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TECHNOLOGICAL DEVELOPMENT, PRODUCTION COSTS AND FORECASTING OF AGRICULTURAL PRODUCTION

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TECHNICAL CHANGES IN FINNISH AGRICULTURE

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Abstract. The goal of agriculture in Finland is to meet the domestic need for those food products that can be produced rationally in Finland. It is also important to guarantee farmers a reasonable income level in relation to other similar population groups. In recent years more emphasis has also been placed on preserving a healthy rural environment.

Finnish agriculture is based on small family farm units, and considering the circumstances, production in several areas is on a very high technical level. Cows produce 4000 litres of milk per year on average and the average yield is about 2000-2200 feed units per hectare. Some 25-30 % of the dairy products are exported and 50-60 % of the eggs. Likewise, bread grain has been exported in recent years. As fas as meat is concerned, we are on average self-sufficient. Vegetable oils, sugar, fruits and vegetables are imported as are high-protein concentrates. At present numerous steps are being taken to limit the growth of agricultural production, as the export market is unfavourable.

Both plant and livestock production are quite highly mechanized. However, the small size of farms limits the use of many machines and makes it difficult to maintain farm income level. Attempts are being made to improve the agricultural structure by granting low-interest loans for purchasing additional fields, underdrainage of fields, agricultural construction, mechanization, etc. The Finnish farmer has traditionally produced several products, and dairy products have frequently been the main ones. The trend, however, is increasingly towars specialization in milk, grain, pork, eggs, beef, and this facilitates e.g. mechanization and reduces production costs. In basic production cooperation between farms on small farms is limited to the use of machines and implements. An extensive network of agricultural cooperatives operates in many product and supply branches and also in food processing and banking. Specialization increases the proportion of contract production.

Technical development costs money, but it does generally pay. It has increased production and reduced the input of human labour. The productivity of human labour in agriculture has increased 2-4 % per year on average. The constant increase in technology on small farms does, however, call for more thought and planning.

1. General

In spite of Finland's geographical position way up in the north, agriculture plays an important role in the economy. Though agricultural output (including fishing and hunting) only accounts for about 5.7 % of the whole net domestic product, close on 15 % of the population make their living from agriculture. Finnish agriculture is typically based on family farming, for less than 1 % of all farms are owned by other groups, and the farming family usually does the agricultural work. The average arable area of farms is small: only a good 10 ha with all farms over 2 ha large. A Finnish farm usually also has some forest land, about 30-50 ha on average. Of course, there are variations in the size of farms. We can say that in southern Finland, for instance, the average arable area is 15-20 ha and there are also quite a lot of farms in this region with 25-40 ha of arable land. There are only some 2,700 farms with more than 50 ha in the whole country. In central Finland the average size of farms is smaller, often 10-12 ha. In northern and eastern Finland the average size is 6-7 ha. The importance of forestry and other incidental earnings is also greater in the north and east than in the south.

Natural conditions - climate and soil - constitute the basis for agricultural production and its development. In the south, grain farming is fairly successful, as is sugar beet and in some places oils seeds such as turnip rape. Apples are also grown in the south, though most other fruit has to be imported. Vegetables and root vegetables are also imported. In the east and north the range is smaller. Potatoes, grass and certain fodder crops do quite well throughout the country with exception of northernmost Lapland.

2. The general goals of agricultural policy

The main goals of agricultural policy in Finland are to produce enough of the foodstuffs for which the country is thought to have rational potential to meet the domestic needs. Another important goal of agriculture is to guarantee farmers a reasonable income compared with other sectors of the population. There has also been more talk about protecting the environment in agricultural policy. It is generally accepted that agriculture and the countryside in general should be developed so as to preserve the rural setting, but at moderate cost.

For some time now, the output of the most important agricultural products has exceeded domestic consumption. About 25-30 % of the total output of dairy products is exported, and about 50-60 % of the output of eggs. In the last few years, cereals, too, have been exported. Finland is in practice self-supporting in beef and pork, though there is occasionally a need to export or import meat. About 35-40 % of the sugar consumption and some 30 % of vegetable fats are also produced in the country. There are also adequate fodder crop supplies though protein feeds are imported, mainly to feed pigs and hens.

Because of the high production costs, exporting is only possible through a system of export subsidies. One current problem in agriculture is in fact to bring production and consumption into balance. There has been a kind of soilbank system here since 1969 and some 150,000 ha of arable land is now out of production. A supplementary system is currently being planned, aimed at elderly farmers. Several other steps aimed at limiting production are also being taken.

Many different measures have to be taken to attain the goals of agricultural policy. They include price control on both products and supplies. Ever since the '50s agricultural incomes have been under some kind of legislative control. The aim is to fix the prices of products and supplies so that agricultural incomes follow the same trends as those for other sectors of the population, i.e. conpensation is made for increases in production costs. As production conditions in different parts of the country vary greatly, a kind of regional subsidy system has had to be set up aimed at balancing out income differences between farmers in different areas. Regional subsidies are paid on the most important agricultural products according to a progressive scale in various zones. The most important supsidies affect milk and meat. A higher price is also paid for rye in central and northern areas. Similarly subsidies are paid in the north according to the number of animals kept. As transport costs are exceedingly high in sparsely-populated areas, a milk transport subsidy, for instance, is paid to dairies in central and northern Finland. The government also helps to balance out the cost of transporting supplies and in principle fodder, fertilizers and other vital production supplies cost the same all over the country.

Because earnings from agriculture only ensure an adequate income on large and medium-sized farms, a special small farm subsidy has had to be introduced. This is paid according to the size of the farm, i.e. under 10 ha in southern Finland, under 15 ha in central Finland and under 20 ha in northern Finland. The subsidy is also a social welfare measure in that a farmer whose income is above a certain limit is not granted it.

3. Future development of family farms

One important problem in Finnish agriculture is the small size of farms. Milk production using fodder produced on the home farm, with the related meat production, is a typical Finnish form of production. The average size of the herd is currently a bare six cows. About 20 % of the milk is produced by herds of 1-4 cows. Herds of 5-9 cows produce just less than 50 % and herds of over 10 cows a bare 30 %. On the other hand, it should be pointed out that at present the goal is to have herds of at least 20-25 cows and the average size of herds is growing all the time. Pork is also produced in small units. Farms with less than 100 pigs produce about 50 % and farms with 100-500 pigs not quite 40 % and those with over 500 about 10 % of the total output. In the last few years there has been an increase in the number of commercially-run pig farms with several thousand animals.

Eggs, too, are produced in small units. At the beginning of the '70s about 60 % of all eggs came from poultry farms with 500-1,000 chickens and slightly over 20 % from those with over 1,000. In the last few years a number of large-scale commercial poultry farms have been established. At the moment official permission is needed to set up large commercial pig and poultry farms because of over-production. Cereal growing is concentrated in the south and south-west of the country and on farms of larger than average size.

An important task of agricultural policy is to increase the size of farms. The view is that larger farms cut production costs and thus lower consumer prices. At the same time, an increase in the size of farms makes it easier to manage price policy and watch over agricultural income levels. Low-interest government loans are available to buy out co-heirs or in general to purchased a farm and to buy more land. A loan can also be obtained to build farm buildings and repair them. The same applies to measures to promote rationalization of agriculture, such as drainage of fields, mechanization, etc. Steps aimed at increasing the size of farms have been taken for several decades now, but the results are slow. It is only recently that a new law to develop the structure of agriculture has been passed; this adjusts earlier objectives and takes more effective action.

The aim is to form larger units that will guarantee enough work and an adequate income for farmers, for instance by uniting small farms. A number of studies have attempted to show what size farm the normal family can run in Finland. A normal family is one with two adults and one member of the family, pensioner or minor who helps for part of the year. The size of the farm depends vitally both on the type of products and on what machines and other aids are available. Similarly, on the livestock side, it depends whether the farm produces its own fodder or buys it in considerable quantities. The following figures on size of farm refer to cases in which livestock fodder is mainly produced on the farm. From surveys based on norm figures in agriculture and from practical experience we can state that with new technology a family can run a 30-45 ha farm producing milk as its main products, with 30-40 dairy cows. If there is greater specialization in beef production, the family can run a 50-80 ha farm, raising 100-200 cattle a year for slaughter. In both cases, production can well include some plants for sale. In pig farming, too, a family of two can run a 50-100 ha farm and at the same time keep at least 200-400 pigs if they also produce their fodder. In addition, 30-40 % of the arable land can be devoted to other plants.

If fodder is bought on a large scale, a pig farm with 500-800 pigs can be run with moderate mechanization. If the farmer specializes in grain, the family can cope with 100 ha or even more. Because of the seasonal character of farming, when grain, beef and pork are produced on this scale a considerable amount of the farm family's working capacity is availbble for work outside agriculture proper in winter.

It looks as though the working capacity of a normal family is not the limiting factor if farms are being enlarged. The maximum sizes given above cannot be considered the general goal, in the short term at least. The small size and scattered position of the fields are in many places the barrier to enlarging farms. In developing the structure of agriculture, we must rest content with certain intermediate goals, and to begin with, at least, it will probably rarely be possible to form farms of the size referred to. If, for instance, a 15-30 ha unit is formed from a 7-12 ha farm, this is already a big step forward in many areas.

Increasing the size of a farm calls for a lot of capital, for as well as the extra land it often means putting up new buildings and making other basic repairs. This means having a detailed development schedule in any case and extensive agricultural planning. Enlarging a farm takes time and comes expensive. For this reason, the aim should be to develop land lease and cooperation between farms, which give at least some of the benefits of a larger unit. Even if farms are enlarged, the goal should be to develop viable smaller units, too, for only a proportion of farms can be turned into family enterprises offering full employment. There are problems in the north, in particular, and especially in developing areas, where the conditions for production and farm growth potential are limited.

4. The current state of technical development in agriculture

The application of technology in industry in general, and thus in agriculture too, takes many forms. We can perhaps make a distinction between biological and mechanical technology. The former includes the improvement of cultivated plants and livestock, artificial insemination, livestock feeding methods, ways of using fertilizers, irrigation of fields, other plant husbandry, animal health care, prevention of pests and plant diseases and other comparable action, all aimed at increasing the crop of cultivated plants and the yield of animals. They may also improve the quality of the agricultural products. Mechanical technology means buying machines and equipment, which are often used primarily to reduce the amount of human labour and make the work easier. All these measures usually mean additional costs.

a. Crops and factors affecting them

Finnish crops vary greatly from year to year because of the weather. There are also rather large regional differences. In 1970-74 the spring wheat crop average some 2,500 kg/ha throughout the country and the barley and oats crop was about 2,400 kg/ha. In the same period the average sugar beet crop was 30,000 kg, potatoes about 15,000 kg and hay 3,800 kg/ha. Of course the size of the crop can be raised by using fertilizers. The average amount of all nutrients (N, P_2O_5, K_2O) used on the entire country's arable land in 1974 was 216 kg/ha. Of course the figures vary, depending on the plants concerned. Use of fertilizers has been rising all the time. In recent years about 5 kg more nitrogen fertilizers (N) per hectare a year have been used, about 1 kg of phosphorus (P_2O_5), and close on 2 kg of potassium (K_2O). Fertilizing technology also affects the crop level. It has been estimated that fertilizer placement raises the crop per hectare of grain by about 8-12 %. Almost all farms over 15 ha in size are using this new fertilizing method at the moment.

