

The adverse effects of intensive plant production have lately received a strongly growing interest from the public and the political system. In Denmark it has been decided that both nitrate leaching and consumption of pesticides must be halved. Nitrate leaching is in focus because of its effect on ground and sea water quality, and pesticide consumption because of fear of residues in food, fear of health risks and general fear of long-term effects of decomposition products in soil and ground water. As already mentioned, the increase in nitrogen commerical fertilizer and pesticide consumption topped in 1984 and has decreased since then.

Production surplus

The problem of production surplus within the EEC-countries is among other crops related to the production of cereals. For these crops the overall rate of growth of productivity in the EEC-countries has been approximately 2.5 % per year over the last ten years. The present surplus situation and the policy of the EEC to overcome the problem may lead to falling prices of cereals. Also the question of marginalization of agricultural areas is brought into question in this connection, both on EEC-level and on national level.

Reduction of production costs

In view of the expected falling prices in future for major groups of crops, one of the primary aims in crop husbandry will be to reduce costs rather than to increase production. The "ten tonnes club" will no longer be as attractive as earlier. The net return of the various crops and of the rotation of crops will be a criterion of increasing importance.

Consumer preferences

Along with the growing interest in agriculture and its effect on the environment, there is also a growing interest in the public in product quality in a very broad sense. In crop husbandry the concept of product quality refers to both fodder crops and crops for human consumption. Special attention is paid to plant products produced without the use of chemical fertilizers and pesticides - organic farming. In Denmark it is generally assumed that the demand for such products constitutes at least 10 % of the total demand, especially in the area of green vegetables.

4. Ways to go

Plant production must meet those challenges listed above. The challenges must be met by an integration of economic and environmental regards and by a diversity in production. Research and new technologies are important remedies.

Integrated crop production

There seems to be two distinctly different philosophies to follow in order to solve the agricultural/environmental conflict. One is to separate the production function from the environmental function of the open landscape. This philosophy is advocated by those who see marginalization including reforestation as a chance of bringing land back to nature. A major problem is, however, that the land taken out of production often will be the less favoured areas with the least production potential. Hereby the environmental problems in the rest of the agricultural land with presumably still intensive input of production factors will prevail.

The philosophy of integrating the two functions, the production function and the environmental function, on the contrary, is believed to represent a markedly better solution. Combining the techniques applied in conventional agriculture with high input of fertilizers and pesticides with the techniques from organic farming at a lower input level will be the result along with a lower

production risk. Simultaneously, the somewhat lower production level will contribute to a solution of the present surplus production and create an environmentally acceptable situation and in the end even maintain farm incomes at acceptable levels.

Integrated crop production means a difficult balance between the two regards, economy and environment. Research programmes have been started with the aim of developing plant production systems for integrated crop production. This involves optimal use of organic manure with mineral fertilizer used supplementary and extended use of crops with growing period during autumn and winter to catch the mineralized nitrogen and thereby prevent leaching. The dependence on pesticides is attempted reduced through the rotation of crops, application of resistant varieties and use of reduced dosages based on warning models and the prevailing meteorological conditions.

Alternative crops

With the problem of production surplus in mind, effort is put into alternative plant production. This includes new applications of traditional crops, e.g. for the production of cellulose out of straw. It also includes other applications in the non-food area, both of traditional and new crops. In this connection, close cooperation with the industrial sector is of great importance.

Alternative crops also include organic farming, where there is a consumer demand. A programme has been set up for promoting organic farming and for ensuring the consumer that products marketed as organic farmed products are produced according to specific rules adopted to this way of production. Organic farming, however, is only interesting to the farmer to the extent that consumers will pay the additional price needed to cover the additional costs of production.

Additionally, more exotic plants are being investigated for their relevance as alternative crops. This includes plants with contents of interest for the medical and health industry. A major problem with such new crops is that the market demand for products often can be satisfied by only very few growers.

Some years ago, crops such as rape and protein legume plants were considered as alternative plants. Because of the EEC-effort of becoming self-sufficient in vegetable oil and protein and the following price-policy, these crops now cover a considerable acreage in Denmark and in the other EEC-countries.

Crop management systems

In reducing production cost in plant husbandry, research programmes for developing crop management systems play a major role. Mathemathical modelling and information technology are appliced to combine existing and new knowledge as to the timely and optimal input of production factors as fertilizer, pesticides and irrigation water. An important factor in reducing these costs is the use of information on past, present and forecast weather conditions. Also in this aspect, information technology is central, both in collecting and managing the huge amounts of data, and in processing data in farm management systems. The importance of correct and timely weather information - also at farm level - will increase as the farmer is able to control more of the other, above mentioned production factors.

Crop quality

The importance of crop quality will increase at the expense of crop quantity. This is one of the consequences of consumer demand, and the aspect represents great challenges to research workers and to practical farmers. One of the primary goals is to define the concept of crop quality and to develop unambiguous and reproducible methods of measurement. The next step will be to develop growing methods for the input of plant growth factors suitable to meet defined quality criteria. The aspect of crop quality will of course be of considerably increased interest to the farmer to the extent that accounts will be made according to quality criteria.

5. New technologies

The ongoing development of new technologies presents an offer to the farming community. Two technologies deserve mentioning in this outlook on development in plant husbandry: information technology and biotechnology.

Information technology has been an important tool for the research worker for a number of years, and application of databases and numerical models is now an integrated part of many research projects. The development of expert systems, which is a special branch of the area of artificial intelligence, represents a new but yet untested opportunity for agricultural research. Expert systems are designed to handle knowledge, including heuristic knowledge, rather than numerical data. Knowledge is what the expert in farm management implicit is handling when deciding how to manage the crop.

Information technology including expert systems is also important in the process of linking research with the advisory system and with the crop grower. A personal computer with on-line access to host computers for information retrieval and for subsequent handling of data in crop management systems will be a central tool at the commercial farm in future.

Likewise, biotechnology is - and will to a great extent be - a technology of immense importance to crop husbandry. Numerous publications on the subject concern the possibility of introducing wanted resistance properties in well-known crops, introducing nitrogen-fixation properties in cereals and introducing genes for production of special qualities. Only lack of fantasy sets the limits for these scenarios.

6. Concluding remarks

Not many years ago, plant production and plant production research aimed mainly at the increase in production and the improvement of productivity. The present development shows that other aspects such as environmental considerations must be included. This calls

for more overall solutions - a holistic approach. The philosophy of integrated crop production includes this holistic point of view and inspires to research in cropping systems as a whole rather than in single crop production factors separately. This complicated situation for the farm manager with several - and sometimes conflicting regards to take into consideration - represents a great challenge to crop husbandry research and to the reasonable application of new technology.