Agricultural policy options distinguishing a subsistence sub-sector in Bulgaria

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Abstract

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Non-Technical summary

Not available

1. Introduction

The process of transition has attracted the attention of policy makers, experts and the general public both in the EU and the CEEC countries. Despite the political desire to expand EU membership eastward, the harmonization of economic activity and policy between the would-be members and the EU countries is considered to be a difficult problem. Agriculture is one of the most controversial sectors.

The further expansion of the EU would be a mixed blessing both for the EU and the CEEC countries. From the EU perspective, the fiscal problems of incorporating the CEECs fully into the CAP in its current form, even with the 1992 reforms, are so enormous as to be virtually unthinkable. The distortion of trade has the potential to pose a major problem for those CEECs that wish to become EU members; EU markets remain highly distorted by the CAP and new members are unlikely to receive full EU price or income support. Highly-priced imports from within the EU will displace lower-cost imports from other CEECs and the rest of the world, and could even create a social problem.

Measuring the effects of the accession is a task of primary importance for the EU and the CEECs. One powerful approach is sector modelling that provides analyses of the behaviour of the sector. The development of appropriate sector models requires a thorough knowledge and understanding of the problems or uses envisaged for the model and the factors (e.g. technical, biological, government and economic forces) that can provide policy-makers with a clearer vision of the economic environment in which they operate.

Successful sector modelling involves the consideration of a country's specifities. In evaluating the response of Bulgarian agriculture to different scenarios applied in the accession process researchers and policy-makers have to take into consideration the existing structure of the sector in Bulgaria.

Bulgarian transition has been marked by a number of shocks, creating major macroeconomic instability. The delay in land reform, combined with the agricultural policies implemented that squeezed agriculture between high input and low output prices, and the underdeveloped land market, impeded the formation of market-oriented production structures. The process of radical land reform, which is still continuing, created a great number of new landowners. This combined with income and employment problems formed a fragmented system of agricultural production, dominated by small-scale farms. The result of these developments is the presence of widespread small-scale subsistence farming.

This small-scale farming is carried out alongside large productive units, i.e. co-operatives, private farming companies cultivating rented land, and informal associations and partnerships. As a result Bulgarian agriculture is currently

characterised by a dualistic structure comprising the market-oriented sector of commercial farms on one hand and small-scale subsistence farming on the other.

Subsistence farming is a phenomenon that cannot be attributed just to agricultural development but to the overall economic development of a particular country. Therefore any attempt to provide insights into the problem has to take its complex nature into account. The nature of subsistence farming cannot be understood unless the links of agriculture with the other branches of the economy are studied. However, the latter requires significant efforts and a rather detailed data set, which unfortunately is difficult to obtain in most countries, and particularly in Bulgaria.

Subsistence farmers are prone to maximize utility functions that reflect both economic and non-economic factors and are subject to both economic and non-economic constraints. Subsistence farming uses resources which otherwise could be used elsewhere in market-oriented farming and other sectors and may induce a loss of production efficiency. The small-scale farmers are not susceptible to react to the policies implemented in a "rational way". When they dominate production of some products, predictions based on “normal” economic models tend to be unreliable.

The reactions of the small farm sector to market signals are probably weak and a market-oriented agricultural policy may not have a substantial influence on it. This is one of the reasons for some of the perverse and surprising results which some agricultural policies have produced in Bulgaria during recent years.

Hence, the prevalence of subsistence farming is a major problem in obtaining a predictable and more stable agricultural situation and in perceiving the aggregate effects of the different agricultural policies. This uncertainty about the future developments of the subsistence-farming sector creates problems for Bulgarian agricultural development, and also impedes efforts towards EU accession. Thus the explanation for, and analysis of, this phenomenon is vitally important for policy-making strategies, which will lead to adjustments to the agricultural and rural economy and a successful accession to the EU.

The widespread impression that expansion of subsistence farming is only associated with the general fall in household incomes and employment opportunities outside agriculture and the belief that the problem will disappear when the overall income and employment situation improves, should be questioned and, if possible, tested empirically. A crucial factor, confirmed by statistical data for the pre-transition period, is that subsistence farming has traditionally occupied a strong position in the production and consumption of some main agricultural products (pork, vegetables, potatoes). Some none-price policies such as land reform and the promotion of market information and infrastructure should also have substantial impact on the future developments and transformations within agriculture, including subsistence in the small farm sector.

Identification of the paths of development that subsistence farming in Bulgaria is likely to follow is important not only in view of the effects on aggregate agricultural output, but also for the capability of Bulgarian agriculture to meet the requirements for full membership of the EU. Subsistence farming of a considerable magnitude is modifying and shaping the effects of agricultural policy and it is important to understand how subsistence farming itself and the wider rural economy will be affected by the introduction of CAP-like policies and the other instruments for rural development in the EU. The possible losses of efficiency associated with subsistence farming on the one hand and the alleviation of income and employment problems on the other can only be measured and compared if a comprehensive explanatory framework is constructed for subsistence farming. Therefore an in-depth analysis of the factors influencing the small farm sector and sustaining its existence in Bulgaria is required.

Problems concerning the dualistic structure of Bulgarian agriculture have not been recognized and discussed in the Bulgarian post-reform literature until recently. Mishev (1997) suggests that subsistence farming will require policy measures, other than those applicable for commercial farming. His work concentrates on the financial security of agriculture and he concludes that the subsistence sector is to be regarded as an income-supporting type of activity, lacking sufficient resources for financing even the cash-flows and therefore not susceptible to further growth.
The AECD (Agency for Economic Coordination and Development, Sofia) 1997 annual report investigates the above-mentioned problem mainly on the basis of household budget data. Subsistence is explained by the fall in real incomes, but neither the methodology nor the indicators with which these conclusions were reached are presented.

Another approach can be found in Todorov (1998) who assesses the non-marketed sector using the social accounting matrices approach; this is an alternative approach for obtaining an overview of the problem. However, this type of assessment of subsistence is lacking in confidence. The macro view on agriculture incorporates some additional elements into the subsistence sector, such as the effects of the black economy, and therefore overestimates its importance. As a result the information obtained by this method may be used only for illustration, but not for analysis.
Subsistence farming, not surprisingly, seems to flourish when markets are incomplete and imperfect and market transactions are only weakly supported by legal conventions. Some preliminary quantitative results relating to the influence of the subsistence sector on the whole of agriculture are implicitly included in Mishev et al. (1996). They estimate two sets of elasticities based on produced and marketed quantities respectively. The significant variation between these two types of elasticities demonstrates the effects which are brought about by subsistence agriculture. However, no attempt has been made so far to obtain a quantitative estimation of the factors underlying these results

In the light of the future accession of Bulgaria to the EU, the latter invokes a number of questions. How will this small-scale agriculture be affected by the accession

process and how may it modify the impacts of this process? Could it minimize the positive effects of accession on agricultural production, or even hinder it?

2. Model description

The model used is based on Liapis (1998) single country version of the ESIM (European Simulation Model), with some amendments.

