Netherlands Journal of Agricultural Science 44 (1996) 193-208

Scenarios of technical and institutional change in Dutch dairy farming

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Received 31 October 1995; accepted 17 August 1996

Abstract

Scenario analysis is used in this paper to assess consistent sets of future circumstances in Dutch dairy farming. The fields of interest are technical and institutional change. Technical change includes improvement in fodder and milk production. Institutional change includes changes of environmental policy and of market and price policy. All key factors are historically analyzed and forecasts are made for 2005 and are bundled into four scenarios. The scenarios are governed by environmental policy and common agricultural policy. For environmental policy a moderate and a severe variant are distinguished, and for common agricultural policy a price support and a two-price variant.

Keywords: forecasting, dairy farming, scenarios, technical change, institutional change

Introduction

Dairy farming in the Netherlands faces significant uncertainties in the fields of (1) technical change, (2) environmental policy and (3) market and price policy. Technical change pertains to plant production and animal production which are the two production processes that take place on a dairy farm. The input/output relations that reflect the efficiency of these processes have changed continuously over the past decades. Environmental policy includes all governmental legislation meant to decrease the burden on the environment caused by agriculture. Since the awareness of environmental problems at governmental level is relatively new, this kind of policy is still in a development phase. The market and price policy of the EU strongly influences the prices a dairy farmer receives for his products and to a lesser extent also the prices of production factors. This policy is likely to change as a consequence of GATT negotiations among other things.

The objective of this paper is to make systematic forecasts for these uncertain factors and to combine them into consistent scenarios representing possible circumstances for the year 2005 for dairy farming in the Netherlands. By doing so the future of Dutch dairy farming becomes more tangible and understandable. The paper starts with a short literature review on scenario analysis ending in the choices that are made in this study.

Scenario analysis

Principles of scenario analysis

In literature several definitions of the term scenario can be found. Consensus exists about (1) a scenario, 'not being a prediction of the future' (Zentner, 1982) but 'being an exploration of an alternative future' (Wilson, 1978) (2) the number of scenarios used for a certain subject which must be greater than one (Zentner, 1982) and (3) the number of aspects included in a scenario which must be greater than one since scenarios are multifaceted (Wilson, 1978). Scenarios can be longitudinal or cross-sectional (Schnaars, 1987). Boucher (1985) calls them 'path-through-time' and 'slice-of-time' scenarios. As most of the scenarios proceed in a logical sense at present (Coates, 1985), serious literature mostly deals with longitudinal scenarios. A second distinction is that of scenarios describing some kind of future state versus scenarios describing future circumstances. Firms appear to primarily use scenarios in the latter sense for 'depicting corporate environmental assessments for planning purposes' (Linneman & Klein, 1983, p.100). Interaction between forecasts of individual factors adds the extra dimension to scenarios according to Linneman & Klein (1983) and Zentner (1982). Others do not explicitly state that interdependencies must exist but they write about a scenario being an internally consistent set of forecasts (Millet, 1988).

Scenarios can be used for forecasting if other methods fail. For example, a model can be used for forecasting if the factors influencing a future state or environment are known, if their number is low and if the relationships governing the interactions between factors are well understood (Amara & Lipinski, 1983, p. 43). Good examples of these kinds of situations can be found in physical sciences. A shortcoming that empirical models have in common with trend extrapolation is that both methods are based on historical data, which means that events without a precedent cannot be taken into account (Schnaars, 1987). This leads to the conclusion that scenario analysis can be useful if uncertainty is high and if the number of choice moments and variables are high (Amara & Lipinski, 1983, p. 44). If crucial variables that are hard to predict can be reduced to a few, then scenario analysis is the best method to forecast future environment (Schnaars, 1987).

Literature offers several methods for developing scenarios (see for example Huss, 1988; Von Reibnitz, 1988: Zentner, 1982; Wilson, 1978; Schnaars, 1987). Steps, which all methods have in common, are analysis of historical data, development of forecasts for key factors and selection of scenarios. Different opinions exist on the extent to which development of scenarios can take place in a quantitative way. When scenarios were first used in futures research, development included the use of mathematical methods with a focus on probabilities of events happening in the future and on quantification of interdependencies between events (Helmer, 1977). However, Schnaars (1987) argues that the assignment of probabilities to scenarios implies a precision that is not warranted by either the data that were used to derive them, nor by the phenomenon they purport to predict. Kahn (1968) rejects the notion of quantitative model building, stating that quantitative models focus only on those aspects of a problem that are easily quantified, and, therefore, represent only a partial formulation of the forecasting problem. Selection and assessment of scenarios can be done after the analysis of historical data and the assessment of individual forecasts and of relations between the forecasts, or beforehand, on the basis of some global political or social assumptions (Coates, 1985). The first, inductive, way can be used if the number of influencing factors and the numbers of forecasts per factor are small while the second, deductive, way offers some guidelines for the process of selecting and analysing historical data if the number of factors or the numbers of forecasts per factor are high (Schnaars, 1987). The number of scenarios should not be too high to avoid difficulties for the user in interpreting and managing scenarios (Wilson, 1978). From earlier research, Linneman & Klein (1979) stated that three scenarios were used more than any other number. Wilson (1978) offers four criteria for selecting scenarios, namely relevance, credibility, usefulness and intelligibility. In short this means that a scenario must be relevant, it must seem a possible future, it must be useful for the purpose for which it was created and it must be understandable. The contents of scenarios should be based on some sort of logic according to Coates (1985), such as different values of a range of key variables rather than to produce a 'best case', a 'worst case' and a 'surprise-free case'.