Experience has shown that plant breeding raises the yield level considerably. In Finland, the yield level for spring grain rose 35-40 % in 1925-57. According to the tests and estimates made, about 10 % of this rise was due to new varieties and to plant breeding in general. According to the experts, plant breeding can raise yields still further. It is believed that yield of winter rye, for instance, can be raised 5-6 % with new varieties, crops of grasses 2-3 % and those of potatoes about 10 %.

Yields can also be increased with sprinkling. This is still rather rare in Finland, though it is spreading with increased specialization. In 1969 sprinkling was carried out on not quite 9,000 hectares in 1972 on around 24,000 hectares. It has given distinct increases in crop, though the results depend on the summer weather. Tests show that crops of spring grain, for instance, have been successfully raised as much as 25-30 % with sprinkling. The same kinds of increases have been achieved with the sprinkling of pasture and silage. Increases almost in the same class have been achieved with potato and sugar beet crops.

The growing use of combine harvesters, for instance, has increased the amount of weeds growing on farms, but weed control has developed fast, too. In 1974 about 940,000 hectares of arable land, i.e. a good 70 % of the whole area under grain, were treated with various herbisides in Finland. Estimates put the increase in grain crops achieved with weed control at about 10 %. Potato and root crops have also been boosted with weed control, and it also makes for easier management and picking.

Various growth regulators have also been introduced recently, aimed at preventing the grain from lodging. In 1974 straw shortener was used over about 75,000 hectares, corresponding to some 25 % of the area under rye and wheat. As a general estimate, we can say that use of these growth regulators increases grain crops by 2-3 %.

The crop level is also influenced by certain other factors. Because of the short growing season, it is important for fields to dry out quickly. In 1975 about 670,000 ha, i.e. 27 % of the whole country's arable land was drained. About 30-35,000 hectares are currently being drained every year. Draining is calculated to raise the crop 3-4 % and also makes it easier to do various crop husbandry jobs and to use machines.

A factor affecting farming in some places is the acidity of the fields, which can be improved by spreading lime. This is also needed to keep the fields in good growing condition. The amount used nowadays is 5-10 tons a hectare. The annual average for the country's entire arable area is not quite 200 kg/ha of lime. The experts claim the figure should be raised.

b. Mechanizing cultivation and harvesting methods

On the plant cultivation side, we can say of the mechanization of various farm work that practically all farms with over 10 ha of arable land have their own tractor, and farms with over 30 ha already have two. About half of farms with 2-10 ha have their own tractor. Farms without their own tractor lease one from neighbours. There are rather few farms with a share tractor. There were about 180,000 farm tractors in Finland in 1975. In the last few years the number of working hours per tractor on bookkeeping farms, for inctance, was some 450 a year.

All farms with over 50 ha have a combine harvester, and about 60 % of farms with 20-50 ha. Among farms with between 10 and 20 ha of arable land, 20 % have their own combine, but very few farms with less than 10 ha have one. It is fairly common for small farms to share the use and ownership of a combine. In 1975 there were about 35,000 combines in the country. The average number of working hours per machine averages below 100 per year.

The spread of combines has greatly increased the need for driers. There were 54,000 mechanical grain driers in 1975. In addition, many farms use primative systems of grain drying. Farms with several hectares of potato have both potato setting and picking machines. The same applies to sugar beet, which is sowed, managed and lifted with special machinery on the whole.

c. Yield levels and mechanization of livestock production

The size of farms for various products is given above. Milk production in Finland is quite modern. The mean yield of cows has been growing all the time and averaged about 4,000 litres per cow in 1975. This result was achieved largely as a result of livestock breeding and improved feeding. It has been estimated that about half of the increase in yield is due to breeding and half to improved feeding and care. Artificial insemination has increased the efficiency of breeding and it is currently available to almost all cows. As the import of feeds from abroad has been restricted in recent years because of over-production, the feeds needed for milk production, in particular, have had to be produced on farms. Silage made from various grassland plants and feed grains has in fact become an important type of fodder. Fodder crops have been boosted with heavy nitrogen fertilizing, in particular and the protein content of fodders has also been raised. About 25-30 tons (c. 4,000 feed units) per hectare of silage raw material is obtained. As far as the mechanization of milk production is concerned, we can say that practically all farms of over 20 ha have a milking machine and 70-80 % of farms with 10-20 ha. The figures are from the early '70s and since then mechanization has increased. Efficient milk production also calls for efficient fodder production, and this makes mechanization essential. One of the basic problems of milk production at the moment is in fact how to produce the necessary fodder with little human labour and without raising machine costs too much at the same time. Mechanizing the fodder production chain, which involves equipment for harvesting, transporting and storage, demands a great deal of capital. The economic use of such equipment would mean having much larger units than today's dairy farms.

Traditionally beef has been produced as a side product with milk. At the moment the trend is towards specialization in beef production, too, and the number of farms producing only beef is increasing.

Two different types of production can be seen in both pork and eggs. For instance, half the pork produced comes from small pig farms where production often uses less advanced equipment. The present trend is towards larger units in which feeding and the removal of manure are arranged mechanically and ready-mixed feeds are used. The mixed feeds are bought or made on the farm. The larger units aim at cutting human labour with machinery and their number is growing. It should also be noted that in the last few years the mean carcass weight has been around 70 kg. It is calculated that about 5 feed units are needed per kilo of pork.

Egg production follows roughly the same lines. In the early years of the '70s, the period of the most recent data, about 80 % of all eggs came from poultry farms with less than 1,000 chickens. More larger units have been set up in recent years. The average yield is about 13 kilos a year and 3-3,5 feed units are estimated to be needed to produce a kilo of eggs. Broilers are raised mainly in rather large and efficient enterprises.

d. Technical development and farm management

Technological progress makes additional demands on the farmer's professional skill and on farm management. The increasing application of technical developments favours specialization and this makes for more risks. Likewise, marketing becomes more important. In some fields technological production leads to contract production and some problems can be solved through cooperation between farmers. As a rule, the application of more technology always increases the need for capital. The factors mentioned above necessitate more planning in agriculture.

5. Use of human labour in agriculture

Mechanization is reducing the need for human labour in agriculture all the time. For instance, in 1974 about 230 man hours per arable hectare were put in throughout the country. On bookkeeping farms, whioh are more efficient than average, the corresponding figure in 1974 was 175 hours per ha, and in 1965 the figure was as much as 260 hours. At the same time production has intensified. The following shows the amount of human labour used in 1974 on bookkeeping farms in south Finland in the various production lines:

South Finland
Bookkeeping farms

	10-20 ha	over 30 ha
Dairy farms		
Direct work	291 h/cow	184 h/cow
Indirect	160 "	118 "
Total	451 "	302 "
Pig farms		
Direct work	26 h/head	12 h/head
Indirect	12 "	8 "
Total	38 "	20 "
Poultry farms		(24.1 ha/2115 hens)
Direct work		115 h/100 hens
Indirect		56 "
Total		171 "
Grain farms		
Direct	50 h/ha	29 h/ha
Indirect	44 "	20 "
Total	94 "	49 "

These figures show that the size of enterprise has a major influence on the need for labour. At the same time it should be noted that these farms are not fully specialized. For instance, specialization is about 85 % on predominantly dairy farms (measured on the basis of total gross returns) and 75 % on pig farms. Correspondingly, the gross return from plant cultivation on grain farms is about 50-60 % of total gross returns and on poultry farms the gross return from eggs is about 80 % of the total. The labour figures include the necessary feed production and the labour needed to produce products other than the main product.

If there is sufficient specialization the need for human labour is obviously lower than suggested above. For instance, with normal mechanization and with a herd of about 30 cows, about 90 man hours of dairy work are needed per year. Similarly, on a pig farm with 300-500 fattening pigs about 0.8-0.6 hours of human work per pig for slaughter are needed if there is modern machinery. On a 3,000-5,000 chicken poultry farm the figure is 45-35 min. per chicken per year. On farms with 20-40 ha the cultivation of spring grain takes about 20-15 hours per hectare, grass-growing 50-40 hours, and potato-growing 160-140 hours. The need for human labour is decreasing because of the spread of machinery and equipment. Similarly, some work which used to be done on the farm is now done either by the trade or the food industry, which cuts the amount that has to be done on the farm.

6. Part-time farming and other incomes

Income from forestry and other non-farm earnings play an important role in the finances of the Finnish farmer. According to the results of all bookkeeping farms, in the last few years 61 % of the farmer's net income (income minus expenditure) came from agriculture, 23 % from forestry and 16 % from other outside sources. The importance of forestry and other earnings varies from area to area and on farms of different sizes. Farmers with 5-15 ha on average do about 250-350 hours of work in outside occupations and on larger farms the figure is 150-200 hours a year. The amount of part-time farming is growing. According to the figures for 1969 there were slightly less than 300,000 farms (over 1 arable ha) in the country and about 240,000 farmers who worked regularly on the farm (more than 150 days). On all farms, the outside occupations were as follows:

Work outside agriculture per year	Number of farmers
1 - 9 days	4,988
10 - 49 days	23,445
50- 149 days	31,230
150 days or over	50,109

Due to mechanization the need for human labour in agriculture is decreasing and this makes it possible for farmers to work outside agricultural sectors.

The above showed how large a farm a normal family can operate with modern technology. With specialization in milk production and a farm of the maximum size given (30-45 ha) the total labour contribution of the family throughout the year is used for agriculture. In beef and pork production and the corresponding case (50-80 ha), about 40 % of the family's labour cannot be used and in grain farming (100 ha) even more. Thus even if the size of farms increases in future, many farmers will still have time for work outside agriculture, especially in winter.

7. Benefits from technical changes

Technical changes can be seen clearly in agriculture in the decrease in the human labour needed and in the increase in the capital needed for production and the role played in general by inputs that are purchased. In addition, the yields have risen remarkably. The effects of the whole process can be evaluated from the point of view of the economic result of agriculture or its productivity, for instance. The monitoring of developments is complicated by rapid changes in prices and wages and other such factors. The economic result of agriculture in real terms in the last few years, on bookkeeping farms for instance, has been the same as in the mid '60s or slightly lower. Of course, it has to be pointed out that the economic result has been rising slightly in the '70s. There are also differences in the economic result between the various sectors. Farms specializing in milk production show a lower result than those specializing in e.g. grain, pork and eggs. The rise in the net productivity of human labour in agriculture in the '50s and '60s has averaged 2-3 % per year according to several surveys. Taking annual fluctuations into account, the average rise in productivity in the '70s is in the range of 3-4 %. There are considerable annual fluctuations in productivity and profitability figures.

A number of surveys have aimed at calculating the marginal productivity of the most important production factors on the basis of material from bookkeeping farms. This research applies to various sectors of production and farms of various sizes. For the marginal productivity of human labour figures between 1 and 2 have been obtained, i.e. one hour of human labour raises gross returns by at least the cost of the hour if other factors remain unchanged. The marginal productivity of the machinery input in grain farming in general and with specialization in certain crops is 1-1.5. In livestock production the marginal productivity of machinery ranges between 0.6 and 0.8. The marginal productivity for bought feeds and fertilizers is between 1 and 2.5. The research concerns 1959 and 1971 and the results for both years are similar. Thus mechanization and other technical advances are profitable on the average.