This is a multi-product, small-country partial equilibrium model. The amendments were made to the model in order to create a possibility for the simulation of developments in subsistence farming and measurement of the potential impact of subsistence farming on agricultural developments within the framework of the initial model.

The model is constructed on the basis of the assumption that agricultural policies result in a change in the prices of agricultural products. Therefore domestic prices are the tool-kit that transforms the policies adopted into corresponding production and consumption responses. As well as the set of prices there are production and consumption series, and additional variables that express the way that prices influence response components.

2.1. Structure of the model

The basic products included in the model are wheat, barley, maize, sunflowers, potatoes, wine grapes, milk, beef and veal, pork, poultry, and eggs. In order to simulate the specific dualistic structure of Bulgarian agriculture during transition the products for which there is a considerable share of subsistence production are split into two components - commercial and subsistence - and these components are presented in the model as separate products. The effect of subsistence farming is considered for the following products: maize, potatoes, wine grapes, beef and veal, pork, poultry and eggs. The allocation of the total production between commercial and subsistence products is on the basis of data for output marketed for each product. Subsequently, in terms of the current model "subsistence" has to be considered as non-marketed production, left for self-consumption. The distinction between subsistence and commercial products is made upon this basis, i.e. whether the product is marketed, and therefore does not cover any specific production units. The products with a relatively negligible small share (less than 10%) of the non-marketed production in the total quantity produced are not considered separately as subsistence products. For this reason the number of commercial products is larger than that of those considered to be subsistence products.

On this basis the products included in the model can be aggregated in the following groups:

- commercial crop products - wheat, barley, maize and potatoes

- subsistence crop products - maize and potatoes
- industrial crops - sunflowers
- commercial livestock products - milk, beef and veal, pork, poultry and eggs
- subsistence livestock products - milk, beef and veal, pork, poultry and eggs
-

The main variables used in the model are presented in Table 8.1.

Table 8.1 Main variables used in the model

Endogenous variables	Exogenous variables
area for each crop	General
production	GDP and GDP growth
yields (crops)	incomes and income change,
rates of feed use	population and population change
(livestock	total area (crops)
food demand	domestic prices
feed demand	tariff
(crops)	elasticities and other response
exports and	coefficients
imports	crush rates and rates for industrial
	use and/or stocks
	consumer preferences and other
	shifters
	small producers' share
	shifters, transforming subsistence
	to commercial prod.
	Policy parameters
	production quotas
	set aside rate
	compensation payments

Although the model is a partial equilibrium model, some macro-economic variables are included as exogenous variables and their impact on the agricultural sector is taken into account. Such exogenous variables used in the model are GDP growth, the rate of income growth, changes in population, changes in the real exchange rate, and inflation. They are used in the analysis of the agricultural developments under different scenarios. Income growth is specified as a separate variable due to the structural imbalance in the GDP structure in the base year, resulting from the dramatic transition process undergone and particularly from the macro-economic shocks which occurred at the end of 1996 and beginning of 1997. It is assumed that GDP will re-establish its previous structure, which implies a greater income growth in the first years of the period under simulation. The preliminary data for 1998 confirm this suggestion.

Other exogenous variables are the various shifters, included in the model. They can be used to model various technical shifts, transitional breaks or consumer preference changes. Their mechanism is similar to those of the elasticities. These shifters are used in order to achieve a more correct simulation of the pre-accession development. Other exogenous variables used in the model are those characterising the CAP. They may be used not only where accession is concerned, but also to simulate the impact of different elements of CAP-like policy on Bulgarian agriculture. There are switches determining whether and, if so, which CAP-like instruments are to be implemented for a given product. Subsequently the effect of the policies on production is measured on one side by the price impacts, and on the other by the other non-price measures (quotas, set-aside). These policy parameters are used to simulate the application of such policies to Bulgarian agriculture. The small producer's share is a parameter that can be included in this group inasmuch as it influences the mechanism of applying quotas and set-aside.

Since the model is designed to analyse the impact of the policy changes on supply and demand in a small country case, the prices in it also constitute exogenous variables. They play an important role in assessing the impact of different policy scenarios. The parameter "tariff" is included to transform world prices into domestic ones in an appropriate way, according to the policies adopted. It expresses the relative difference between the world and domestic price in the absence of any government interventions or liberal foreign trade regime and should not be understood according to its literal meaning. This relative difference is a result of the price transmission mechanism between the world and domestic market and is added or subtracted from the world price, according to whether the product is importable or exportable.

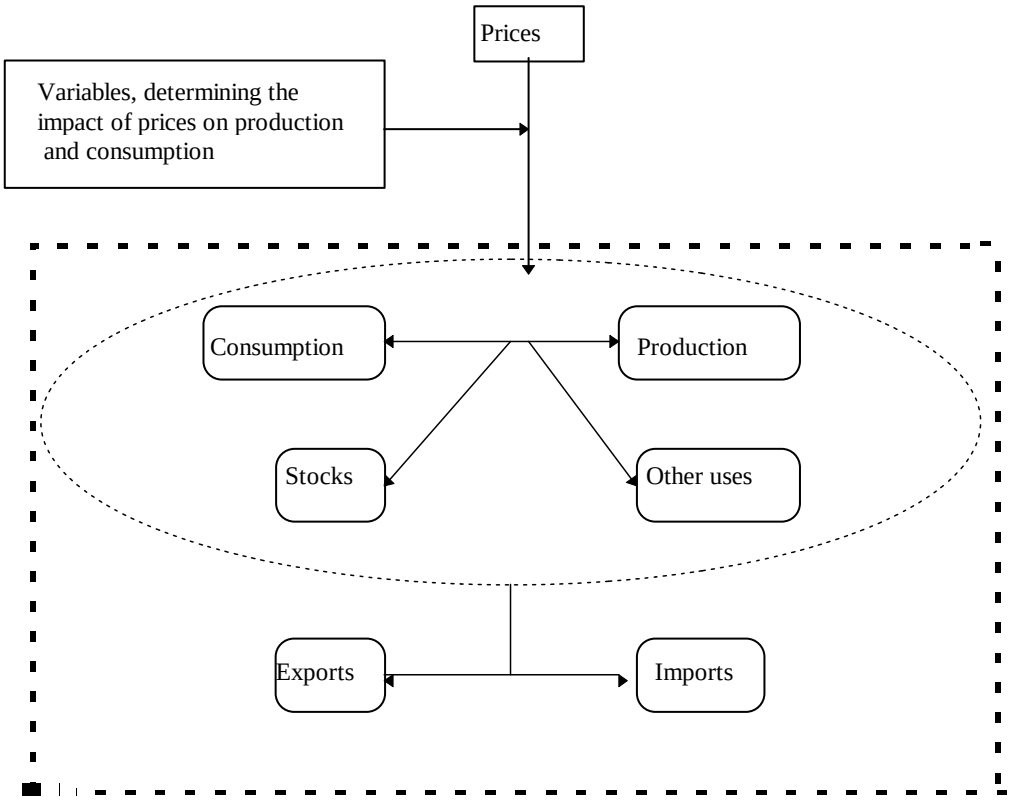
Notionally, the variables that transfer the impact of prices on production and consumption can be split into two groups.