The use of scenario analysis in this study

In this study scenario analysis is used to compose possible future circumstances for dairy farms. The conditions which lead to scenario analysis as being the best method for future forecasting are almost completely met in dairy farming. Firstly, the subject matter lies in the field of social affairs so timeless laws like in physical sciences are missing. Secondly, the main influencing factors are the state of technology and institutional regulations concerning the market and price policy and the protection of the environment, so the number of crucial variables can be kept low. Finally, the uncertainty, especially in the field of institutional regulations, is high.

An important scientific criterium is that scenarios are verifiable. This requires (1) that scenarios proceed in a logical sense on the present and (2) that scenarios are as quantitative as possible. The longitudinal character of the scenarios is realized by developing forecasts for key factors that currently proceed in a logical sense although this can happen with sudden changes. The quantitative aspect will be restricted to the content of scenarios. A quantitative content also makes the scenarios suitable for modelling purposes. Probabilities will not be attached to scenarios.

The steps that will be taken in the development of scenarios are as follows:

1 The key influencing factors will be assessed in both influencing areas (technology and institutional regulations).
2 Following analysis of historic data on every key influencing factor and based on expected changes, one or more forecasts will be developed.

3 The individual forecasts will be bundled into three or four scenarios, taking into account interdependencies between the factors. The scenarios will be selected based on relevance, credibility, usefulness and intelligibility.

From the above it can be seen that scenarios are assessed after analysis of historic data and assessment of individual forecasts. This inductive way is chosen because the number of influencing factors as well as the number of forecasts per factor is small.

Changing factors in dairy farming

The external changing factors that influence dairy farming are grouped into factors of technical change, factors of institutional change and other factors.

Technical change

Cochrane (1958, p.46) defines technical change as 'an increase in output per unit of input resulting from a new organization, or configuration, of inputs where a new and more productive production function is involved'. A more specific definition is given by Ruttan (1959, p.606). He defines technical change in what he calls a functional sense as 'changes in the coefficients of a function relating inputs to outputs resulting from the practical application of innovations in technology and in economic organization'.

On a specialized dairy farm two main production processes take place, i.e. plant production and animal production. According to the definitions mentioned above, technical change is expressed by the continuous change of these processes. Plant production on a dairy farm is mainly equivalent with grass and silage maize production. Other roughages are of minor importance. Animal production includes milk production, meat production and reproduction. Milk production is of major importance and meat is considered a by-product.

Grass production

The average net energy production per hectare of grass in the Netherlands has increased from about 40,000 MJ NEL (megajoule net energy for lactation) in 1971 to about 62,000 MJ NEL in 1983. Since 1985, when milk production was restricted, net energy production has declined (Anonymous, 1993a). From 1974 to 1993 the losses of energy as a result of grazing and forage-making declined on average from about 27% to 22% (Anonymous, 1974, p. 94; Asijee, 1993, p. 182). This decline was the result of better grazing and mowing management and improvements in conserving roughage. Gross energy production (Figure 1) can be calculated from the net energy production and the assumption that losses declined by 0.25% per year. Ongoing research on grazing and mowing management and on harvesting and conserving roughage makes it feasible to assume that losses will continue to decline by 0.25% per year till 2005.

An important factor influencing grass production is the supply of mineral nitrogen by fertilizer and manure. Mineral N supply from manure was assumed to be 20 kg