There are a number of farm model studies which aim at assessing the effect of technological change on the management of farms. Farm models have been used to study the effect of new technology on gross return, production costs and economic result. Separate studies have been made of milk, grain, pork and egg production with a farm size of 10, 25 and 50 ha. The results indicate that the improved technology with which some modern farmers experimented already in 1973-1974 gives a better result than generally applied production technology. The improved technology also led to a rise in yield levels of crops and livestock. These studies would seem to show that technical advances as a whole have been in the right direction. At the same time, though, one can easily point to individual cases in which it has been uneconomic for a small farm to buy some expensive machine or piece of equipment. In any case, technical advances continue to be made. If farmers are to get the maximum benefit, more thought about the applications of technology is needed, though.

Sources:

Agricultural Policy in Finland. OECD Agricultural Policy Reports, Paris 1975, 1-51.

IHAMUOTILA, RISTO 1972. Productivity and Aggregate Production Functions in the Finnish Agricultural Sector 1950-1969. Publ. of the Agr.Econ.Res.Inst. 25:1-87.

MELA, TIMO, HAAPALAINEN, MARKKU 1971. Hehtaarisatojen ja tärkeimpien satoon vaikuttavien tekijöiden kehitys vuosina 1956-75 ja ennuste vuoteen 1985. Maatal.tutk.kesk. kasvinvilj.lait.tied. 4:1-60.

TORVELA, MATIAS 1966. Tuotantopanosten käytöstä ja käytön edullisuudesta maataloudessa Etelä-Suomen alueen kirjanpitoviljelmillä. Summary: On the Use of Agricultural Inputs on Bookkeeping Farms in South Finland. Publ. of the Agr. Econ.Res.Inst. 8:1-141.

TORVELA, MATIAS, IKÄHEIMO, ESA 1973. Tuotantotekniikan muutoksen vaikutus viljelmän talouteen. Summary: The Impact of Changes in Production Technology on the Farm Management of Different Farm Types. Res.Rep. of the Agr.Econ.Res. Inst. 20:1-96.

TORVELA, MATIAS, MÄKI, SEPPO 1974. Perheviljelmän koko rationaalisessa maataloustuotannossa. Summary: The Size of Holding that the Farm Family can Operate Using Different Types of Technology. Publ. of the Agr.Econ.Res.Inst. 30:1-79.

Tutkimuksia Suomen maatalouden kannattavuudesta. Tilivuosi 1974. Summary: Investigations on the Profitability of Agriculture in Finland, Business Year 1974. Publ. of the Agr. Econ.Res.Inst. 34:1-88.

WESTERMARCK, NILS 1976. Maatalouden teknologinen kehitys talousmiehen silmin. Maaseudun Tulevaisuus 130, 1976.

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PRODUCTION COSTS OF MILK AND GRAINS ON FINNISH FAMILY FARMS

JOUKO SIRÉN

PRODUCTION COSTS OF MILK AND GRAINS ON FINNISH FAMILY FARMS

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Abstract: Agricultural production in Finland takes place on relatively small family farms. Among the different products milk plays the most important role and animal production totals up to 80 per cent of gross returns from agriculture.

When investigating the profitability of production on farms of varying size or production efficiency, production cost calculations often are used. Both ordinary production expenses and interest claim on total capital invested in production are included in the production cost concept. The level and structure of costs of milk and grains which both are important lines of production are explored in this paper.

In milk production the production costs decrease with increasing farm size. This is due to the more efficient use of capital input and human labor. The milk price equals to the production costs of the farm having 20-25 cows and using modern production technology.

In grain production capital costs play the most important role. On large farms the use of machinery is more efficient which reduces both capital and human labor costs. Depending on the crop produced, the producer price equals to the production costs of farms having 40-60 hectares of arable land.

It was found that the structure of costs is strongly affected by the line of production. Similarly, the cost level decreases with increasing farm size arising from opportunities of larger farms to use modern technology more efficiently. By developing the farm structure into larger units it is possible both to increase the farm family income and to decrease the price of food through more efficient use of inputs.

1. Agricultural production and the stage of specialization

Agricultural production in Finland takes place mainly on family farms, for less than 4 per cent of total labor input in agriculture consists of hired labor. The average size of farms, having at least 2 hectares of arable land, is in the whole country about 11 hectares, a little higher in the South and a little smaller in the East and North. About 60 per cent of farms have an average size of under 10 hectares and 7 per cent only more than 25 hectares.

Animal production plays an important role totalling up to 80 per cent of gross returns from agriculture. Milk's share is about one half of the value of animal production. The existing production structure in Finland is effected by climatic conditions which are the most limiting factors with respect to the extent of plant cultivation and plant composition.

Traditionally Finnish farms produce many products. This has to relatively great extent quaranteed the self-sufficiency of farm families in food. Also the risk can be decreased in diversified production enterprises. However, the drastic decrease of farm population has necessarily led to the necessity of using human labor more rationally, which is now possible with new improved production technology. In consequence of this development, specialization, the producing of only one or a few products on a farm, has been increased in recent years. A short summary is given in the following to show the extent and structure of the most important lines of agricultural production.

Milk

Every second Finnish farm has cows and the average size of the herds is 6 cows. The distribution of farms according to the size of the herds was in 1974 as follows:

under 4	cows	45	per cent of farms
5-9	"	42	-"-
10 or more	"	13	-"-

In the 1970's, about 9 per cent of milk producers, mostly on small farms or in the southern part of the country, annually have given up milk production, moved to other enterprises or changed the line of production.

Beef, pork and poultry

Most beef is still produced on dairy farms as a by-product. There are, however, according to estimates about 2000 farms specialising in ordinary beef production. Calves are mostly supplied to these farms through the organized agency of slaughteries.

The development of feeding and production technology in the animal husbandry sector has been most rapid in pork and poultry production. In these sectors there are family farms having even more than 10 000 hens or 2000 pigs. The average size of piggeries is in any case still quite small. In 1974 there were pigs on 10 per cent of all farms and 90 per cent of these farms had a biggery accomodating less than 100 pigs. At the same time 20 per cent of all farms had poultry and 90 per cent of these had less than 500 hens.

Grains

Farms specialising in grain production are situating mainly in the South, which is a suitable area both for fodder- and bread-grains, such as spring wheat and rye. Winter wheat is cultivated in the south and southwest coastal areas. The average size of farms is in South Finland 15-18 hectares. Bread-grain farms, however, are generally larger than farms on the average. Grain in Central, East and North Finland is mostly cultivated for feeding farm animals.

2. Production costs of milk and grains

a. Methods and data

In spite of specialization in farming it is usual that farms are still to some extent multiproduct enterprises and produce one product only in special cases. When production costs of only one product are examined, difficulties often arise when dividing e.g. capital costs, which are common to the whole farm. To eliminate these difficulties production costs and their structure can best be examined on farms which are as far as possible specialized to produce only one product.

To investigate the profitability of farming in Finland book-keeping was commenced in 1912. Nowadays there are altogether about 1000 farms in different parts of the country which keep records of the economy of farming. These records are the primary material for investigating the economy of Finnish agriculture at farm level. Book-keeping statistics give quite a good picture of the average Finnish farm. However, their efficiency level is somewhat higher than on an average farm.

Because of lack of data farm models are often used e.g. when studying changes in profitability of production caused by price changes or when comparing the relative profitability of different products with each other. Even if models are to some extent theoretical they can be made to correspond very well with a real farm.

Production costs for some agricultural products are examined in the following according to the book-keeping statistics and farm models.

b. The production cost concept

The concept of business results in agriculture is not the same in all countries which, of course, makes it difficult to compare the results of these countries. In all the Scandinavian as well as in many Central European countries the following production cost concept is in use (table 1).

Table 1. Some concepts of business results of agriculture

<table>
<tr><td colspan="7">Gross return</td></tr>
<tr><td>Material costs</td><td>Depre-ciation</td><td>Wages paid</td><td>Other costs</td><td>Value of family (incl. operator) labor</td><td>Profits</td><td>Interest claim on capital</td></tr>
<tr><td colspan="5">Production expenses</td><td colspan="2">Return to capital</td></tr>
<tr><td colspan="5">Production</td><td></td><td>cost</td></tr>
<tr><td colspan="4">Operating costs</td><td colspan="3">Farm family income</td></tr>
</table>

As is seen in table 1, the production cost concept includes both ordinary production expences[1] (materials, depreciation and repairs to buildings and machines, wages paid as well as value of farm family labor and other costs) and also an interest claim on total capital invested in resp. production. When the interest claim on total capital is included in the production cost concept, a farm can be

1) Taxes are not includedin production costs becuse no possibility exists to split up the taxes among the varions activities of the farm.

compared with any other firm or investment which is supposed to give interest on invested capital. Concerning the interest rate, theminimum target can be the rate which is paid on bank deposits. In the official Finnish book-keeping interest of 5 per cent is used.

c. Production costs for milk

Milk production is based mainly on home-produced feed, dry hay, silage, pasture and fodder grain. To satisfy the mineral, vitamin and protein reguirement fodder preparations, however, are needed. So the land area of the farm often sets limits on herd size.

Table 2 shows some characteristics of farms specialising in milk production

Table 2. Some facts of book-keeping farms specialized in milk production in South-Finland in 1975.

	Size class, hectares			
	under 10	10-20	20-30	over 30
Size of farm, hectares	7.5	14.8	23.6	35.4
Cows, animal units	4.9	9.8	12.9	19.2
Animals total, "	7.7	14.3	20.8	28.5
Yields:				
Milk yield kg/cow	5440	5197	4905	5375
Crops, f.u./hectare	2636	3061	3193	2892
Percentage distribution of arable land				
Grain	39.0	37.3	38.0	43.6
Green fodder	57.1	58.0	58.9	53.3
Other plants	3.9	4.7	3.1	3.1
Total	100.0	100.0	100.0	100.0
Use of human labor				
Animal husb. h/anim.unit	261	201	154	126
Crop cultiv. h/hectare	112	87	54	46
Total in agric. "	416	299	203	166
Tractor work, h/hectare	33	27	26	24

Many kinds of machinery and equipment are needed on dairy farms with self-supporting feeding and therefore smaller farms do not have equal access to the efficient use of modern technology as large milk-producing farms. As can be seen from table 2, on book-keeping farms having less than 5 cows, the human labor input per cow is about double compared with that of farms with 20 cows. Decrease of human labor in crop and feed production is even more striking.