The first group consists of variables such as elasticities matrices and/or the response coefficients involved. Crop products are included through an area/price cross elasticity matrix and yield elasticities, and the total effect of price movements on production accrues from the combined effects of area and yield responses is equal to the total effect of price movements on production. Livestock production is modelled with the use of production elasticities. In addition the cross-elasticity matrix for fodder crops is used in calculating the feed ratios. For all agricultural products, consumption is estimated via income-demand response elasticities. The elasticities are exogenous and constant for the period of analysis.

The second group of variables consists of feed ratios; these are endogenous variables, which are used for linking the crop and livestock sectors. Feed ratios weight the influence of crop price changes on livestock production and unlike the elasticities, they are not constant. The variation in feed ratios is determined via cross elasticities for fodder crops.

The organisation of the model is represented schematically in Figure 8.1.

Figure 8.1 Model structure



The main assumptions used for the construction of the model are the following:

1. Exogeneity of prices: world prices cannot be influenced by domestic policies, due to the fact that Bulgaria is a small country; the effects of agricultural policies are transformed into domestic prices, which are the result of these policies and are exogenous to the model.

2. Partial equilibrium: markets are at equilibrium in the base and the following periods; other commodity markets outside the agricultural sector are also at equilibrium, and changes in these markets having no direct influence on agricultural markets. The latter effects are brought about by the macroeconomic variables. Therefore, the developments of the other sectors of the economy are implicitly included.

3. Market behaviour is determined only by the real, not nominal, changes in the values of the variables concerned.

4. Every individual product market is cleared through the foreign trade.

5. The total crop area is constant and price movements and other variables affect only the distribution of this area between the different crops

6. Price and income elasticities of supply and demand are constant.

7. The transformation of subsistence into commercial farming depends on the average per capita income, which is supposed to be an indicator for job opportunities and the overall economic development.

8. Technological progress is a spill-over from overall economic development, and is therefore dependent upon GDP growth.

9. Liberal exports and imports: if no specific agricultural policies are assumed, the price of each product equals the world price, corrected with the relative discrepancy assumed as due to the price transmission.

2.2. Treatment of subsistence farming in the model

Insofar as the problem of the specific dualistic structure of Bulgaria agriculture is crucial to the present analysis, the place of subsistence farming within it is of major importance and thus requires more detailed explanation. The initial model has been revised and amended in order to allow analysis and measurement of the potential impact of subsistence farming on overall agriculture. As mentioned, the products are split into two components - subsistence and marketable - and consequently these two components are included separately in the model, each of them retaining the characteristics of the original products. They use separate balances, as the balance-sheet for the subsistence component is built on the basis of the following suppositions: that stock at the beginning is equal to zero and no changes in it are assumed, and that there is no export and import, i.e. subsistence production is equal to consumption. The rationale is the fact that, as pointed out above, the model treats the non-marketed part of the total production of a certain commodity as subsistence. Therefore imports and exports are not possible in the case of the subsistence component and logically the "production" defined as self-consumption has to equal consumption, regardless of the very moment at which this consumption takes place. The consumption part of the subsistence component cannot be related to some demand function in the same way as the corresponding part of a commercial component of the same product.

In addition, subsistence production is assumed to be rather price-inelastic compared to market production, thus different elasticities matrices are constructed for market and subsistence products. The sets of elasticities are estimated from panel data, and consequently the estimated values are improved and adjusted using expert estimation. Insofar as the subsistence part cannot be defined either as a pure '"production", or as a pure "consumption", but has to be regarded as a mixture of the above, the elasticities' sets are different from those of the commercial part of the

model. For some products which are more "subsistence" inasmuch as their production is predominantly influenced by the purpose of consumption, corresponding elasticities are substantially lower than those of the commercial products, while for the other products, where the main reasons for the existence of this subsistence sub-sector are the unfavourable macroeconomic and market conditions, the behaviour of subsistence components is similar to those of their market counterparts; this includes the magnitude of the elasticities. Therefore due to the substantial gap between the magnitudes of the values of the estimated elasticities, the subsistence sub-sector itself has an intrinsically dualistic nature.

Given the logic of the representation of subsistence farming, it follows that it must constitute a comprehensive production system, similar to that of commercial farming though without direct interactions between the two. Based on the viewpoint that subsistence farming is mainly determined by restricted job opportunities and the substantial drop in incomes during transition (Kostov et al., 1995; Kostov, 1996; Mishev et al., 1998) the likely behaviour of the subsistence sector has been predicted and incorporated into the amended model. In view of the crucial importance of income, it is expected that a movement will take place from subsistence to market production along with increases in income (as well as the associated job opportunities). The latter and the link of income growth with GDP dynamics are factors which combine to produce a result in accordance with that of Pingali (1997).
This movement from subsistence to commercial agriculture is captured with the use of income-related shifters which measure the response of subsistence and marketable products to improvements of the income situation. These shifters assess the response of the subsistence sub-sector to the improvements in the economic situation and especially to increased job opportunities, associated with the average per capita income.

A crucial point in the preliminary analysis of the construction of the shifters is the question of whether, when subsistence farming begins to decline due to the increase in opportunities outside agriculture, its means of production will be transferred into the commercial sector or just simply abandoned. The latter is unlikely in the case of Bulgaria due to several reasons. Firstly, during the greater part of transition Bulgarian agriculture faced depressed domestic prices, export bans and restrictions, and had lost the traditional COMECON markets, particularly that of Russia. As a result, agricultural production was far from profitable and correspondingly a substantial part of the agricultural land (about 20% in 1997) was abandoned. After the beginning of foreign trade liberalisation, the prices of the main agricultural products rose and given the increased profitability of farming, there are clear signs of interest among commercial circles for investment in agriculture. In the light of Government measures towards full liberalisation it is to be expected that any means of production available will be employed, inasmuch as they are likely to generate profits. In the case of some products for which the transfer of areas of land could be impeded, for example, because they are to be considered for large-scale production, the land currently abandoned could be utilised to offset the impossibility of such a transfer. The latter raises the question of whether the current area of land used in the

model is not too small. Fortunately, potatoes are the only example of such a product included in the model; they are likely to be affected by the process of cultivation of the abandoned areas and in their case the transformation from subsistence to commercial may be delayed due to such considerations. Bearing in mind that potatoes are included in the model mainly because of their importance for subsistence farming, not for overall agriculture, the effects of the potential discrepancy for this single product on the results for total agriculture will be negligible.

The logic behind the construction of these shifters is based on some analysis of the transformation of subsistence into commercial agriculture (Gudeman, 1978; Pingali, 1997), and on the consideration of how to avert risk (Doss, 1996), and reflects the need for a new view of the subsistence phenomenon (Timmer, 1997; McCalla, 1997). However, the theory provides little basis for selection of the values of these shifters. They have been formulated and selected on the basis of some empirical and theoretical consideration after a number of computer simulations and some final expert estimation. The empirical considerations include the current and historical data (including unofficial sources) about the income level and the state of subsistence in Greece, which has been considered as a country with similar conditions and characteristics of agricultural production, and data concerning income levels in the more developed European countries like France and Germany. The income gap has been applied to the structure of small-scale agriculture in Bulgaria, which is considered to represent subsistence production. The possible scenarios for closing this income gap, corresponding to the disappearance of subsistence farming, have been simulated to obtain the psychological threshold of wage levels for the making of a decision between subsistence and commercial, as defined in Lancaster (1966, p. 146).