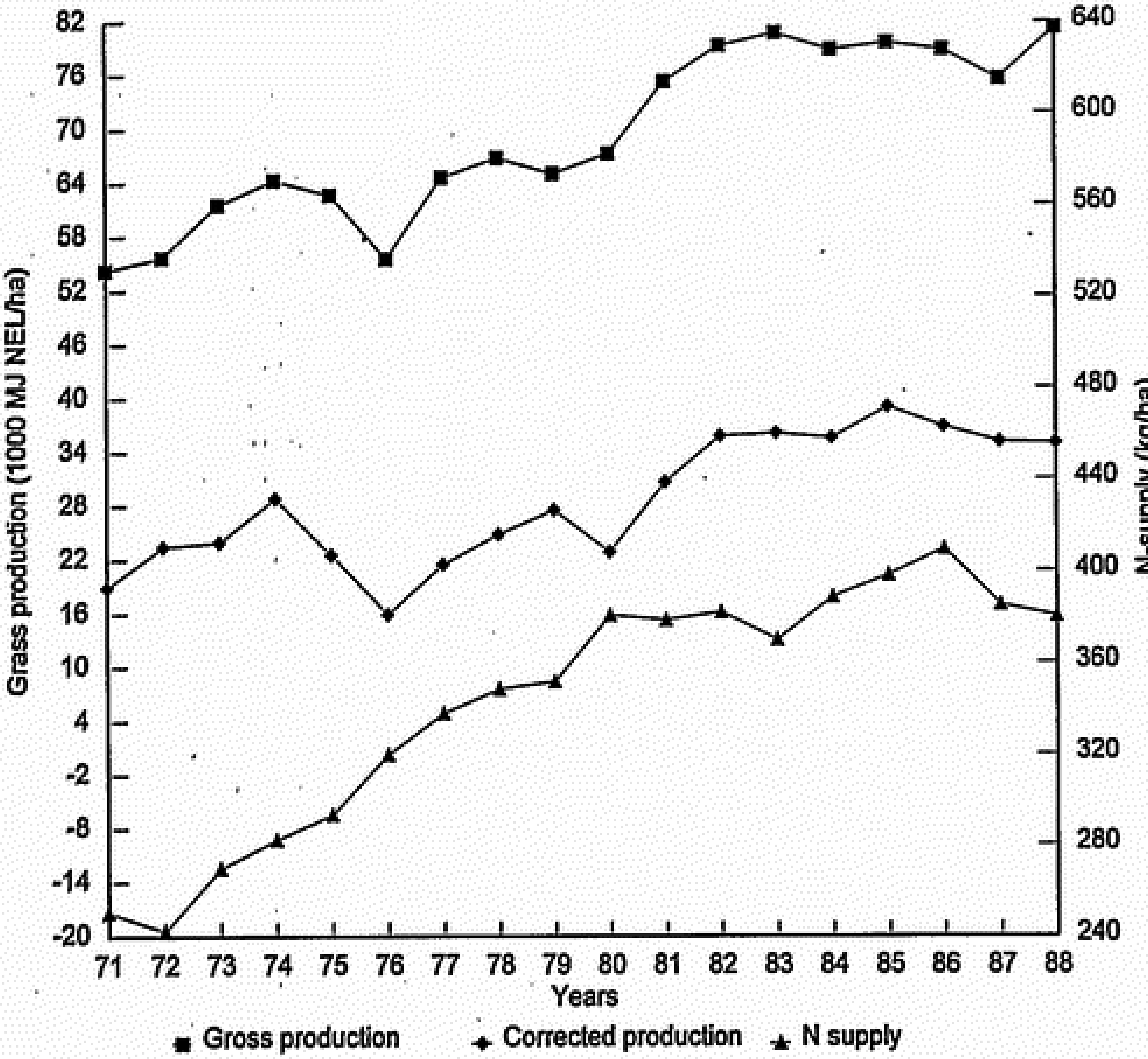

Figure 1. Average gross energy production from grassland in the Netherlands from 1970 to 1988, the corresponding average level of N-supply and the energy production corrected for weather influences and N-supply.

per cow per year, as a result N supply from manure per hectare will vary with animal density. From Figure 1 it can be seen that N-supply shows a course corresponding to that of energy production with a minimum in 1972 of about 240 kg/ha and a maximum of about 400 kg/ha in 1986. Other influencing factors are advances in grass breeding and in grassland management (i.e. better grassland care and methods of harvesting grass) improved drainage of wet soils and improved water supply of dry soils. These advances have all increased the ratio between grass yield and N supply (Van der Meer & Van Uum-Van Lohuyzen, 1986, p. 10) which can be regarded as technical change. A final influencing factor is the weather. A well-known example is the dry summer of 1976 which led to a fall in grass production.

Analysis of the data to obtain the yearly increase of grass production at different levels of N supply by means of linear regression did not result in satisfying coefficients. Therefore another way of analysing was used. First, gross energy production has been corrected by using weather indices for grass production (Oskam & Reinhard, 1992) and the effect of N supply known from experimental research (Berentsen & Giesen, 1995). The resulting curve (Figure 1) shows a production increase due to technical change. Linear regression on this curve, with time as independent variable resulted in an average yearly increase of gross energy production of 1100 MJ NEL per ha. This average increase belongs to the average N supply of the data which amounts to 343 kg/ha. For other N levels it is assumed that the annual increase as a percentage of total grass production equals the percentage at the average N level of 343 kg/ha. This results in a yearly increase in energy production from grass due to technical change of 743, 929, 1061, 1138, and 1160 MJ NEL per ha at an N supply of 100, 200, 300, 400, and 500 kg/ha respectively. It should be noted that the uncertainty about these calculated increases is higher at low levels of N-supply, since the level of N-supply was higher than 200 kg/ha in the period analysed.

For future, improvements in grass breeding and in grassland management make a comparable increase in production likely (Wilkins, 1987; Wilkins, 1991). Especially the increase of information available and the development of systems that convert this information into practical advise can lead to better and more accurate grassland management.

Silage maize production

The acreage of silage maize has grown from 0.4% of the total agricultural area in the Netherlands in 1970 up to 10% in 1990 (Anonymous, 1993a). Reasons for this increase were conversion of mixed farms into specialized farms in which silage maize took the place of grains, increasing slurry output which can be used for growing silage maize very well while grains could not use slurry at all, mechanization of sowing, weed control and harvesting and increasing efforts in breeding silage maize varieties (Te Velde, 1986). Other reasons could be the high energy production per hectare and the high and constant quality of silage maize compared to grass and the good possibility of taking up silage maize in the ration for dairy cows.

Figure 2 shows average dry matter production per hectare of silage maize from 1954 to 1993 (Oskam, 1991, Anonymous, 1993a). Linear regression shows an average yearly increase in dry matter production of 125 kg per ha. This increase is the result of breeding and improved crop management. However, fluctuations between years can be quite substantial and can be explained mainly as the result of weather conditions. Night frosts, periods with low temperatures and severe lack of moisture in particular have a negative influence on production (Te Velde, 1984). The results of maize variety trials in the eighties, showing yields up to 17,000 kg dry matter per ha (Te Velde, 1986), give rise to the expectation that the yearly increase can be continued far beyond 2005.