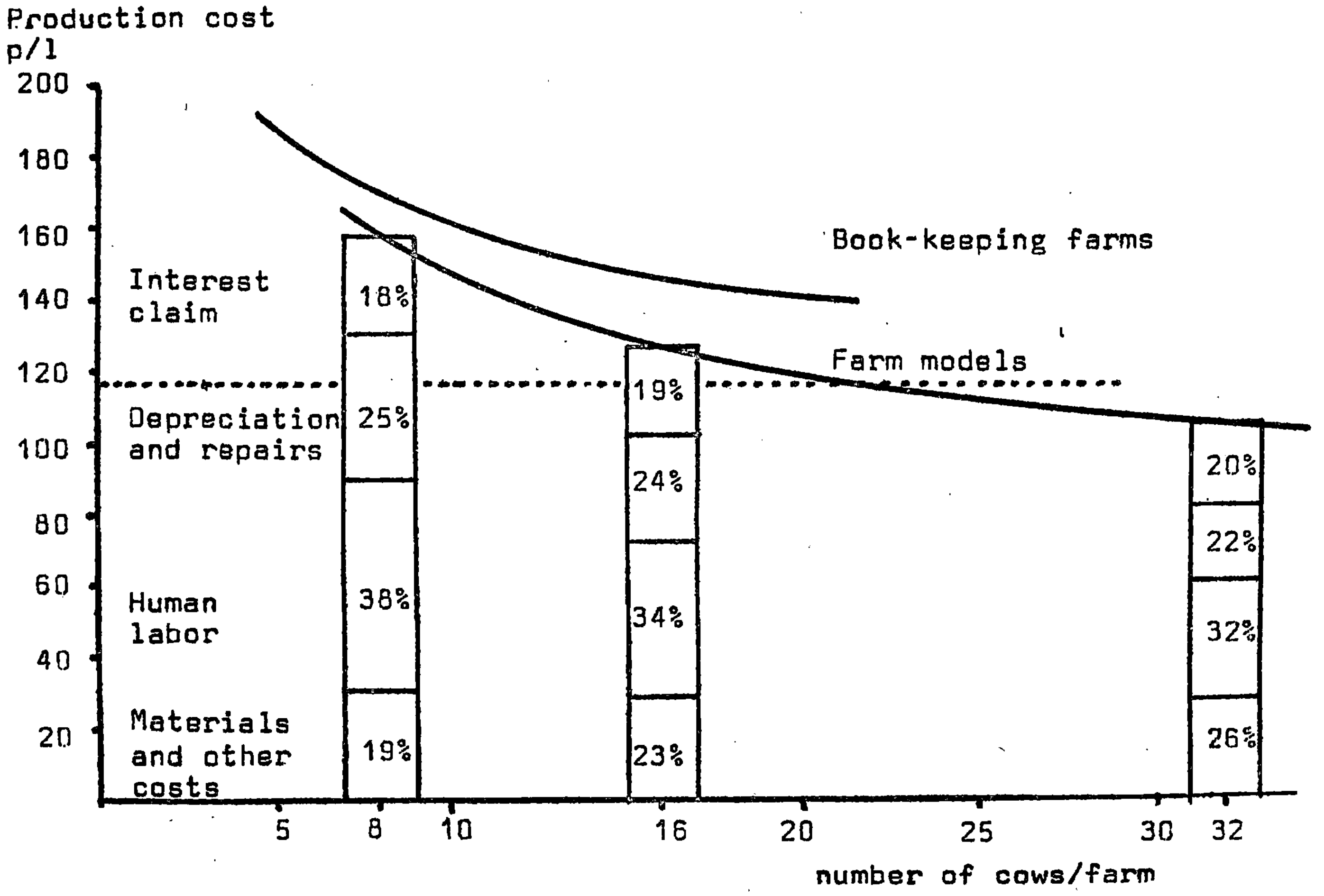

Figure 1. Production cost level of milk on book-keeping farms and farm models of varying size and its distribution in 1975. The dotted line shows the producer price on milk.

The curves in figure 1 show the production cost level of milk on farms operating on two different efficiency levels in 1975. The upper curve, book-keeping farms, represents relatively well the prevailing situation on Finnish dairy farms. On the other hand, the farm model curve corresponds to the cost level, when modern, rational production technology is used. Detailed unit cost structure of milk on farms having 8, 16 or 32 cows is also presented in the figure.

The most evident observation is that unit cost in milk production decreases with increasing farm size. On small farms the producer price of milk is lower than total unit cost even if government subsidies are paid to smaller farms. Among the different cost items such as seed, fertilizers, industrial feed, fuels etc. have an equal monetary share in production cost regardless of farm size. On larger farms, however, cost of human labor is essentially lower both in monetary and proportional terms. This is due to the more efficient use of technology. Investments in buildings, equipment and machines have been succesful because the total capital cost item accounts, irrespective of farm size, for exactly the same proportional share, 42-43 per cent of production costs. Interest claim on capital invested in milk production represents one half of total capital costs.

d. Production costs for grains

Some facts on book-keeping farms specialising in bread-grain production are presented in the following table 3.

Table 3. Some facts on book-keeping farms specialising in bread grain production in South Finland in 1975

	Size class, hectares		
	10-20	20-30	over 30
Size of farm, hectares	15.2	25.3	59.7
Percentage distribution of arable land			
Rye	4.8	11.6	11.2
Wheat	54.3	57.6	43.6
Barley	14.2	9.7	16.0
Oats	9.9	8.4	7.7
Other plants	16.8	12.7	21.5
Total	100.0	100.0	100.0

Yields, kg/hectare			
Rye	2283	2782	2778
Spring wheat	3204	3351	3506
Barley	3167	3345	3455
Oats	3721	2155	2693
All plants, f.u./hectare	3801	3758	3842
Use of human labor			
Crop cultivation, h/hectare	50	43	29
Total in agric., "	94	67	49
Tractor work, h/hectare	17	17	13

About 90 per cent of arable land on bread-grain farms is used for grain. Wheat plays the most important role in South Finland. In addition to this fodder-grains for sale are often cultivated. Production of fodder-grain or grain for seed is very often based on contracts between farmers and marketing organizations.

The use of human labor in grain production, compared with that on dairy farms, is essentially lower. While labor is needed mainly during the sowing and harvesting periods, farm families are in winter free for other activities or enterprises.

The use of human labor is affected by production technology which is normally on a higher level on large farms. As can be seen from book-keeping statistics, the human labor input decreases rapidly on larger farms.

Among the different cost items capital costs play the most important role as is seen in the figure 2. Because of a short growing period, many kinds of machinery are needed even on small farms. On a farm having 20 hectares of arable land, capital costs total about 60 per cent of all costs. On larger farms the use of machines and equipment is more efficient which, of course, reduces the share of capital cost. However, even on an 80 hectare farm depreciation and repairs account for 29 per cent and interest claims for 24 per cent. Accordingly total capital costs total to 53 per cent of production costs. As can be seen from figure 2 the proportional share of ordinary production materials increases with increasing farm size amounting to about one third of production costs.

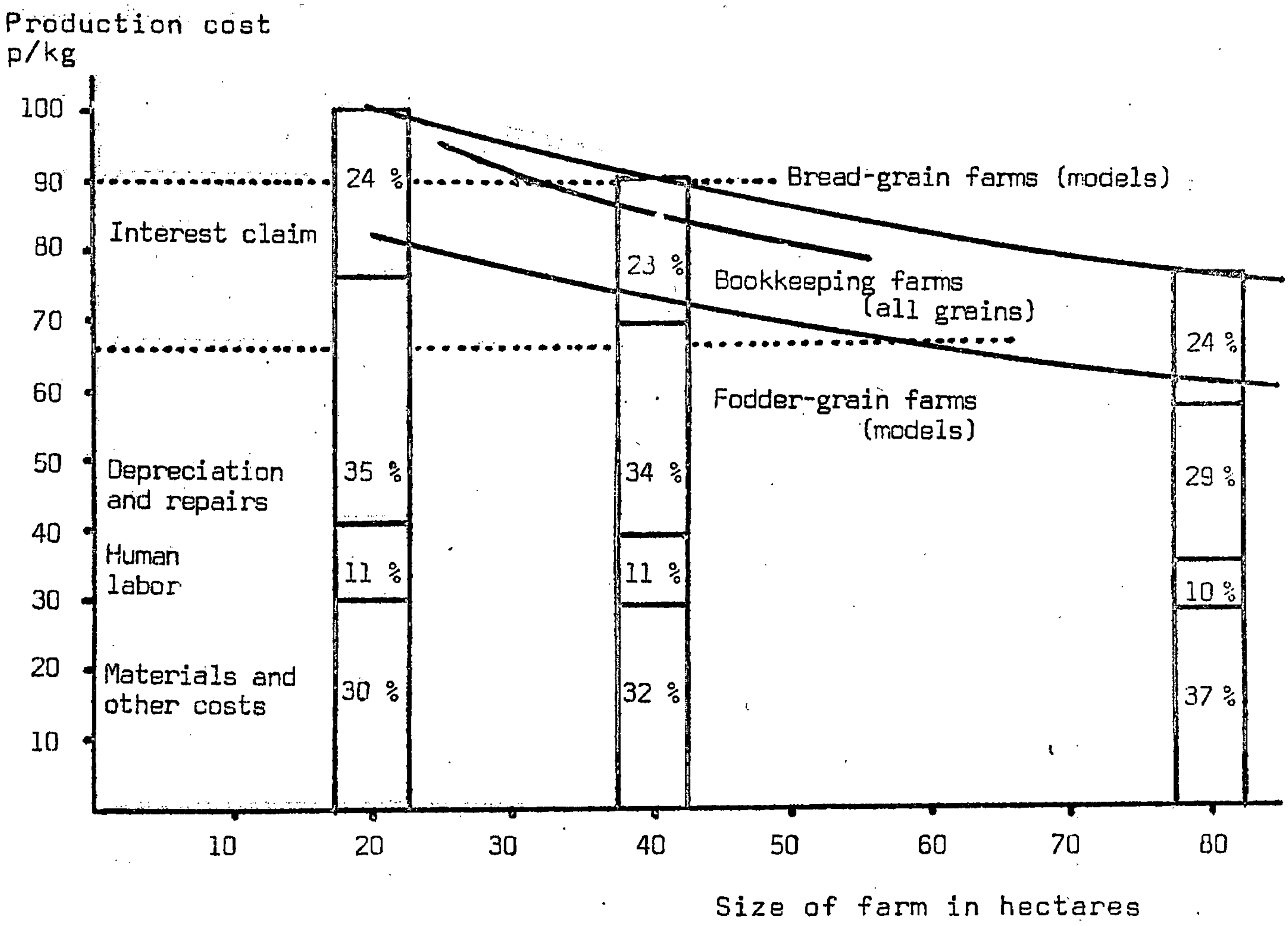

Figure 2. Production cost level of bread- and fodder-grains on bookkeeping farms and farm models of varying size and its distribution on bread-grain farm models in 1975. The dotted lines show the producer price of grains (bread-grains 90 p/kg and fodder-grains 66 p/kg).

When comparisons are made between costs and producer prices of grains, it is found that the production costs of both bread- and fodder-grains are higher than on small farms. In bread-grain production, the price equals the production cost on farms having 40 hectares or more of arable land. In fodder-grain production the corresponding farm size would be 55-60 hectares.

3. Some conclusions

Backgroundand methods of production cost concept are discussed here with examples of cost level and structure in milk and grain production on Finnish family farms. It is seen that the structure of costs is strongly affected by the line of production. On dairy farms human labor plays an important role and it often limits the size of farms. On farms producing grain, on the contrary, capital costs are the most important item and in poultry and pork production, which are not discussed here, material costs such as feeds etc. may total 70 or 80 per cent of all production costs. Thus price increases for machines, feeds, labor etc. have an influence on total production costs, which is different depending on the line of production. Taking the cost structure into consideration is very important for example when specifying the producer price level of different agricultural products.