The theoretical considerations include the fact that the constan- elasticity functional form of the model is extremely restrictive, and in the case of scenarios of considerable income growth it may give a poor representation of the likely developments in the agricultural sector. In the case of agricultural production, due to its relatively low price elasticity the deviations will be smaller and can be overcome with appropriate assumptions. The demand part of the model, however, needs serious reconsideration.

In fact, the simulated transformation from subsistence into commercial works as a continuous shifter that changes the base values in the production and consumption parts of the commercial farming to which the constant elasticities are applied. The latter is equivalent to changing the elasticities, while keeping the base values unchanged; a similar process takes place in the subsistence part of the model. Consequently, regardless of the constant elasticity form, the model will produce results comparable with those of a flexible elasticity model. It is thus possible, with appropriate adjustment of the shifters that simulate the transformation of subsistence into commercial, to meet the requirement of additivity. Following the basic scheme introduced by Frisch (1959) and approximating the relative change of Frisch's

parameter (also named " the flexibility of the marginal utility to expenditure" or " the flexibility of the marginal utility to money") through a function of the income change index, as suggested by Sato (1972), the preliminary values of the shifter mentioned were re-estimated to constitute an additive demand system of flexible elasticities.

2.3. Functional description of the model

A main requirement of the model is a product balance in the base year for any product included. Different types of uses i.e. food consumption, feed use by type of animal production (if applicable) and industrial use are considered separately in the product balance. It is assumed that the system is in equilibrium in the base year and will reach equilibrium in any consecutive year.

Domestic price is exogenous in the model. Nevertheless, in the case of liberal external trade, the world-domestic price transmission cannot be expected to be one-to-one. The price transmission mechanism in this case is represented by a specific variable, named "tariff", which provides the relative difference between domestic and world prices. The general form of this mechanism can be represented as follows:

$$P = T * WP \tag{1}$$

where P is a vector of domestic prices for products included in the model, WP is a vector representing the world price by products, T is a diagonal "tariff" matrix with values on the diagonal equal to the relative discrepancy between the world and domestic prices (1±relative tariff, according to the foreign trade parity of the product).

The T matrix can alternate the way the relative tariffs are applied to its diagonal elements from year to year, according to whether the product related to this element is on net exports (then the relative tariff will be subtracted) or on net imports (the net tariff will be added).

The functional organisation of the model can be regarded as an assembly of three main parts: production, consumption and the rest of the balance sheet elements (stock, foreign trade). The production and consumption systems for commercial and subsistence products are separated, and the process of transformation of subsistence into commercial farming is simulated via direct production and indirect consumption transfers. Subsistence products do not have stocks, imports and exports. The reason for this is the definition of subsistence used in the model. Non-marketed production can be neither exported, nor imported, while the time of exact consumption and the form under which the subsistence products will be consumed cannot be determined and is beyond the scope of the present study. Thus subsistence production and consumption are equal and stocks may be disregarded.

Production.

The production system is organised in different ways for crops and livestock products. In the case of crop production separate consideration is given to the effect of prices and other variables on area allocation and yield, then these effects are combined to obtain the total production response. In the case of livestock production, this response is direct.

Crop production can be divided into commercial and subsistence. Their functional forms are similar, but these systems are relatively autonomous - inasmuch as there are no cross price effects between commercial and subsistence crop products, they do not interact directly.

Commercial crops

The area under commercial crops is a function of the relative price changes and the CAP policy measures of set-aside and compensation payments.

The price changes and macroeconomic effects can be expressed by:

$$L_t = L_{t-1} + diag(L_{t-1}) * [\varepsilon] * \Delta P) + LT \qquad (2)$$

where L_t is the vector representing the area under the crops considered in period t, in the absence of set-aside policies and compensation payments, $[\varepsilon]$ is the area-price elasticity matrix, ΔP is the vector with the indices of real prices changes for the products included, LT is the vector of land transformed from subsistence to commercial use, and the symbol $diag(.)$ denotes diagonalisation of a vector.

The base area is obtained by adding the impact of the compensation payments and the difference between the compensation payments for cereals and oilseeds to the pure price effect. It can be represented as follows:

$$BA = CP * L \qquad (3)$$

where BA is a vector of the base area for the crops, for which the set-aside policies are to be implemented (i.e. potatoes and grapes are not considered). CP is a diagonal matrix, which in the case of no set-aside is an identity matrix, and in the case of set-aside, has elements equal to 1 or $|\delta|^{-\mathrm{sgn}(\delta)e}$, where δ is the relative share of the difference in the compensation payment for the product and the compensation payment for the competitive set-aside products (oilseeds, if the analysed product is a cereal, or vice versa) in the price of the product (in per cent); and e is the elasticity of substitution for this product. The elements of the matrix are equal to 1 when δ is less than1, i.e. when the relative difference is less than 1%. These coefficients model the effect of the compensation payments on the internal distribution of land between the crops to which they are applied.

The total effect of all variables and policies on the area under different crops comprises the harvested area, which is a result of the implementation of the whole system of variables.

$$HA = [\Theta] * BAB - SA \tag{4}$$

where HA is the vector of the area under different crops, BAB is the vector of the base area allocated, SA is the vector with set-aside, $[\Theta]$ is a diagonal matrix with the shares of the products in the total base area.

Therefore, to summarise:

For the products to which the set-aside policies are likely to be applied in the case of accession (cereals, oilseeds) the harvested area is

$$HA = [\Theta] * CP * (L_{t-1} + diag(L_{t-1}) * [\varepsilon] * \Delta P) + [\Theta] * CP * LT \tag{5}$$

while for the crops for which set-aside policies are not applicable

$$HA = L_t = (L_{t-1} + diag(L_{t-1}) * [\varepsilon] * \Delta P) + LT \tag{6}$$

Yields are assumed to be dependent upon the real change in the price of the product. The latter can be viewed as an indicator of the farmers' gross margin, representing an incentive to modernise production. GDP growth is an impetus for increasing investment and introducing new technologies and is therefore included in the determination of the yields.

The general form of the yield equations can be written as follows:

$$YI_t = Yi_{t-1} + diag(YI_{t-1}) * ([\lambda] * \Delta P + [\mu] * \Delta G + TR) \tag{7}$$

where YI_t is the vector representing yields by product in period t, $[\lambda]$ is the the yield/price elasticity matrix (the model uses only own price elasticities and therefore this matrix is a diagonal one), $[\mu]$is the diagonal matrix of coefficients, representing GDP growth spill-over effects on the yields, ΔG is the real GDP growth, TR is the diagonal matrix with the yield trend (in case of no trend $TR = I$).

The total production for any product is estimated by multiplying the harvested area by yield.