Milk production

Increase in Fat corrected milk production per cow per year in the Netherlands for 1950–1992 exhibits four distinct periods (Figure 3). In the first period (1950 to 1975), average increase was 45 kg per cow per year. This period was characterized by low use of artificial insemination and by a considerable growth of the total num-

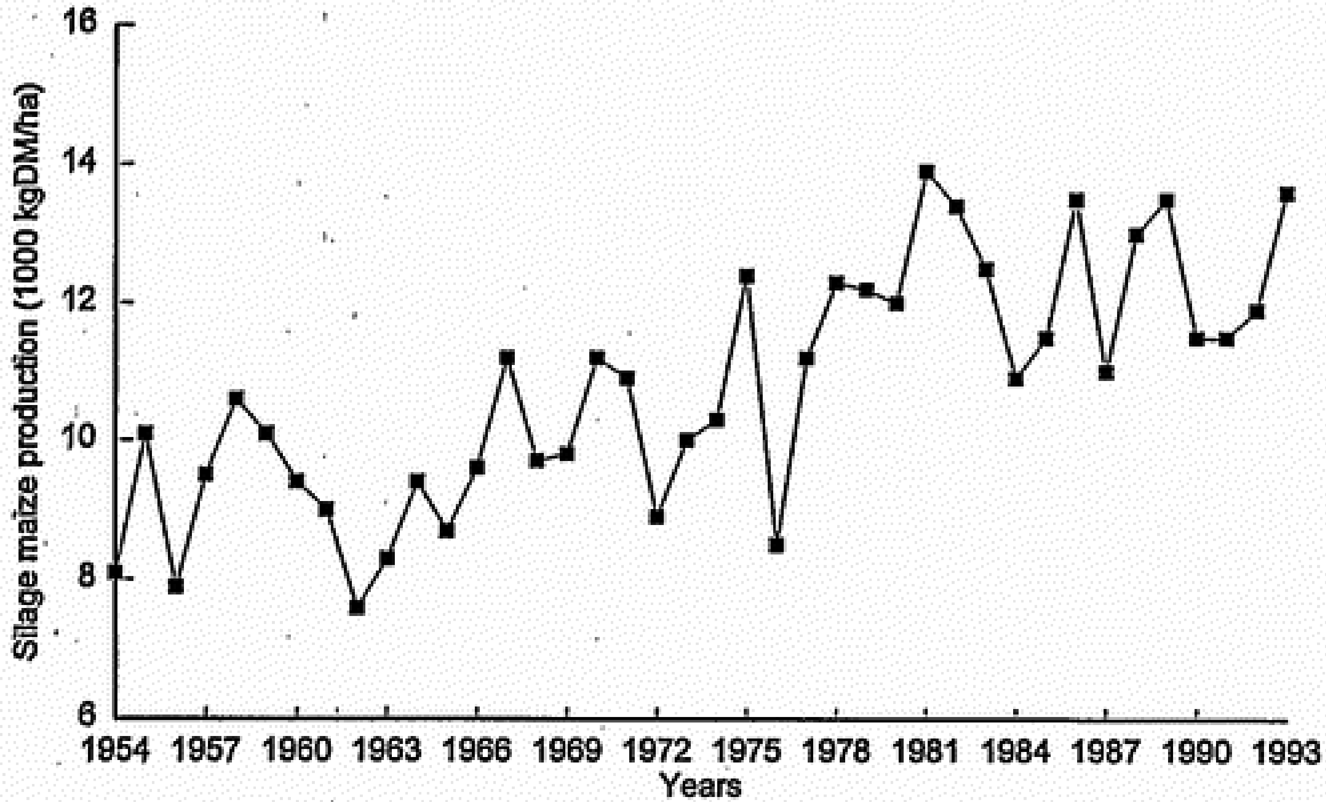

Figure 2. Average gross dry matter production from silage maize in the Netherlands from 1954 to 1993.

ber of dairy cows. As a result the effect of breeding remained low. Also the effects of improved cow management (including feeding management and health care) on milk production per cow appeared to be low throughout the whole period.

In the second period (1975 to 1984), the yearly increase in milk production was about 100 kg. Increasing use of artificial insemination, development of sophisticated