Some guidelines on the profitability of production are also found in production cost calculations. On large farms the cost level is essentially lower than in small production units. This is caused by the more efficient use of technology and human labor. By developing the farm structure into larger units it is possible to increase the living standard of farmers. Also from the consumer's point of view as well as that of the entire national economy it is important to decrease the price of food with more efficient use of inputs. However, the actual production cost level on small Finnish farms is high and the farmers themselves have only limited resources for new investment. Therefore, one of the most important tasks in Finnish agricultural policy will be to develop farm structure and provide financial aid both for investment in and enlargement of farms.

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ON METHODS FOR FORECASTING PRODUCTION AND CONSUMPTION OF AGRICULTURAL PRODUCTS

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On Methods for Forecasting Production and Consumption of Agricultural Products

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Abstract. Some alternative methods recently developed for forecasting production and consumption of agricultural products are discussed in this paper. Methods used in practical forecasting of agricultural phenomena vary from simple guesses to sophisticated mathematical and econometric techniques. Accordingly, the field this paper deals with is wide and systematic description of all the methods is impossible in this short paper. Therefore, it only concentrates upon a few methods, which - - in the author's opinion - - are to be considered relevant alternatives when planning systems for predicting production and consumption of agricultural products. They are 1) classical econometric models, 2) stochastic models for single time series, and 3) recursive programming models. This presentation does not attempt to give any complete description of the techniques mentioned above. Instead, the introduction of these techniques is mainly made by illustrating some of their applications which may be of interest from the standpoint of practical forecasting.

1. Introduction

A number of different techniques for forecasting agricultural production and consumption have been developed in the past. They range from simple guesses by experts to complex econometric and mathematical techniques. The abundance of forecasting tools reflects the problems that, in general, exist in forecasting phenomena interesting from the economic standpoint. On the other hand, this vast array of different techniques also implies that there is no single technique which is superior to other methods in every forecasting situation: the method which has proved to be the best in forecasting the behavior of a certain economic system, may not be equally efficient in the case of some other system.

There is no criterion to determine beforehand which technique will be the most adequate for a given forecasting assignment. The prediction performance of a given model can, in practice, be tested only on the basis of results from empirical forecasting in a real situation. Accordingly, this paper does not include any assessments of the validity of different techniques nor recommendations for the choice of forecasting methods. It only tends to describe the main characteristics of three different approaches that have been used for forecasting the phenomena of the agricultural sector: 1) classical econometric models, 2) stochastic models for single time series and 3) recursive programming models. However, we have to point out that the paper does not attempt to give any thorough presentation of these techniques. It has been written by an agricultural economists, who is no expert in the theory behind the models, but who has gained some experience through the application of certain of these methods to forecasting.

2. Econometric Models

2.1. General

Econometric models are - - among more sophisticated forecasting techniques - - obviously the most common approach to predicting the future development of agricultural systems. The basis of a forecasting assignment is an econometric model or a single relation which in one way or another describes the structural relationships between the variable(s) we are interested in (dependent variable(s)) and independent variables. Accordingly, the first question to be considered is concerned with the way econometric models are built for forecasting purposes. As to selecting independent variables, causal relationships and so-called economic laws provide a good starting point for model building.

However, the efficient use of the model for forecasting the future development of the phenomena under study imposes additional restrictions on the choice of independent variables. An ideal forecasting model should be such a one that the values of its independent variables should be actually observed values and not forecasts obtained through other available techniques. This means that all the predetermined values should be lagged at least by the length of the prediction period. When the forecasting horizon is relatively short, this requirement can usually be fulfilled easily. However, when we are interested in long-term prediction, this goal conflicts with the recommendation that the model should be based on sound causal relations between variables. This dilemma has led to the use of recursive models in forecasting long-term development (i.e. to the use of chain principle in forecasting, see WOLD 1964). In the following we will briefly discuss the models and the problems of short-term and long-term forecasting without defining the time horizons of these two approaches exactly.

2.2. Model Building for Short-term Forecasting

The short-term prediction of agricultural phenomena is still even today of great importance for many purposes. It provides fresh information, for example, for the basis of the day-to-day decisions policy makers have to make in implementing agricultural policy. Also, farmers and processing sectors are usually interested in the short-term market outlook etc. The models and the problems of short-term forecasting of various agricultural phenomena may differ remarkably from each other mainly depending on the nature of the phenomena under study and also on data availability. For example, predicting changes in agricultural land utilization pattern in one year perspective is evidently quite a different problem from predicting the same change in livestock production. Accordingly, there is no general type of econometric model to be used for all kinds of short-term forecasting, but rather the structure of models and the nature of predetermined variables varies. In the following there will be a short description of the models used in the short-term forecasting of livestock production in Finland.

Due to the time requirements of production, livestock censuses and related statistics form a good starting point for short-term livestock production forecasts. Models based on the data mentioned above are demographic by nature. Production in period t is hypothesized to be a function of the number of animals in different age categories at the time of census.

Likewise, hatchings of eggs as well as the numbers of sows and cows inseminated during the appropriate time period may serve as predetermined variables in short-term production forecast models. Hence, the coefficients of these models mostly reflect technical relationships of the sector in question (turn-off rates).

As an example of a short-term production forecast model we illustrate below the econometric model which has been developed for forecasting egg output in Finland. The model is based on the quarterly time series data for hatchings:

$$(2.1) \quad Q_t = b_1+b_2H_{t-2}+b_3H_{t-3}+b_4H_{t-4}+b_5H_{t-5}+b_6H_{t-6}+b_7H_{t-7}+u_t,$$

where

t = Current quarter and (t-i) relates to the lagged period
Q_t = Quantity of eggs marketed in period t
H_{t-i} = Number of chickens born in period t-i (i=2..7)
b_i = Coefficients to be estimated
u_t = Random variable

The model basically states that the quantity of eggs marketed is a function of the total laying flock in period t. However, because the rate of lay and other factors are different for layers of different ages, the flock has been divided into different age groups indicated by chickens born from 2 to 7 quarters earlier. The coefficients in this model indicate the contribution of these age groups to the total quantity of eggs marketed in period t. Thus, they reflect many factors influencing egg output such as the rate of lay, mortality and culling in each age group. Also variables other than hatchings could be included in the model such as variables indicating profitability development (egg-feed price ratios), seasonal dummies, trend, etc.

Egg quantities can be predicted for two quarters forward with this model using only actually observed values of the predetermined variable (H_{t-i}). Likewise, forecasting in one year perspective requires extrapolating hatchings for only two additional quarters. Under normal conditions this has not proved to be too difficult.

Models which are in principle of this type can also be built for other livestock products. The most relevant factors influencing the reliability of forecasts are among others 1) the reliability of livestock censuses, for censuses may show in some cases significant errors, 2) as to forecasting meat production, incorrect estimates of the development of breeding herds may also lead to erroneous forecasts, and 3) variations in the technical coefficients of the model due to price changes and feed supplies.

2.3. Model Building for Long-term Forecasting

Also in the agricultural sector, the time horizon of planning is generally moving farther into the future and, accordingly, the importance of long-term forecasting of agricultural phenomena increases. In addition to single equations, the models most frequently built for longer-term prediction are recursive by nature.

A recursive model for predicting egg production in Finland is given below as an example of the type of econometric model which can be used for longer-term forecasting (see; NEVALA 1976). The semiannual model is

$$SP_t = a_1 + \sum_{i=0}^{3} b_{11i} PKT_{t-i} - \sum_{i=0}^{3} b_{12i} PR_t + b_{13} T - b_{14} D_2 T - b_{15} D_2 + u_1$$

$$KK_t = a_2 + \sum_{i=2}^{5} b_{21i} SP_{t-i} - b_{22} PKT_t + b_{23} PR_t + b_{24} D_2 + u_2$$

$$SK_t = SK_{t-1} + SP_{t-1} - KK_t$$

$$TS_t = a_4 + b_{41}(SK_{t-1} + 0.5SP_{t-1} - 0.5KK_t) + b_{42} T + b_{43} D_2 + u_4$$

where subscript (t-i) refers to the periods and SP and SK = the number of chickens and layers respectively at the end of period. KK = the number of culled layers and TS = egg production. PKT and PR = the price of eggs and feed respectively, T = trend and D_2 = seasonal dummy. Thus, the equations form a typical causal chain: the model assumes that the number of chickens purchased in period t depends on the prices influencing profitability. The number of culled layers, on the other hand, is related to the number of chickens lagged 2-5 periods. Egg production is then hypothesized to be a function of the current laying flock, in which the change in period t naturally depends on the number chickens purchased in period t-1 and the number of layers culled in period t.

The only relevant independent variables whose values have to be predicted for the prediction period are prices for eggs and feed. The other independent variables are either lagged ones or their values are generated by the other equations of the model. Our experience with this model suggests that egg output can be predicted relatively accurately for 2-3 years. The cumulative nature of forecasting errors usually leads to a deterioration in the performance of the model beyond this forecast horizon.

3. Forecasting with Stochastic Models for Single Time Series[1)]

Different kinds of stochastic models have also been applied for predicting the production and consumption of agricultural products. A number of models of this type have been developed recently. Relatively much attention has been paid to the models developed by BOX and JENKINS (1970). They deal with linear stationary models, in which the residual process is a stationary process. They also have demonstrated methods for transforming non-stationary models to stationary ones. The essence of their approach is that the data (=time series in question) is used for identifying and estimating random components in the form of moving average and autoregressive processes. Thus, it does not identify and measure structural relationships as is attempted when forecasting with econometric models.

Stochastic model building can be divided into three stages: 1) identification of the model 2) estimation of the parameters, and 3) diagnostic checking (=is the model adequate?). The purpose of identification is to explore and determine which kind of model best fits the time series data. There are two main stages in the identification process:

1) Checking the stationarity of time series under study. Sometimes time series have a slope of a certain type. This kind of non-stationary series is first transformed to a stationary one by differencing original time series X_t as many times as is needed to produce stationarity. Usually the first or second difference is enough for this purpose. By differencing we are able to reduce the process to a mixed autoregressive, moving average model of the order (p,q) which can be written in the general form as

$$(3.1)\quad Z_t - c_1 Z_{t-1} - \dots - c_p Z_{t-p} = A_t - f_1 A_{t-1} - \dots - f_q A_{t-q},$$

[1)] This approach is also called by some authors parametric time series modeling (see, SCHMITZ and WATTS 1970).

where

Z_t = The d'th difference of the time series under study X_t. Usually the first or second difference ($X_t - X_{t-1}$ and $X_t - 2X_{t-1} + X_{t-2}$, respectively) is sufficient to produce a stationary model.

A_t = Random series of normal deviates, each with zero mean and variance σ^2

c and f = Parameters to be estimated.

2) In the second stage we identify the resulting mixed autoregressive, moving average process. The difference series Z_t is explored by means of the autocorrelation function and the partial autocorrelation function to find out the exact form of the model that best fits the time series data (the procedure is described in BOX and JENKINS 1970). In practice, models with few parameters have usually proved to be adequate enough to describe the process generated the time series.