Subsistence crops

The production system for subsistence crops is in principle the same as for commercial ones, but compensation payments and set-aside are not applicable to the subsistence sector. Additionally, the transformation of land from subsistence into

commercial production is included. Therefore the general equation for the area under subsistence crop is expressed as:

$$LS_t = LS_{t-1} + diag(LS_{t-1}) * [\text{ɛs}] * \Delta P + [\gamma] * diag(\Delta Y) * LS_{t-1} \quad (8)$$

where LS is the vector representing land used for subsistence production by product, $[\text{ɛs}]$ is the area/price elasticity matrix for subsistence products, $[\gamma]$ is the diagonal matrix with income shifters showing transformation of land used by products from subsistence to commercial use with income increase, ΔY is the index of the real change in income.

The area-price elasticities for subsistence production are much lower that the area-price elasticities for commercial production. The land transformed from subsistence to commercial use in the last equation is included in the equations for the land area under commercial products, that is:

$$LT = [\gamma] * diag(\Delta Y) * LS_{t-1} \quad (9)$$

The area-price elasticities for both commercial and subsistence products are homogeneous of degree zero and consequently the total area, which is the sum of the areas under the different crops, is constant.

There is no difference in the functional form of the yield equations for commercial and subsistence products, but the elasticities for subsistence production are lower than for commercial production.

Commercial livestock products

The general form of the production equations for livestock products is different from those for crops. It is organised on the basis of constant production price elasticities. For commercial livestock products, production is determined as follows:

$$Q_t = (I + \Delta FC + [\nu] * diag(\Delta G)) * Q_{t-1} + diag(Q_{t-1}) * [\text{ɜ}] * \Delta \Pi + PT \quad (10)$$

where Q_t is the production vector of the livestock products in period t, I is the identity matrix, $[\text{ɜ}]$ is the production-price elasticity matrix for commercial livestock products, $[\nu]$ is the matrix (diagonal) with the spillover effects of GDP growth on the production of livestock products, $\Delta \Pi$ is the vector with indices of real changes in prices of livestock products, ΔFC is the matrix with the relative change in feed cost for livestock products, PT is the vector with production transformed from subsistence to commercial use; other abbreviations used are as above.

Subsistence livestock products

For subsistence livestock production, the assumptions related to the policy measures are the same as for crops. Therefore the general form of the equations for subsistence livestock production is:

$$QS_t = (I + \Delta FC + [\phi] * diag(\Delta Y)) * QS_{t-1} + diag(QS_{t-1}) * [\partial s] * \Delta\Pi \quad (11)$$

where QS is the vector representing subsistence production by product, $[\partial s]$ is the production price elasticity matrix for subsistence products, $[\phi]$ is a matrix with income shifters showing transformation of production from subsistence to commercial use by product, with income increase.

As above the production transformed from subsistence into commercial use is:

$$PT = [\phi] * diag(\Delta Y) * QS_{t-1} \quad (12)$$

Feed ratios

The feed ratios provide the link between crop and livestock products in the model. They help determine the livestock production. The value of the feed cost for a given livestock commodity is a product of the prices of crop products and the feed ratios. Hence feed ratios participate as a parameter in livestock production. On the other hand, they define the feed use of the crops, given the livestock production. Due to their important role in the model, they are allowed to be flexible and change according to the relative prices of the feed crops. The feed ratios for a given livestock product in a period t can be expressed as:

$$FR_{i,t} = (I + TR) * FR_{i,t-1} + diag(FR_{i,t-1}) * [x_i] * \Delta P \quad (13)$$

where $FR_{i,t}$ is the vector of the feed ratios for livestock product i in period t, $[x_i]$ is the matrix of coefficients of substitution between the feed crops with regard to livestock product i. There are separate matrices of coefficients of substitution with regard to every livestock product.

Consumption

The general equations for consumption have two forms depending on the type of the product, commercial or subsistence. Consumption where commercial products are concerned is a sum of the different types of consumption: food, feed, and industrial. For some products, not all types of consumption are included (i.e. in the case of livestock products feed consumption is not included).

Food consumption for commercial products incorporates both direct and indirect consumption. For example, food consumption for wheat includes consumption in the form of bread, flour, pasta etc. The model does not distinguish between the different

food uses of a given product. Food consumption can be presented in the following way:

$$C_t = (I + [\eta]) * \Delta Y + [\psi] * diag(\Delta POP) + \xi] * \Delta PR) * C_{t-1} \quad (14)$$

where C_t is the vector of food consumption in period t, $\Delta PR = \begin{bmatrix} \Delta P & 0 \\ 0 & \Delta \Pi \end{bmatrix}$, $[\xi]$ is the matrix of food consumption-price elasticity, $[\eta]$ is the diagonal matrix with income elasticities, $[\psi]$ is the diagonal matrix with the relative shares of the commercial products in the total, ΔPOP is the index of population change.

In the case of commercial crop products, feed consumption is estimated by adding feed used in the production of livestock products.

$$FU = FR * Q \quad (15)$$

where FU is the vector of the feed use of the feed crops, FR is the feed ratios matrix, Q is the production vector of livestock products.

Industrial use is usually maintained as a share of the total consumption, determined from historical data. For some other crops it is dependent on production, via technical ratios (such as the crush rates for oilseeds). On the other hand, in the case of the oilseeds the model distinguishes industrial production. The latter has the same characteristics as the non-industrial part of the product, but set-aside does not affect it. This is achieved by setting industrial use to be equal to:

$$IN = (C + FU) * k/(1-k) + CR * (R - RI) + RI \quad (16)$$

where IN is the vector of industrial consumption, k is the predetermined share of industrial use in total consumption, CR is the matrix of production linked technical ratios, R is the vector of production of both commercial crops and livestock products, RI is the vector of the production, designed for industrial use.
The equations for the consumption of subsistence products, according to the definition of subsistence in the model are:

$$CS = RS \quad (17)$$

where CS is the consumption vector of subsistence products, RS is the vector of subsistence production.

One can note that here, unlike in the case of production, where the land area (or the production) is directly transformed from subsistence to commercial use, the transformation of subsistence consumption into commercial is more subtle. Since subsistence consumption is not divided into different components, it is not clear how

the transformation can take place. Furthermore, the conditions and motivations in the subsistence and commercial sectors are very different, particularly in relation to consumption. Therefore the best way to model the transformation under question is to expose the production transformed from subsistence to commercial to market conditions.

In the case of food consumption, what is in fact "transferred" is a given number of "population" for each product, according to the dynamics of subsistence farming. The transition from subsistence to commercial drives population out of the subsistence sector into the market. This process is multi-faceted and the model builds separate markets for every product, with different "populations" in each market. Therefore the transformed food consumption is equal to:

$$CT = [\psi_t] * diag(\Delta POP_t) * C_{t-1} - [\psi_{t-1}] * diag(\Delta POP_{t-1}) * C_{t-2} \quad (18)$$

and is implicitly included in the model.

Feed use and industrial consumption are influenced by the transformation of production, intrinsically comprising both transformed and non-transformed consumption and thus closing the transformation cycle.

Stocks, imports and exports

Stocks are determined externally. They can be determined as a share of the total production, to be set to zero, or included as specific values in order to model, for example, the preparation for the implementation of intervention measures. Since initial stocks are equal to the final stocks from the previous year there is only a need to adjust the final stock.