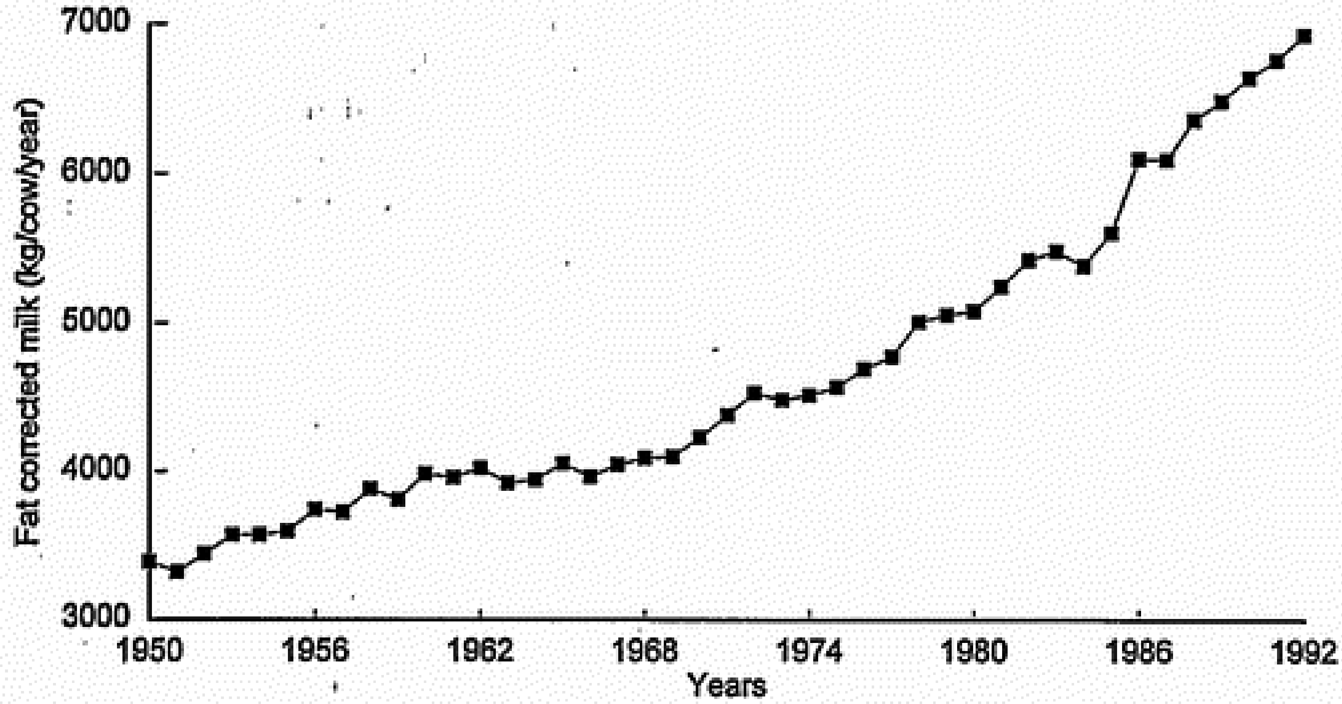

Figure 3. Average fat corrected milk production in the Netherlands from 1950 to 1992.

breeding programmes, and introduction of Holsteins into breeding programmes increased the genetic potential for milk production. A better feeding management and a change in the housing and the milking system also contributed to the higher yearly increase.

The third period (1984–1986) was a shock period. It included the years of adaptations of farmers to the introduction of the quota system with sudden deviations in the annual increase of milk production per cow (Burrell, 1989; Dillen, 1989, p. 91).

In the first three years of the fourth period (1987 to 1992) the milk quota were reduced further by 4% (Krijger, 1991, p. 21). The yearly increase in milk production per cow was 145 kg. On top of the factors that previously played a role, the quota system itself became a factor affecting milk production per cow. It gave rise to increased selection at farm level, increased attention to individual cows and more emphasis on increasing milk production per cow (one of the few factors left which could improve income).

If total production remains limited, Fat corrected milk production per cow can be expected to increase at 145 kg per cow because of new breeding techniques and improvements in feeding and health management. Total milk production or numbers of dairy cows may be limited by the quota system but also by environmental regulations. If no production limitations exist, a yearly increase of 100 kg can be assumed.

Increases in milk production caused by automatic milking or by the use of BST are not included in these estimations. Automatic milking is still in a development phase and necessary investments are estimated that high that automatic milking remains economically unattractive for the coming years. The use of BST within the EU is prohibited by legal regulation till 2000 and it is assumed that it will be so till after 2005.

Institutional change

By institutions the rules of society or of organizations are meant (Ruttan, 1987, p. 58). Specific rules for agriculture are laid down in policy regulations by the national government and the EU. National policy that applies to dairy farming and that can be expected to change concerns acidification and eutrophication of the environment. EU policy applying to agriculture is laid down in the common agricultural policy (CAP). By far the most important part of the CAP concerns the market and price policy of the EU.

National policy on acidification

Acidification takes place through deposition of sulphur oxides, nitrogen oxides and ammonia (NH_3). Calculations show that Dutch agriculture was responsible for 32% of total acid deposition in the Netherlands in 1990, almost entirely through emission of NH_3. Other Dutch sources such as cars, trucks, industries and electricity plants contributed a further 21% while the remaining 47% came from abroad (Anonymous, 1993b, p. 80). Dairy farming contributes substantially to acidification by volatilization of NH_3 from manure in the sheds, in storage and on the land.

Legislation to reduce NH_3 emission from agriculture was passed in 1991 and basi-

Table 1. Two variants of expected environmental policy for 2005 concerning nutrient losses from dairy farming

	Moderate policy	Severe policy
Ammonia emission:		
– acceptable emission level (kg NH_3/ha)	40	25
– levy (NLG/kg NH_3)	30	60
Phosphate losses:		
– acceptable losses (kg P_2O_5/ha)	35	20
– levy on first 10 kg exceeding (NLG/kg P_2O_5)	5	5
– levy on higher exceeding (NLG/kg P_2O_5)	20	20
Nitrogen losses:		
– acceptable losses (kg N/ha)	275	180
– levy (NLG/kg N)	2	2

cally consisted of (1) manure must be applied with a low emission technique and (2) manure storages must be covered. The obligation to apply manure by means of a low emission technique on sandy soil (and only for a part of the year) became effective in 1992. Beginning in 1995, all manure on all soil types must be applied by means of a low emission technique.