After the model has been identified parameters c and f can be estimated. The estimation method applicable to these models is a computationally difficult iterative procedure including nonlinear estimation. Special computer programs have been made for estimation of these models, but they are not dealt with in detail in this short paper. A very important part of model building is the diagnostic checking of the estimated model. If the model seems to be adequate, it can be used for forecasting of future values of X_t.

In order to illustrate the type of stochastic models recently developed and applied to forecasting, we refer to the models constructed by SCHMITZ and WATTS (1970). They compared various models for forecasting wheat yields per acre (denoted by X_t) in terms of the performance of the models in forecasting actual development. One of the models they estimated, was a mixed autoregressive, moving average model of order (2,1):

(3.2) $$Z_t - c_1 Z_{t-1} - c_2 Z_{t-2} = A_t - f_1 A_{t-1},$$

where

(3.3) $Z_t = X_t - X_{t-1}$,

in which X_t= original observations and A_t= a purely random process. Parameters to be estimated are c_1, c_2 and f_1. In order that forecasts can be made, equation (3.2) may be written in terms of actual observations by substituting equation (3.3) in equation (3.2). We obtain:

(3.4) $X_t = (1+c_1)X_{t-1} + (c_2-c_1)X_{t-2} - c_2X_{t-3} + A_t - f_1A_{t-1}$

Equation (3.4) expresses the value of X in time t in terms of past values of X, parameters and purely random inputs. Thus, after estimation of the autoregressive and moving average parameters and residuals, forecasts of wheat yield can be made by substituting observed values of X_{t-i} (i = 1 ... 3) and by setting the residual at time t equal to its expected value of zero. In this way, the values of X_t can be forecasted for as many period as necessary. One of the most important requirements for successful forecasting with these models is that there should be no structural changes in the process that has generated the values of the time series under study.

4. Recursive Programming Models

4.1. General

Different types of programming models were developed for forecasting agricultural production in the 1960's as alternatives to econometric analyses. Much attention has been paid to representative farm programming (i.e. deriving aggregate response from the supply functions of representative farms through the use of the programming models; see SHARPLES 1969). Programming models in general, as argued by DAY and others, had certain advantages over econometric models in forecasting production response (data problems are easier to solve, they may be more effective in dealing with dramatic changes in technology and agricultural policy, etc.). However, in spite of an appealing idea -- to predict aggregate response via micro route -- the empirical applications of the representative farm programming were not very successful. The main difficulties in this approach were unrealistic firm-level assumptions, selection of representative farms, changes in farm size, interdependence and also computational problems.

Recursive programming (i.e. the introduction of flexibility constraints into regular programming models) was first used as a simple alternative when efforts to build all the behavioral constraints explicitly into the response model led to unsatisfactory results.

4.2. Characteristics of Recursive Programming

According to DAY (1961 and 1962), the recursive programming model has been designed in an attempt to simulate the reactions of agricultural producers to changes in various socio-economic forces affecting the production of agricultural products. Thus far it has been used mainly for forecasting agricultural land utilization patterns both at the aggregate and regional level (see; SCHALLER and DEAN 1965, SAHI and GRADDOCK 1974).

Recursive programming consists of a sequential chain of recurring linear programming problems, in which the parameters of the model in time (t) depend on the solution in time (t-1). This relationship is created through flexibility constraints described later in this paper. Thus, the recursive programming deals with the positive dynamics of decision making by describing the process of optimizing over a limited time horizon on the basis of knowledge of the past. Decisions in time (t) are viewed in terms of deviations from the existing production patterns in period (t-1).

Recursive programming attempts to reflect the fact that farmers wish to maximize incomes. However, they do so with regard to the uncertain nature of the environment. Their yearly response may be influenced by a number of interacting forces such as (see; HEIDHUES, 1969):

1) Multiperiod production processes
2) Investments in durable assets may lead to rigidities in adapting to new conditions
3) Supply of money capital changes due to variations in the income, consumption and saving of farm families
4) Learning process is usually necessary when adopting new technologies
5) Fixity of land and labor on small farms trends to restrict the mobility of these factors
6) Time requirements of the production processes
7) Uncertainty about future agricultural policy direction, etc.

The interaction of these forces generally leads to smaller production changes over time than might be expected otherwise. In theory, such behavioral constraints could be built explicitly into the programming model. However, the empirical efforts have not been very successful mainly due to the fact that these forces are difficult to measure. Flexibility constraints were considered a very simple way of trying to reflect this complex array of factors. Generally these constraints specify that production in any year t can deviate from the previous year's (t-1) production only within specified limits.

We can illustrate recursive programming with the following simple aggregate model, which has been developed for forecasting agricultural land utilization necessary to maximize net farm income:

Find non-negative x_j which

$$\max \quad \pi(t) = z_1(t)x_1(t)+\ldots+z_5(t)x_5(t) \qquad t=1\ldots T$$

subject to

$$
\begin{array}{llllll}
x_1(t) + & x_2(t) + & x_3(t) + & x_4(t) + & x_5(t) & \leq A(t) \\
x_1(t) & & & & & \leq (1+b_1)(t)x_1(t-1) \\
 & x_2(t) & & & & \leq (1+b_2)(t)x_2(t-1) \\
 & & x_3(t) & & & \leq (1+b_3)(t)x_3(t-1) \\
 & & & x_4(t) & & \leq (1+b_4)(t)x_4(t-1) \\
 & & & & x_5(t) & \leq (1+b_5)(t)x_5(t-1) \\
x_1(t) & & & & & \geq (1-\bar{b}_1)(t)x_1(t-1) \\
 & x_2(t) & & & & \geq (1-\bar{b}_2)(t)x_2(t-1) \\
 & & x_3(t) & & & \geq (1-\bar{b}_3)(t)x_3(t-1) \\
 & & & x_4(t) & & \geq (1-\bar{b}_4)(t)x_4(t-1) \\
 & & & & x_5(t) & \geq (1-\bar{b}_5)(t)x_5(t-1)
\end{array}
$$

where

$\pi(t)$ = Total net return in year t
$x_j(t)$ = Acreage of jth crop in year t (j=1...5)
$z_j(t)$ = Net return per acreage unit of jth crop in year t
$A(t)$ = Total land availability in year t
$(1+bj)(t)$ and $(1-\bar{b}j)(t)$ = Flexibility coefficients of the acreage of jth crop in year t

Given the values of x_j in year t-1 and the flexibility coefficients, we can generate the right hand side values of the constraints. After that, the model can be solved for $x_j(t)$ using ordinary solution methods for linear programming problem.

The first constraint expresses the total land restriction, and the last ten equations are the flexibility constraints for activities x_j. The first five of them state that x_j in year t shall not exceed $x_j(t-1)$ by more than $b_j(t)x_j(t-1)$ and the last five equations on the other hand state that x_j in year t shall not fall short of $x_j(t-1)$ by more than $\bar{b}_j(t)x_j(t-1)$. There is no reason why $b_j(t)$ should equal $\bar{b}_j(t)$. As can be seen from the model, the flexibility coefficients are among the most important factors influencing the solution of the model. That is why, the main question in the recursive programming is the determination of flexibility coefficients. Accordingly, much attention has been paid to this problem.

4.3. Estimation of Flexibility Coefficients

A number of alternative ways have been developed to determine flexibility constraints. They range from informed judgement to estimation by statistical techniques (see; SCHALLER and DEAN, 1965 as well as SAHI and GRADDOCK 1974). Some of the most common methods are:

1) Flexibility coefficients estimated as averages of positive and negative percentages changes in the past and the different variations of this approach (maximum changes, etc.).

2) Estimation of flexibility coefficients by general least squares models

(4.1) $x_j(t) = c_{j0} + c_{j1}x_j(t-1) + c_{j2}P_j(t-1) + \dots + u_{jt}$,

where P_j is the price of jth crop. The model may also include other variables. This model can be used to develop flexibility coefficients by splitting the data into two subsets and performing two regressions. In this case, the flexibility coefficients $(1+\bar{b}_j)$ and $(1-\bar{b}_j)$ are estimated regression coefficients for c_{j1} and $\bar{c}_{j1}$:

(4.2) $c_{j1} = (1+b_j)$ for $x_j(t) > x_j(t-1)$ increasing years

(4.3) $\bar{c}_{j1} = (1-\bar{b}_j)$ for $x_j(t) \leq x_j(t-1)$ decreasing years

One may also adjust the flexibility coefficients by standard errors. These standard errors may be either 1) the standard error of regression coefficient c_{j1} or 2) standard error of the estimate of $x_j(t)$.

3) Use of a single least squares equation to derive both bounds. In this case, a least squares point estimate plus and minus some function of the standard error serves as upper and lower bounds.

4) Recently SAHI and CRADDOCK have developed an interesting technique for deriving the flexibility coefficients. According to their scheme, the flexibility coefficients $(1+b_j)$ and $(1-\bar{b}_j)$ are estimated directly by using the following least squares equation

(4.4) $$\frac{x_j(t)}{x_j(t-1)} = c_{j0} + c_{j1}x_j(t-1)...+u_{jt}$$

The time series data are split into two subsets: increasing years and decreasing years. When the regression is estimated for increasing years, the estimate of the dependent variable

(4.5) $$\frac{x_j(t)}{x_j(t-1)} = (1+b_j)(t)$$

is the flexibility coefficient to be used for determining the upper bound of the activity x_j when solving the model for year t. Similarly, the lower bound for activity x_j is derived by estimating the flexibility coefficient $(1-\bar{b}_j)$ (t) on the basis decreasing years

(4.6) $$\frac{x_j(t)}{x_j(t-1)} = (1-\bar{b}_j)(t)$$

Since the flexibility coefficient is in this case the dependent variable itself, the flexibility coefficients $(1+b_j)(t)$ and $(1-\bar{b}_j)(t)$ are different every year. To define flexibility coefficients in solving recursive programming problem, one needs only to plug in values of the variables on the right hand side of the model (4.4) for every successive year. Since it is assumed that in model (4.4) $c_{j1} < 0$, a large flexibility coefficient would be estimated if $x_j(t-1)$ were small. Likewise, a small flexibility coefficient would result if $x_j(t-1)$ were large. This kind of nature of flexibility coefficient seems to be very appropriate assessing on the basis of producers' possibilities to change their production volume in these situations. One drawback of this procedure is the additional computational work. One may also argue that these models could be quite accurate predictors of supply in themselves. On the other hand, this method also uses predicted values to estimate flexibility parameters and errors may cumulate as a result.

Many economists argue that factors in addition to the production of preceeding years should be used in estimating the flexibility coefficients. These variables include the prices of the product and its main competitors, weather, and some index of technology. For example, SAHI and GRADDOCK used variables of this kind in deriving the flexibility coefficients for their model. They also compared the empirical prediction performance of the method they developed with that of certain other methods for deriving flexibility coefficients. According to the tests of performance they used (Theil's inequality coefficient U_1 and comparing turning point errors) their own method seemed to perform best (SAHI and GRADDOCK 1974, p. 356).