Exports and imports are used to clear the market. The net trade (the sum of production + initial stocks –consumption - final stocks) results in exports, if positive, and otherwise in imports. Technically this is achieved by establishing that:

$$E = MAX(0, NT);$$
$$I = MAX(0, -NT), \quad (19)$$

where E and I are exports and imports respectively and NT is net trade.

Normally GDP is used as an approximation of the income level in a country, but in the case of Bulgaria it could not be assumed that GDP growth is equal to income growth. For the period 1994-7, the annual average GDP growth was –3 %, with an average income growth of –5 %. As a result of this, the share of labour in GDP during the period declined from 45 % in 1994 to 32 % in 1997. The 1998 data show some increase in the share of labour in GDP, as well as a GDP increase (3.5 %). The increase in income in 1998 was nearly 38%. Thus we cannot expect that in the future

the share of income in GDP will remain constant and the growth rate in GDP and income be equal. Another argument in support of this concerns structural change, particularly the increase in the share of the private sector which will impact on the share of labour (salaries in the private sector are higher than average for the economy). For this reason, the income growth rate is used separately from GDP growth in the model, as the assumptions about income growth are made on the basis of GDP growth projections and the change in the labour contribution to GDP.

2.4. Technical notes on the adjustment of the shifter from subsistence to commercial farming

Although the elasticities in the model are constant, due to the transformation from subsistence to commercial farming the results obtained are as those from a model with variable elasticities. Hence an attempt can be made to adjust the model in such a way that the final results are similar to those accruing from a flexible elasticity demand system. The supply system is not a problem because of the low elasticity of agricultural production which, in contrast to more flexible functional forms, does not allow the projections to differ substantially in the short and medium term.

The key problem in adjusting the model is the modification of its demand part. The transformation of the existing constant elasticity demand system into a flexible one, however, comes at a price. In order to calculate the flexible elasticities, additional assumptions are needed, and the most appropriate from the computational point of view is to assume additive demand utility function.

The theoretical background of this adjustment is based on the suggestions of Frisch (1959), as well as those of Greedy and Dixon (1995), Lluch et al. (1977), and Tolley and Giessman (1963).

For any additive demand utility function the following holds true:

$$e_{ij} = -E_i\left(a_i - \frac{1 - a_i E_i}{w}\right) \tag{20}$$

$$\mathrm{e_{ik}} = -\mathrm{E_i a_k}\left(1 + \frac{\mathrm{E_k}}{\mathrm{w}}\right) \tag{21}$$

where e_{ij} is the price demand elasticity for the products i with regard to product j, E_i is the income elasticity, a_i is the share of the product in the total expenditure, w is the flexibility of the marginal utility.

Imposing the restriction of homogeneity of degree zero

$$\sum_{\mathrm{i \neq k}} \mathrm{a_{ik}} + \mathrm{a_i} = -\mathrm{E_i} \tag{22}$$

and differentiating the above equations with respect to w, we arrive at:

$$\frac{\partial e_{ii}}{\partial w} = -E_i\left(\frac{1 - a_i E_i}{w^2}\right) \tag{23}$$

$$\frac{\partial e_{ik}}{\partial w} = \frac{a_k E_i E_k}{w^2} \tag{24}$$

Similarly

$$\frac{\partial e_{ii}}{\partial E_i} = -a_i + \frac{1 - 2a_i E_i}{w} \tag{25}$$

$$\frac{\partial e_{ik}}{\partial E_i} = -a_k \tag{26}$$

$$\frac{\partial e_{ik}}{\partial E_k} = \frac{-a_k E_i}{w} \tag{27}$$

The objective is to obtain total consumption estimated by a model with variable elasticities, based on directly additive utility function. For this purpose, the model is divided into two separate models: model A in which the data are pooled altogether for commercial and subsistence components and model M, which comprises both commercial and subsistence products. The variable elasticities are to be applied to model A, and the shifters from subsistence to commercial in model M have to be adjusted in order for the two models to achieve comparable results for total consumption. The objective is:

$$ICA + FUA + CA = ICM + FUM + CM + SC \tag{28}$$

where ICA and ICM are the industrial consumption estimated by model A and the commercial part of model M respectively, FUA and FUM are the feed consumption values, according to the two models, CA and CM are food consumption, SC is subsistence consumption (from model M).

Evidently, all variables at the right hand side of the above equation are dependent upon the values of the shifters from subsistence to commercial. By contrast, CA is to be estimated using variable elasticities.

Technically the adjustment of the shifter values takes place according to the following steps (due to the computational burden models M and A use only the basis year and one projection year for this adjustment):

1. From (20), initial elasticities and the data for the consumption shares of the products from the commercial part of the model M , w_0 are calculated.

2. We then estimate w_1 (the exact way in which this is done is explained below).

3. Using (23) and (24) the price elasticities (in model A, using the consumption shares from model M) are updated.

4. On the basis of (22) the values of the income are corrected.

5. Using (25), (26) and (27) the price elasticities are corrected with respect to the income elasticities. (20) and (21) cannot be used for this purpose, because the elasticity values, estimated in the previous steps, are conditional.

6. Steps 4 and 5 are repeated until convergence.

7. Based on (9) an optimisation procedure is launched with respect to the shifter (restricting the shifter values to around those obtained using expert estimates (±25% is a working restriction).

8. Using the new shifter value, model M is recalculated.

9. The values are updated for price elasticities in model A, based on the new consumption shares in model M and equations (1) and (2).

10. Steps 8 and 9 are repeated until the discrepancy between models A and M is reduced to some predetermined threshold level (3% in the case of this application).

The above procedure has been applied for 3 %, 5 % and 8 % income increases and world and EU prices in the reference year. The results for the shifters have been averaged.

There is a problem only in calculating w_1 in step 2. Sato (1972) has showed that under certain conditions, which hold in the current model, the change in w is a function of the real income changes. If the relative price changes and their influence are discarded this relationship can be approximated as:

$$\ln\left(\frac{w_1}{w_0}\right) = -\left(\sum a_{i0}(E_{i0}-1)^2\right)\ln\left(\frac{I_1}{I_0}\right) \qquad (29)$$

where I is the income, 0 stands for the base year values and 1 for the reference year. In general, the influence of the relative price changes, which is neglected in the above, reduces the impact of the income changes. The latter could lead to overestimated values for w_1. This can be partially offset by the use of the different income growth scenarios to estimate the values of w_1 and, correspondingly, the

shifters. Insofar as the value of the expression in the brackets on the right hand side will decline with income increase, it suggests that there is a decrease in the elasticity of w_1/w_0 with respect to I1/I0 and that the shifter values are likely to be variable at different income levels. Therefore the approach presented is able to provide reliable estimates for the shifter only in the short and medium term.

3. Scenarios and Main Assumptions

The analysis considers two basic scenarios: full liberalization, and application of future CAP policy with 3 sets of macroeconomic indicators imposed for each of them. The basic characteristics of the scenarios considered are summarised in Table 8.2.