The government target for a maximum NH_3 emission at farm level is 20 to 30 kg NH_3 per ha in 2015 (Anonymous, 1993b, p.108). To achieve this, the government is developing a system that estimates NH_3 emission at farm level and imposes a levy on emission exceeding the accepted level. Since the levy and the effectiveness of the system are still unknown, two policies are assumed for 2005 (Table 1). The moderate policy assumes an acceptable emission of 40 kg NH_3 per hectare and a levy of NLG 30 per kg emission above the accepted level. The severe policy assumes an acceptable emission of 25 kg/ha and a levy of NLG 60 per kg. The levies are based on extra costs of a low emission cow shed that would be NLG 23 to NLG 55 per kg reduction of NH_3 emission (Van der Kamp *et al.*, 1993).

National policy on eutrophication

Eutrophication of the soil and of ground and surface water are closely related. Eutrophication of the soil takes place by binding phosphate (P_2O_5) to soil particles and by accumulation of organic bound N in the soil. When the capacity of the soil to bind P_2O_5 is exceeded, P_2O_5 is transported by water to surface and ground water. The same counts for organic bound N that is mineralized and not used by plants. Eutrophication of ground water by P_2O_5 and N makes it costly to use ground water as drinking water. It is mainly caused by excessive use of animal manure and fertilizer by agriculture. Eutrophication of surface water leads to excessive algal growth that threatens existing eco-systems. It was calculated that in 1990 agriculture was responsible for about 25% of P_2O_5 and for about 70% of N in surface water (Anonymous, 1994, p. 97).

Legislation to decrease eutrophication by agriculture was introduced in 1987 and focused on the period during which animal manure can be applied to the land and on the amount of manure that can be applied per hectare. The period during which manure can be applied to the land has been restricted to the growing season when nutrients are utilized by plants. Application outside the growing season in the past has led to excessive leaching of nitrates. The amount of manure that can be applied is measured by its P_2O_5 content and based on a normative P_2O_5 production per animal and a standard use per hectare depending on the crop that is grown. Although these standards were tightened several times, the P_2O_5 legislation so far hardly affected dairy farming (Berentsen *et al.*, 1992). Shortcomings of this legislation concern the exclusion of P_2O_5 from chemical fertilizer and the use of a normative P_2O_5 production per animal which makes it unattractive to change the actual P_2O_5 content of manure by changing feed rations.

In December 1995, the government and the parliament reached agreement on the introduction in 1998 of a system of nutrient balances for P_2O_5 and N at farm level (Anonymous, 1995). These balances will register all yearly input and output of nutrients and consequently estimate nutrient losses. A levy will be imposed on losses that exceed an acceptable level of losses. This system will replace the current standards on the maximum use of P_2O_5. The acceptable losses will be decreased in a number of steps. The agreed levels of acceptable losses for the different years are provisional. Depending on the results of research, these levels can be changed. Because of this uncertainty, again two policies for 2005 are used here (Table 1). The acceptable losses under the moderate policy equal the provisional acceptable losses for 2000. The acceptable losses under the severe policy equal the provisional acceptable losses for 2010 (Anonymous, 1995). The levy on P_2O_5 losses increases stepwise with increasing transgression of the acceptable losses.

Market and price policy of the CAP

The main reasons for government intervention in agriculture lie in the special importance for national welfare that governments assign to agriculture and its products and in particular aspects of supply and demand of agricultural products (De Hoogh, 1994). Agriculture's special importance follows from its production of primary necessities of life (i.e. food production) which makes agriculture a vital sector. Particular aspects of supply are the influence of weather, which makes the output in the more traditional agricultural sector less controllable, and the existence of long-lasting production cycles that makes it difficult to react rapidly to changing production circumstances and changing consumer demands (Atkin, 1993). Also the organization of agricultural production in many small family farms where labour is a much more fixed input factor than in industrial organizations makes agricultural supply rather insensitive to changing prices (see Helming *et al.* (1993) and Thijssen (1992) for the case of Dutch dairy farming). The demand of agricultural products is rather inelastic because the amount of food used by consumers is rather independent of the food price and of the income of the consumer. Together, these supply and demand aspects lead to large price fluctuations, often low incomes for farmers and uncertainty in food security (Atkin, 1993). Targets of government intervention are price stabilization, low food prices for urban population or high prices to support agricultural incomes and to stimulate agricultural production (De Hoogh, 1994).

Governmental intervention via the CAP started in 1962 as guaranteed prices for cereals, later followed by guaranteed prices for butter and milk powder. Although at the end of the sixties butter surpluses had already appeared, it was not until 1984 that the introduction of the quota system stopped further increase of milk production within the EU (Fearne, 1991). The next fundamental change in the CAP came in 1992 when the EU member states reached agreement on a derivate of the MacSharry proposals. Pressure from outside the EU to reach an agreement was caused by the Uruguay round of the GATT at which it was agreed to liberalize international trade, including trade in agricultural products.