There are some other interesting applications of recursive programming especially in forecasting the acreage of different crops (SCHALLER and DEAN 1965). Their study is also the most recent one available, in which the performances of the recursive programming and econometric models have been compared with each other. They stated that econometric supply response models in general performed somewhat better than recursive programming models. However, in situations where important structural changes or technical changes are expected, the latter method may serve a very useful purpose.

References

BOX, G.E.P & JENKINS, G.M. 1970. Time Series Analysis. Forecasting and Control. 542 p. San Fransisco.

DAY, R.H. 1961. Recursive Programming and Supply Prediction. In Agricultural Supply Functions ed. by HEADY et.al. 108-125. Ames.

- " - 1962. An Approach to Production Response. Agr. Econ. Research 14 (1962): 134-148.

HEIDHUES, T. 1969. Recursive Programming Applied to Agriculture. In Contributions to Input-output Analysis ed. by CARTER and BRODY.

NEVALA, M. 1976. An Econometric Model for the Finnish Egg Industry. J. Scient. Agric. Soc. Finl. 48: 427-521.

SAHI, R.K. & GRADDOCK, W.J. 1974. Estimation of the Flexibility Coefficients for Recursive Programming Models - Alternative Approaches. Am. J. Agr. Econ. 56: 344-350.

SCHMITZ, A. & WATTS, D.G. 1970. Forecasting Wheat Yields: An Application of Parametric Modeling. Am. J. Agr. Econ. 52: 247-254.

SCHALLER, N.W. & DEAN, G.W. 1965. Predicting Regional Crop Production: An Application of Recursive Programming. U. S. Dep. Agr. Tech. Bull. 1329: 1-110.

SHARPLES, J.A. 1969. The Representative Farm Approach to Estimation of Supply Response. Am. J. Agr. Econ. 47: 681-695.

WOLD, H. 1964. Forecasting by the Chain Principle. In Econometric Model Building. Contributions to the Economic Analysis 36 ed. by WOLD: 5-36.

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PRODUCTION FORECASTS

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PRODUCTION FORECASTS

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Abstract. The forecasts of agricultural production for Finland presented in this paper are based on a) per hectare yields of different crops, b) the development of feed use efficiency in animal production and c) consumption projections of agricultural products. The forecasts are usually conditional, based on various assumptions of future agricultural policy. They are also preliminary, because the research project has not yet been fully completed.

The yields per hectare in crop production will increase about 1.5 per cent per year on the average. The total yield of crop production may even be higher if production shifts to those products whose yields are higher than the average.

The feed conversion efficiency in milk, pork and egg production will improve about 0.5-1.0 per cent per year.. For beef production no improvement is assumed due to the facts that the average slaughter weights will rise. The production forecasts are based on consumption projections and various self-sufficiency targets. Therefore, the forecasts may be called targets predictions and, accordingly, they are normative by nature. Milk production cannot evidently grow from the present level, but has rather to decline 10-20 per cent. Since beef production is connected to milk production - to the number of dairy cows - beef production will stay at the present level or will decline slightly. Pork and poultry production will grow 46 and 127 per cent, respectively, whereas egg production has, obviously, to decline about 15 per cent due to marketing difficulties.

Taking into account the consumption of grains, potatoes, vegetables, and other plant products, the total use of soil production would be about 200 mill. feed units.

Since the total crop production will be about 6400 mill.feed units in 1985, there will be a difficult overproduction situation, if no action is taken to withdraw more land from production.

I The background for the study

1. Introduction

The need for long term production forecasts has been realized on many occasions. The decision makers in the public sector need them for the setting of production targets and for the practising of every day agricultural policy. Forecasts of the equilibrium of production and consumption are needed for the preparation of the state budget. Production forecasts are also valuable to the distribution and processing sectors for the planning of investment. A private farmer may also utilise production forecasts in choosing the appropriate production line in order to avoid marketing difficulties.

Production forecasts for Finnish agriculture have been made both in Finland and in international organisations, but they have been trend projections and have not taken into account the special features of Finnish agriculture. Therefore the Agricultural Economics Research Institute together with the biological-technological research institutes began a research project for forecasting agricultural production. It has been partly financed by the Ministry of Agriculture and Forestry from special funds.

2. The structure of the research project

The forecasts of the yields per hectare in crop production serve as a basis for the whole project. They were made by the Plant Husbandry Department of the Agricultural Research Centre. The total plant production (in feed units) depends, of course, on the per hectare yield and on the cultivated area of each product. No forecasts of the total area cultivated are made because the total area can be considered as a policy variable which is dependent, among other things, on the equilibrium of production and consumption.

Another important sub-project consists of the efficiency of feed use forecasts. The milk output per cow is increasing, which means that the ratio of feed input per unit of output is decreasing. Feed conversion efficiency is also improving in pork and egg production.

The same is perhaps true for beef production but since the average slaughter weight is increasing, the actual feed use efficiency may not improve. In the long run feed conversion efficiency becomes quite important. - The Animal Breeding Department of the Agricultural Research Centre prepared the forecasts for this purpose.

Based on these two sub-projects, forecasts for yields of plant products and forecasts for the efficiency of feed use, the final production forecasts are made. Because it is possible by means of price policy to guide the production of some products such as grains, pork and eggs, production predictions have to be made by using alternative policy assumptions. There may be certain internal factors in agriculture which determine the development of production to some extent (for example in milk production), but the predictions of production are mainly conditional, i.e. predictions are based on certain policy assumptions. On the other hand, if all arable land is cultivated, the equilibrium or lack of equilibrium of production and consumption has certain policy implications.

Production predictions can also be made by utilising consumption predictions if they can be considered to be independent of each other. For example, the production of pork or eggs can be adjusted to consumption rather easily. In fact, the use of consumption forecasts is the only meaningful way of making production forecasts for pork and eggs. Of course, the desired self-sufficiency ratio can be taken into account when using this method.

Finally, a balance sheet of feed supply and feed use in animal production gives valuable information concerning the equilibrium of production and consumption. However, no attempt is made to determine whether overproduction should be directed a) to grain production and exported as such or b) to those animal products which are economic from the point of view of exports or c) overproduction should be curtailed by withdrawing more land from production. This is a subject of a further study and it requires more knowledge of the development of world market prices.

II. The preliminary results of the study

Since the study is not yet completed, only preliminary results can be given. They may change later on, but it is hoped that they will give an overall view of the future development of Finnish agriculture.

3. Yields per hectare

Projections of the yields of the most important products were made by the Plant Husbandry Department of the Agricultural Research Centre (table 1). They were not made by using a standard method, but rather by utilising various earlier studies, field experiments, and subjective consideration and views obtained from various sources. This kind of mixed method was chosen for it was thought that pure mathematical methods cannot take into account certain factors such as the possible shortage of energy and raw materials in the future. It is possible that the pace of biological and technological development has been underestimated and the predicted change will turn out to be too small as has been the case quite often earlier.

Table 1. The yields for main crops in 1975 and 1985.

	1975[1)]	1985	Change
	kg per ha		per cent
Winter wheat	3020	3280	9
Spring wheat	2680	3040	13
Rye	2210	2670	21
Barley	2510	2950	18
Oats	2470	2900	17
Potatoes	14030	19500	39
Sugar beet	29700	33000	11
Hay (dried)	3910	4300	10
Silage	19190	21500	12

[1)] Trend values from years 1971-75.

There are many factors which improve the crop yields. The use of fertilizers is assumed to increase slightly from the present level, even though it has been decreasing during the last two years due to the rapid rise of fertilizer prices. The improvement of fertilizer placement technigues can also be considered a factor that will raise yields. Plant breeding is obviously less sensitive to economic fluctuations, so it is also likely to increase yields. The spread of existing new varieties also guarantees a certain increase in yields. The increasing use of pesticides as well as education and intensified advisory service are also improving yields. Weather is, of course, one of the major factors causing the annual variations in yields and it may also have long term effects. It is, however, impossible to predict these.

The predictions show relatively small increases in yields. Therefore, they cannot be considered unrealistic. In fact, they were reached as early as 1976 due to favorable weather conditions. The average increase in yields depends on the areas of the various crops in 1985. By using the areas for 1975 the increase in yields is on the average 15 per cent or 1.5 per cent per year.

4. The efficiency of feed use

For the animal production predictions it is important to know how much feed is needed for each type of animal production. On the other hand, it would be necessary to examine, what type of feed will be used in the future, but in this connection we have to make do with the total use of feed, measured in feed units. - Predictions of the development of feed conversion efficiency were made by the Animal Breeding Department of the Agricultural Research Centre and Agricultural Economics Research Institute.

The most difficult task was to determine what is the actual level of feed use per unit of output; it seems to be easier to make forecasts for the development of feed use efficiency. The estimates are, however, preliminary and further research is needed on them.

Table 2. Feed use per unit of output in animal production in 1975 and 1985.

		1975	1985
Milk	f.u per l	0.84	0.80
Beef	f.u per kg	12.0	12.0
Pork	-"-	5.3	4.8
Eggs	-"-	3.3	3.0
Poultry (meat)	-"-	7.5	7.5
Broiler	-"-	3.2	2.9
Horses[1)]	f.u per year	2000	2000
Sheep[1)]	-"-	575	575

[1)] For horses and sheep, feed use estimates are made for live animals only.

As to the methods for determining the feed use coefficients it may be mentioned that in the case of milk production, only the feed use for the maintainance of a milking cow is included in the figure but not the feed for the replacement of a cow, which is included in beef production. It has been estimated that the improvement in feed use efficiency in milk production has been about 0.5 per cent per year and this trend is assumed to continue.

Feed use in beef production is assumed to be constant due to the rising average slaughter weight. Othervise, it would also improve. The rise of average slaughter weight depends on the profitability of beef production and thus, it cannot be predicted very well. In order to promote beef production, a premium is paid when the slaughter weight is over 160 kg. This will be continued and it allows us to assume that slaughter weights will increase.

Feed use in pork and egg production is in principle simpler to determine than that in milk production though not necessarily easy. Research is usually directed to the marginal efficiency of production whereas for our purpose, the average feed use for the whole pork production is needed. The figure in table 2 also includes, therefore the feed required for pig production. In egg production, the feed for the raising of hens is included in the poultry meat production. A great proportion of hens dies during the production period and since no meat is received in this case, that part of feed use required for the raising of hens is included in the egg production. Again, the level of feed use in pork and egg production is somewhat questionable but the trend should be rather clear.

Feed use for the production of poultry meat consists of raising a chicken to laying maturity and is therefore higher than that for a broiler for which an economic slaughter weight can be chosen. Feed use in both lines of production has been constant in recent years but it is also assumed to decline in the future.

For horses and sheep, it is more reasonable to estimate the feed needed to keep them alive than to try to estimate feed use in meat production.

5. Predictions for animal production

In addition to the biological development there are many factors in animal production that cannot be dealt with separately of the agricultural policy practised. Therefore, the prediction of animal production is a very complicated task and no unconditional predictions can be made. The attempts to maintain overproduction within certain limits will evidently guide animal production in Finland. Predictions are in that sense useless. For example, there are certain suggestions for production targets for 1977-79, the exceeding of which will punish agriculture economically so heavily, that the targets are at the same time a kind of prediction.