The three sub-scenarios imposed for each basic scenario only differ in respect of the values of the exogenously imposed income growth, which is defined as follows:

- pessimistic scenario: 22% (as reported for 1998), 10%, 5%, 3%, 3% … 3%;
- realistic scenario: 22% (as reported for 1998), 10%, 5%, 5%, … 5%;
- optimistic scenario: 22% (as reported for 1998), 10%, 8%, 8%,… 8%.

Technical progress in all scenarios is incorporated via yields and is assumed to depend on overall economic growth.

The full liberalisation scenarios assume that no policy is applied and that there is a perfect price transmission between world and domestic prices from the first simulation year (1998) onwards. It is assumed that the tariffs remain at the level of the base period.

In the CAP under AGENDA scenarios Bulgaria is assumed to be integrated into the CAP and the single market for agricultural products by 2005. By then, a gradual increase in domestic prices to the level of the Agenda prices is assumed, as in 1998 full liberalisation was imposed in Bulgaria due to the full liberalisation of policy introduced in this year. By 2005 a complete alignment of CAP policy is assumed to have taken place. In the grain sector EU policies are assumed to remain as in recent

Table 8.2 Main Scenario assumptions

	full liberalisation			CAP under the AGENDA		
	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
macroeconomic technical progress	pessimistic overall depending on	realistic overall dependin g on	optimistic overall depending on	pessimistic overall depending on economic	realistic overall depending on economic	optimistic overall depending on

total area	constant	constant	constant	constant	constant	constant
Policies	no policies applied, perfect price transmission	no policies applied, perfect price transmission	no policies applied, perfect price transmission	gradual increase in prices in transition period and full implementation of the CAP from 2005	gradual increase in prices in transition period and full implementation of the CAP since 2005	gradual increase in prices in transition period and full implementation of the CAP since 2005
Set-aside	no	no	no	10% for grains	10% for grains	10% for grains
production quotas	no	no	no	no	no	no
compensation payments	no	no	no	compensation payments for area as in the agenda	compensation payments for area as in the agenda	compensation payments for area as in the agenda
price and trade policies	no	no	no	CAP prices administrative prices decreased by: cereals - 20% beef - 30% dairy products - 15%*	CAP prices administrative prices decreased by: cereals - 20% beef - 30% dairy products - 15%*	CAP prices administrative prices decreased by: cereals - 20% beef - 30% dairy products - 15%*

* The reduction in the price of dairy products imposed directly on milk

years i.e. 10% set aside for grains, compensation payments for grains as defined in the agenda and export subsidies for maintaining the higher domestic prices, although it is not clear how the EU will behave in this regard after AGENDA. The production quota for milk is not actually imposed (although according to the AGENDA it will remain in place at least until 2006); the same applies to the headage payments for dairy cows and beef cattle.

Bearing in mind the tendency towards reform of the CAP the two types of price scenario contain the band of possible prices that will be implemented in Bulgaria. On the other hand, higher income scenarios are not unfeasible, in view of the current low income and stable financial situation in the country. The increase in GDP and in

incomes is not always in parallel, at least in the short and medium term. A higher increase in incomes in comparison to the increase of GDP is expected as a result of a reduced burden on the budget of loss-making State enterprises which have been privatised or liquidated; both a rapid flourish of small and medium enterprises and an increase in income transfer from expatriate Bulgarians to their relatives in the country are expected.

Since the prices play a substantial role in the model, the real price changes in the two basic scenarios are shown in Figs 8.2 and 8.3. As seen from the graphs, after the strong initial drop in prices of milk and grains and substantial increase in prices of beef and veal, sunflowers and potatoes, a declining trend in all prices is assumed under the full liberalization scenarios. Under the Agenda 2000 scenarios, after the initial adjustments in prices of all products until the year of accession, prices remain stable.

Figure 8.2 Price changes in liberalisation scenarios

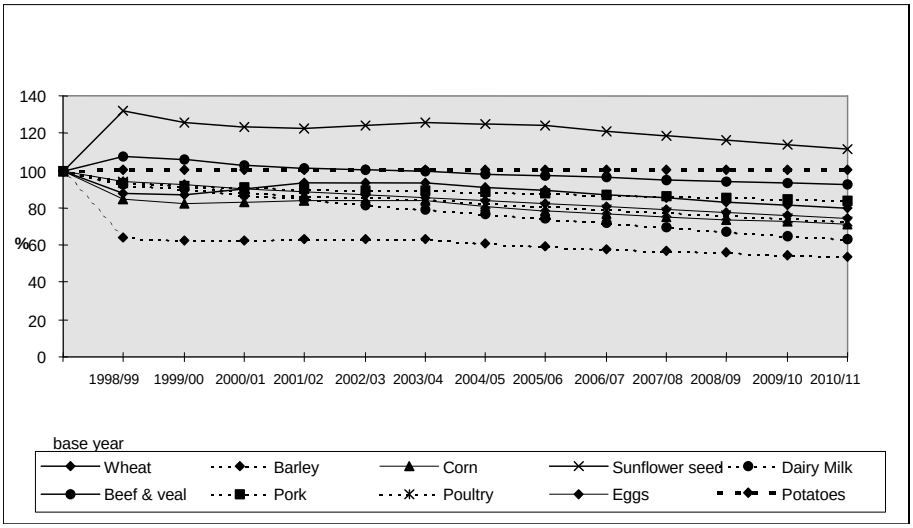
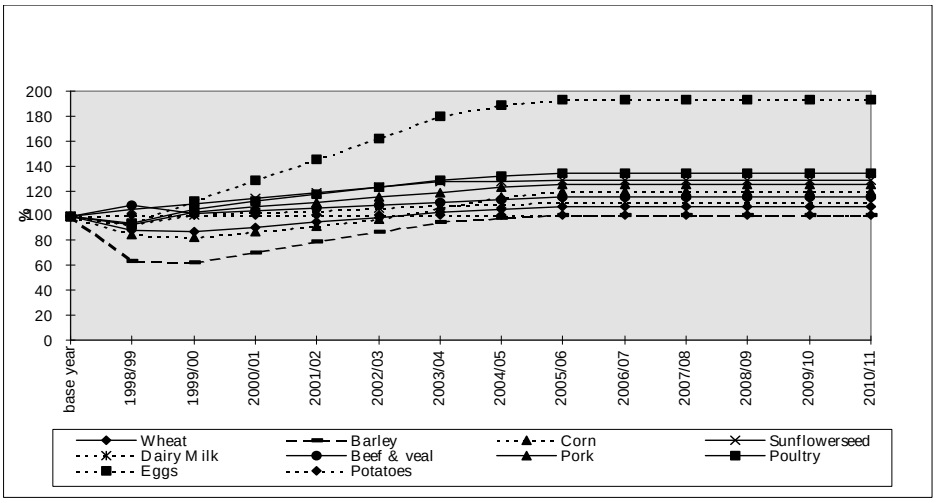


Figure 8.3 Price changes under Agenda 2000 scenarios



4. Results

The results obtained from the model described above (to be designated model M) for total production and consumption by product, are shown in Annex Figures 1 to 18. For comparison, the model described but with zero subsistence production, i.e. with total production considered as commercial (designated model A), was run under the same scenarios and the results are also shown in Annex Figures 1 to 18. The scenarios presented may be considered as frontiers for the future development of Bulgarian agriculture. Projections for the development of subsistence production under the different scenarios, by product, are shown in Annex Figures 19 to 24.