This agreement, which extends until 2000, only marginally affects the market and price policy for milk. The change concerns a decrease in the intervention price of butter by 5% on the one hand and the abolition of the co-responsibility levy of NLG 1.50 per 100 kg milk on the other hand. As a result, the intervention price for milk decreases by NLG 0.50 per 100 kg compared to the price of 1992. Moreover, the milk quota will be reduced by 2% (Anonymous, 1993c). Other parts of the agreement have affected and will continue to affect dairy farming more strongly. The decrease in the intervention price of grain by 30% will lead to a decrease in the price of concentrates, as fifty per cent of the feedstuffs used for concentrates for dairy cows consist of energy sources like grain and grain substitutes (Dubbeldam, 1993, p. 23). A decrease of the intervention price of grain by 30% means a price reduction of about NLG 12 per 100 kg grain. Calculations point out that prices of grain substitutes that are lower than grain prices, will also have to fall to remain competitive (Lapierre *et al.*, 1993). Prices of concentrates can be assumed to fall by about NLG 4 per 100 kg compared to the price level of 1992. The compensatory payment per hectare of grain of (which applies also to silage maize) decreases the price of purchased silage maize and the costs of own produced silage maize. It can be assumed that the premium of NLG 604 per ha will be passed on to the buyer of silage maize which means that the price of silage maize will decrease by NLG 604 per ha compared to the price of 1992. The 15% decrease in the intervention price of beef will affect prices of cattle. It can be assumed that the prices of culled dairy cows will be reduced by about NLG 200 and of beef bulls by about NLG 300 per animal compared to the price level of 1992. It can be expected that the lower revenues will be partly translated into lower prices of calves. A price reduction of NLG 100 per calf is conceivable. For beef bulls lower prices are partly compensated by raising the EU premium per beef bull from NLG 105 up to NLG 235.

After 2000, it is possible that the price support for milk will also be reduced. Total abolition of the quota system is less likely, since the system has proved a valuable instrument to control milk supply (Berkhout and Meester, 1994).

For the situation in 2005 two alternatives are assessed. The price support alternative is a continuation of the situation before 2000. The second alternative is a two-price system with a guaranteed high price (the same price as in the price support alternative) for 85% of the available milk quota and a super levy on an unrestricted production of about 50% of the guaranteed price (so that a price of NLG 40 per 100 kg remains). This alternative is based on milk consumption within the EU being about 85% of total EU milk production and on the heavy EU subsidy on export of the remaining 15%, given a world market price of about NLG 30 per 100 kg of milk (Anonymous, 1993d, p. 195). Given the EU budget used for supporting the milk price, lower support per 100 kg milk that is produced over 85% of the available milk quota results in a larger volume of milk that can be supported. This system allows efficient producers to increase their production while less efficient producers will decrease production. Restructuring of milk production can take place to a certain extent and production can become more market-oriented. This option is based on an alternative to the present system presented by Oskam *et al.* (1988, p. 74).

Other changes

One remaining important factor that affects dairy farming and one that can be expected to change is the number of dairy farms and consequently the distribution of land and milk quota over the farms. The number of dairy farmers who stop farming depends on factors like age, whether they have a successor, and the economic circumstances within and outside the agricultural sector. The economic circumstances outside the agricultural sector are particularly hard to predict. Here it is assumed that the yearly growth of the average dairy farm in the future, which depends on the number and the size of the dairy farms that will stop, will be the same as it was in the period 1985–1992. From Dutch Milk Marketing Board data and from the Farm Accounting Data Network it can be concluded that the milk quota of the average dairy farm increased yearly by about 4000 kg while the area of land increased by about 0.4 ha per year.

Combining changes to scenarios

In the process of developing forecasts one interdependency arose. The yearly increase in milk production per cow appeared to be higher in case total milk production is restricted. Since the two options for the market and price policy differ with respect to restricting total milk production, the high increase in milk production should be combined with the price support option while the low increase in milk production should be combined with the two-price system. However, there are two reasons to assume that the increase of total milk production under the two-price system will be small. First, the price of the extra milk that is produced is so low that increase of total milk production will certainly be restricted by the availability of fixed assets like the capacity of the stable. Second, environmental legislation will probably also restrict increase of total milk production. Therefore, it is assumed that the high increase in milk production will prevail in all situations. Given the unique forecasts for increases in fodder production, this means that there is one unique forecast for technical change.

Technical change and the change of farm size form the decor against which the institutional changes take place. There are two alternatives for both national environmental policy and market and price policy. Consequently the number of scenarios that can be constructed amounts to four (Figure 4). Four scenarios is a number that can be handled, so the number itself gives no reason for further selection. However, a check for relevance, credibility, usefulness and intelligibility is useful.

Relevance means that the factors that make up the scenarios all critically affect the subject. The subject here is the future of Dutch dairy farming. All factors were selected based on their influence on the future of Dutch dairy farming. This means that they are relevant by definition.

Credibility means that the scenarios must be acceptable for people interested in the future of Dutch dairy farming. Acceptable not meaning desirable but imaginable for people who are well aware of the situation in dairy farming. Although this means that the judgement should be made by others, it is possible to say something about the credibility of the underlying factors. There will be little discussion on the existence of technical change. The rate of technical change in the future is based on historical developments, thereby assuming that the same mechanisms will also work in the future. The future of environmental legislation in the Netherlands is becoming clearer and clearer. The system with mineral balances, will certainly going to be used in the future. By choosing two variants for uncertain factors in this system, that are both based on governmental policy proposals, the range of possibilities is covered quite well. The future of the market and price policy of the CAP is certainly the hardest factor to forecast. The two alternatives that were chosen represent continuation of the existing situation and a closer connection with the market. A closer connection with the market can go as far as leaving dairy farming completely to the open market. However, if the market and price policy is headed towards an open market after 2000, it will take a transition period. A two price policy, which includes both protection and a closer link with the market, is chosen because it could very well be used as a transition system.