5.1. Consumption predictions

If the production targets are set as self-sufficiency ratios as has been suggested, consumption predictions will form a basis for production targets and predictions, too. For that purpose, the consumption predictions for the main agricultural products were already made at an early phase in the research project. They are

Table 3. The per capita consumption of agricultural products in 1965/66, 1970 and 1975 and forecasts for 1985, kg.

	1965/66	1970	1975	1985
Wheat	52.7	48.7	46.4	40
Rye	26.3	23.2	22.1	20
Barley	4.8	3.5	2.8	3
Oats	3.0	2.8	2.5	2.5
Potatoes fresh	100.1	80.4	70.8	60
Potato flour	2.6	2.2	2.9	2.5
Beef	20.0	20.8	24.2	23
Pork	15.0	20.6	26.7	35
Poultry meat	0.4	0.8	2.4	5
Eggs	9.3	10.4	10.9	13
Milk:				
Fluid milk (1)	284.9	219.4	238.4	206
Sour milk (1)	19.6	35.1	38.5	40
Cream (1)	4.9	5.7	5.8	6
Dried milk	1.5	2.3	3.0	4
Cheese	3.5	4.3	6.1	8.5
Butter	17.7	14.4	13.3	10
Margarine	4.5	7.3	8.5	10
Sugar	42.9	43.9	38.5	40
Calories per day	2807	2651	2461	2584
(kilo joules)	(11752)	(11099)	(10303)	(10819)
Protein grams per day	81.1	80.8	87.2	89.3
Fat grams per day	107.3	112.6	120.3	117.8

not unconditional either, for by means of price policy, it is possible to guide consumption, too. One of the important factors determining consumption is the price ratio of butter and margarine, which is used for regulating the consumption of butter and margarine. The prediction has, thus, to be based on the assumption of a price ratio. Because butter still has a considerable share in the diet, an error made in forecasting its consumption is felt also in the consumption of agricultural products of domestic origin as a whole.

Margarine, namely, is mainly made from imported raw materials, and as such, less input (measured in feed units) is needed for margarine than for butter.-Here the assumption is made that the price ratio will be constant.

Another essential assumption is made in the case of the price ratio of beef and pork which it is thought will continue to develop in favour of pork. The reason for this is that the supply of beef will not increase if the number of dairy cows declines as was explained earlier. Beef imports cannot be considered desirable due to the balance of payments problems. The shortage of beef supply will, thus, force the price of beef upwards and demand for meat will shift to pork.

The consumption of cereals is predicted to decrease slightly due to the increase in the consumption of animal products, for the total calorie intake is likely to be stable or to decrease somewhat. The consumption of potatoes is decreasing for the same reason. Nutritional knowledge would suggest that more plant products instead of animal products should be consumed. People may become more aware of this and so, the predicted rise in the consumption of animal products may not materialize. The forecasts may be considered to favour producers and may be too optimistic even though they are certainly possible to obtain.

5.2. Production of milk

Milk production still accounts for about 45 per cent of the total revenue from agriculture, so it has a central role in these forecasts. Unfortunately, it is difficult to make predictions for milk, because there are many factors opposed to each other. Milk production is of long duration by nature, for raising of cattle requires time, and investments, and building investments in particular are difficult to transfer to other lines of production, etc. Therefore, short term fluctuations do not indicate the true development of milk production but rather the development has to be analysed by using a longer time span.

Milk production can be guided by many methods of which price, investment and social policy measures can be considered the most important. Working hours, as well as summer holidays and weekend arrangements have become crucial for milk producers. Cattle bind the farmer to his holdings every day of the year, which does not fulfil the modern requirements of a 40 hour working week very well. In recent years there have been some advances in this problem area and now a farmer may get a 10 day vacation but this may not be a sufficient incentive to young farmers to take up milk production.

New investment in building are needed for milk production in Finland, because most of the cow-sheds are old and too small for modern production techniques. All necessary investment may not be possible to finance and this means that the number of dairy cows will decline, but it is difficult to quantify this decline.

The sizeable rises in the producer price of milk will evidently have a positive effect on milk production. Moreover, the real producer price of milk has to be kept at the present level, if the income level of farmers is to rise (as it certainly will), because milk pays such a central part in Finnish agriculture. - As a result of the increased price of milk, production rose last year, even though the depression of the whole economy was also a reason for that: other sectors could not absorb labor from agriculture.

Milk production per cow has increased steadily and the trend is rather linear or about 75 l per year. This can also be expected to continue during the next 10 years. According to the projection, the average yield per cow will be 4850 l in 1985. If there are 750 000 dairy cows in 1985, the total milk production will be 3638 mill. l. This will be about 50 % more than the present milk consumption as a whole.

There is no room for an increase in milk production because consumption of milk as a whole is likely to decrease. World market prices for milk products cannot be expected to rise because over-production is predicted to get worse in the developed countries. Thus, export subsidies per unit of exports will grow. The self-sufficiency ratio of milk cannot be allowed to get higher than what is is now or about 130 per cent. As a matter of fact, the target will obviously be lower, or perhaps 120-125 per cent, or even lower. To be truly self-sufficient, the ratio has to be more than 100 per cent due to seasonal fluctuations of production and consumption.

If we assume 120 per cent self-sufficiency, the production target for 1985 would be 2580 mill.l (440 l per capita consumption per year, population 4.88 mill.). As the average yield per cow will be 4850 l in 1985, the 2500 mill. l of milk can be produced by 530 000 cows. If consumption were to stay at the present level of 500 kg per capita, milk production would be 2930 mill. l, which requires about 600 000 cows. The latter figure is likely to be the upper limit for the milk production target.

The natural development would seem to help in attaining this goal. The linear trend for the number of cows suggests that there will be about 550 000 dairy cows in 1985. This kind of development can occur, if no strong action is taken to change it. But taking into account the need to keep the milk market in a manageable equilibrium, the decision makers have no choice, but to let the number of dairy cows go down. The rise in the average yield per cow slows down the decrease in milk production.

The structural change in milk production has a considerable effect on Finnish agriculture. In 1960 about 70 per cent of farmers produced milk, but in 1975 the corresponding figures were already less than 50 per cent. If the average size of herds, which in 1975 was about 6 cows, were to be for example 10 cows which is still rather small, it would mean that in 1985 there would be only 50 000 - 60 000 farms producing milk or only half of the present figure.

5.3. Meat production

The production of beef will mainly depend on the number of dairy cows, for there are still few beef herds in Finland. Since the number of dairy cows will fall, fewer calves than previously will be available for beef production. The rise in the average slaughter weight will counter the decline in the number of animals slaughtered.

Slaughter weights can be raised by, among other things, giving up the slaughtering of small calves, which is, however, already rather small. Price policy has been tried as a means for increasing slaughter weights. A premium on a slaughter weight over 160 kg is, for example, paid in order to promote beef production. According to trend development, the average slaughter weight will be about 200 kg in 1985.

Depending on the number of dairy cows (530 000 - 600 000) beef production may be 95-108 mill.kg or it could be lower than at the present.

For pork production forecasts can be made only on the basis of consumption, because production can be adjusted to the prevailing market situation. Again, the self-sufficiency ratio is decisive for the production target. If it is set at 110 %, which can be considered reasonable to secure the food supply, pork production should be 185 mill. kg in 1985. No attention is then paid to the cyclical fluctuation of pork production.

Predictions for the production of poultry meat have to be made on the basis of consumption forecasts, because production can be assumed to satisfy domestic needs. The consumption forecast presented earlier means a production of 25 mill. kg in 1985 of which about 22 mill. kg will be broiler.

The production of other meats e.g. horse meat and mutton is expected to decrease slightly, but no forecast is made here. Moreover, they have only a small share in the total meat production.

5.4. Production of eggs

The production of eggs has exceeded the domestic consumption by 60-65 per cent in the last two years. Since international egg markets are unstable and the world market prices are very low, policies are constantly formulated to check and reverse the growth of egg production. A special committee suggested in 1976 that the self-sufficiency ratio of eggs should be gradually lowered to 130 per cent within three years. A long term target might be 105-110 per cent self-sufficiency. Egg production should accordingly decrease about 30 per cent from the present level by 1985 or it should then be about 70 mill. kg. It is possible to adjust production to this lower target, but since there is going to be quite a lot of overcapacity in Finnish agriculture, it is possible that the egg production may occasionally exceed the target.

5.6. Total production of Finnish agriculture

By combining the production forecasts of animal production and the feed conversion coefficients we get an overall look at the Finnish agricultural production as presented in table 4. As has been

Table 4. Animal production and feed use in 1975 and 1985.

	1975			1985		
	f.u/kg	Production mill. kg	Feed mill. f.u	f.u/kg	Production mill. kg	Feed mill.f.u
Milk	0.810	3164	2562	0.773	2660	2056
Beef	12.0	112	1344	12.0	95	1140
Pork	5.3	127	673	4.8	185	888
Eggs	3.3	80	264	3.0	68	204
Poultry	7.5	4	30	7.5	3	23
Broiler	3.2	7	22	2.9	22	64
Horses[1]	2000	38[2]	76	2000	30[2]	60
Sheep[1]	575	56[2]	32	575	50[2]	29
Total			5003			4464

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[1] For horses and sheep, the annual use of feed is estimated

[2] '000 of horses and sheep

emphasized earlier, the predictions are still preliminary and conditional in many respects. The study is still going on and "better" results will be obtained later on.

The level of total feed use may be somewhat inaccurate, but the future development should be as predicted. Past history supports this view. The decrease in feed use is about 11 per cent, of which about 6 per cent is due falling production and 5 per cent due to the improvement in the feed conversion efficiency. Milk production has, of course, a central role in the total balance sheet. Feed use in milk production falls about 500 mill. f.u of which 80 % is caused by falling production. If milk production were to stay at the 1975 level, the total feed requirement would be about 50 mill. f.u greater than in 1975. This also includes beef production of 112 mill. kg. Consumption of pork would then be a little lower than in the original forecast.

No forecasts were made for horses and sheep. Their numbers are decreasing even though there have been attempts to slow down the development and reverse it.

The consumption of plant products (grains, potatoes, sugar etc.) is about 730 feed units. This has to be added to the consumption of animal products to get the total consumption measured in feed units. In 1975 the net consumption was 5140 f.u and according to the predictions about 4900 f.u in 1985.

So far, no attention has been paid to the production of grains and other crops for human consumption. The self-sufficiency ratio points in the direction of about 110 per cent, even though it could be a little higher due to large production variations. The self-sufficiency of sugar cannot be raised from the present 40-50 per cent, but production of oil seeds could be increased so that it would correspond to the domestic requirement. At present it is only about 20 per cent of total consumption.

The production of feed-grains (barley and oats) should exceed domestic use by 5-10 per cent in order to secure the smooth development of animal production.

If we draw up a total balance sheet of animal and plant production, we arrive at a production of 5200 mill. feed units. This is much less that what can be produced. If all arable land were kept under cultivation in 1985 total plant production whould be about 6400 mill. feed units. Supply would be 23 per cent in excess of predictions and the over all export requirement would be about 2320 mill. feed units. This is the approximate situation in 1976-77 after a good yield in 1976 which corresponds to the trend estimate of 1985. If self-sufficiency in agriculture is to be kept within the planned limits, the only solution to overproduction would seem to be to withdraw from production about 20 per cent of the arable land.

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