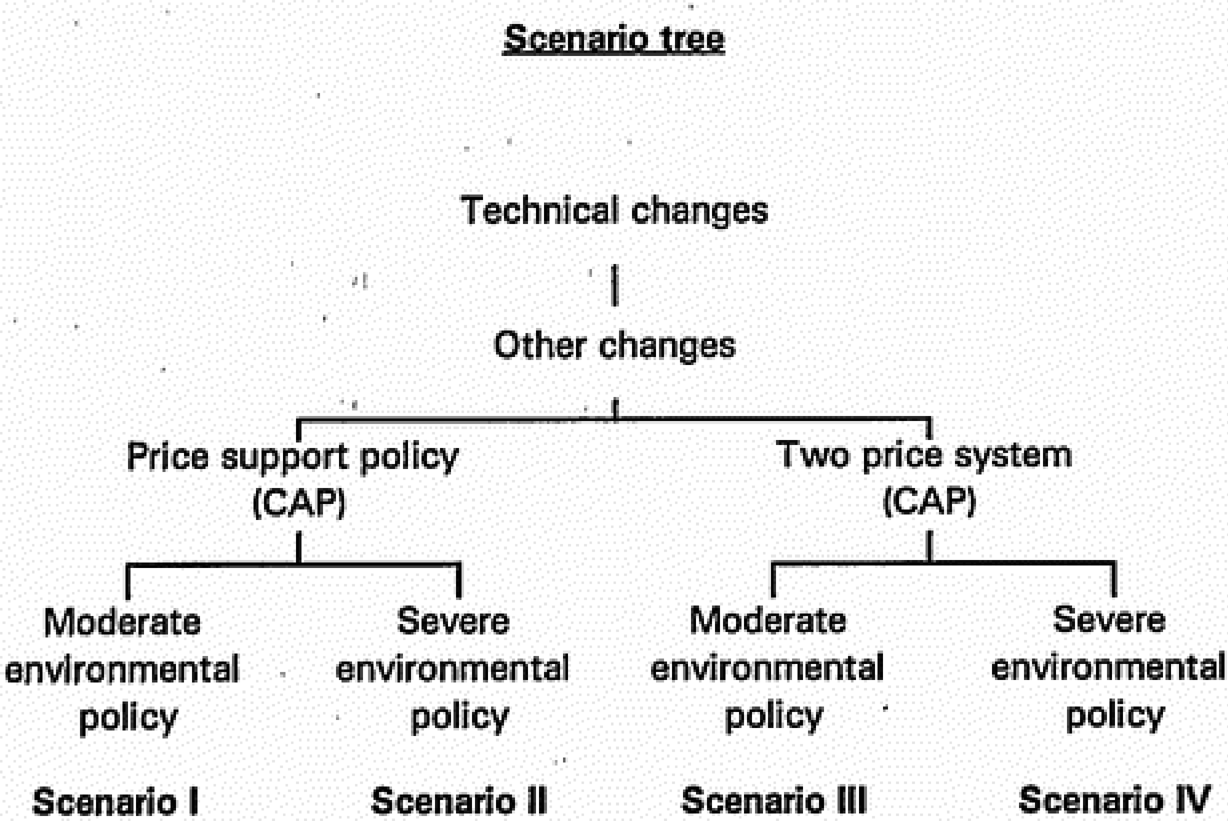

Figure 4. Construction of the different scenarios.

The usefulness of scenarios depends on the accuracy of the description of the scenarios. Moreover, if scenarios of future circumstances are to be used in modelling, they must necessarily be quantitative. As forecasts of all underlying factors are quantitative, all scenarios are quantitative and as a result they are equally useful.

The intelligibility of scenarios depends on the complexity of the scenarios. The complexity follows from the numbers of factors that make up the scenarios and from the interdependencies between the forecasts of individual factors. The numbers of factors underlying the scenarios are equal for all scenarios and moreover, they are relatively low. Together with the absence of interdependencies between individual forecasts, this makes the scenarios easy to understand.

Discussion

The data that were used to determine technical change all relate to dairy farming in the Netherlands in general. This means that the forecasts generated from these data are average forecasts. It is conceivable that factors like soil type with regard to fodder production and cattle breed with regard to milk production have an influence on yearly increase that differs from average. This should be borne in mind when individual forecasts or the scenarios are used for a specific situation.

Technical change can be underestimated by the scenarios if unforeseen innovations become important before 2005. However, there are not many examples of such innovations in the past. Most major innovations take a long time before they are ready to be used in practice and to be adopted by a substantial number of farmers.

In the section on the market and price policy of the CAP, price changes are given that will follow from the agreement of the MacSharry proposals. These price changes necessarily refer to 1992, the year of the agreement. General price developments for important inputs and outputs are not given. Data on nominal prices of milk, beef and concentrates since the introduction of the quota system show no clear trend in terms of increasing or decreasing prices. The only clear conclusion that can be drawn is that prices fluctuate.

In general, the scenarios but also the forecasts for individual factors can form a basis for exploring the future of dairy farming in the Netherlands both from a policy and a farm management point of view. In subsequent research, the scenarios will be used as input for a dairy farm model (Berentsen and Giesen, 1995) to asses the consequences for representative dairy farms on sandy soils.

Acknowledgements

The authors would like to thank H.G. Van der Meer (AB-DLO) and A.J. Oskam (WAU) for their valuable comments on the section on grass production and the section on market and price policy of the CAP respectively. The responsibility for the text, however, remains totally with the authors.

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