The six scenarios applied have differing impacts on the main outcome of agricultural policy, i.e. on production; export/import and consumption. As one can expect there are clear differences in the results of the two models (A and M) under the scenarios simulating world prices and EU prices. Similarly the different income scenarios have led to considerable differences in the projections of the two models.

4.1. Full liberalisation (world prices) scenarios

The production of most of the products (wheat, maize, sunflowers, pork, poultry, eggs and potatoes) increases in the period 1997. Only a few products exhibit a decrease (barley and milk) or maintain (beef) the same level of production during the period. The increase in production is not very significant, especially if the final results are compared not with the base year 1997/98 but with the second year, 1998/99. Production in 2011 increases in comparison with that in 1999 by 9 % in the case of wheat, 2 % in the case of maize, 6% in the case of sunflowers, 15% in the case of pork, and 8 % in that of poultry. One possible explanation for the above result is that the initial positive reaction of production to change in prices to the

world price levels cannot overcome the influence of the more important structural constraints on output growth.

The income increase /GDP increase has a strong influence on agricultural production. The more optimistic income scenarios result in a substantial increase in agricultural production even with the same price level; furthermore, the production increase is steadier over the whole period. In scenario 3 wheat production in 2011 increases in comparison with that in 1999 by 18%, maize by 9%, sunflowers by 15%, pork by 21%, and poultry by 14%. In the case of products for which a negative production development (barley, beef, milk) is observed in scenario 1, either an increase (barley) or a decrease (to a smaller extent) in production is observed.

The trends in consumption revealed in the scenarios are controversial. For some products consumption decreases or remains the same (wheat, barley, maize, sunflowers, milk). In the case of some livestock products (pork, poultry, eggs) and potatoes consumption increases. As can be expected in Scenarios 2 and 3, the negative trend in consumption of most of the products is overcome with the increase in income, and the trend in consumption takes an upward turn, with the exception of sunflowers and milk.

Consumption in the M models comprises two parts – that through the market and that in the self-sufficient sector. Higher income growth reduces the importance of subsistence production. The consumption from the subsistence sector decreases and the increase is in the market sector. Even the smallest increase of income (3 %) reduces the importance of subsistence agriculture, but at this income level the increased consumption through the market is not enough to compensate the decrease in the self-sufficient sector and for some of the products the result is a decrease in general production which is not the case in scenarios 2 and 3.

The combination of increased production and decreased or increased (to a lesser extent) consumption results in greater export of most of the products, i.e. wheat, maize, sunflowers, milk, pork, eggs. Only few products have a net import position, e.g. barley and potatoes; the markets for poultry and beef are nearly balanced. In scenarios 2 and 3 the increase in income exercises greater impact on production than on consumption growth. This results in the increased export of wheat, maize, sunflowers, and pork in the higher income scenarios. For some products, however, such as poultry, potatoes and milk, higher income leads to the opposite result. Obviously, the trade position depends on the level of satisfaction of consumer demand or efficiency of exports.

A comparison of the results obtained from models A and M reveals considerable differences. Due to the different price responses of subsistence and commercial farming in higher income scenarios production and consumption increased more in model A than in model M (maize, milk, beef, pork, poultry, potatoes). The conclusion is that subsistence agriculture is much more conservative than commercial agriculture.

4.2. CAP under "Agenda 2000" Scenarios

Scenarios 4-6 reveal some other trends and tendencies. The production of many of the products (wheat, sunflowers, pork, potatoes) increases less than in corresponding world price scenarios. Consumption of some products (wheat and sunflower) also increases in EU price scenarios in comparison with world price scenarios, and the result is a decrease in exports. Other products (maize, milk) exhibit the opposite trend – production increases more than in world price scenarios, consumption decreases and as a result there is a turn towards an export position.

The increase of income in these scenarios leads to an increase in the consumption of nearly all products (demand-driven increase). As a rule, however, just as in the case of production, the increase in demand for many products is smaller than the corresponding increase in scenarios 1-3. The exception is in the case of maize, milk and beef. The structure of consumption and the changes in it are similar to those in world price scenarios. The differences in production and consumption in EU price scenarios when compared to world price scenarios do not result in significant differences in export/import position and quantities.

5. Conclusions and policy implications

Despite the almost fully liberalised price system in Bulgaria since mid-1997, the simulations showed an increase in production under world prices. This reflects the existing market deficiencies and poor transmission along the food chain in Bulgaria.
Secondly, for some products (milk, barley, beef and potatoes) the application of world price scenarios decreases production. The reason for this is inefficient production in these sectors and domestic prices already higher than world prices.

Thirdly, the high sensitivity of production to income increase shows that the main factor for increasing production is no longer constituted by prices and trade policy measures, but by a larger domestic market and technological progress.

Fourthly, the rapid decrease in the importance of subsistence in the higher income scenarios shows that this sector is a temporary phenomenon and with the successful ending of the transition period will lose its present importance.

In addition, the results from the implication of EU prices and Agenda 2000 are disappointing. The production of products for which the country has comparative advantages (wheat, sunflowers, pork, and eggs) decreases as well as their export (in the case of wheat and sunflowers). Just the opposite is the situation with the production of milk and beef, for which even the natural conditions in Bulgaria are worse than those in most of the EU Member States. An increase in their production, and even export, is realized under these scenarios. The conclusion could be that the

price structure imposed with CAP is quite at variance with the structure and efficiency of production of Bulgarian agriculture.

Finally, the increase in production of most of the products is less under EU scenarios than world price scenarios; the situation is the same with consumption. The limitation of Agenda 2000 policy depressed production, and increased prices depressed consumption. The overall result is that EU price scenarios are less favourable than world price scenarios.

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Annex

Figure 1. Production of wheat under different scenarios

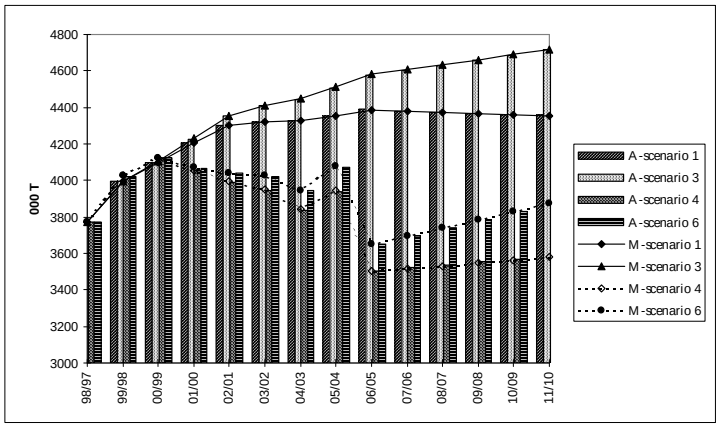


Figure 2. Consumption of wheat under different scenarios

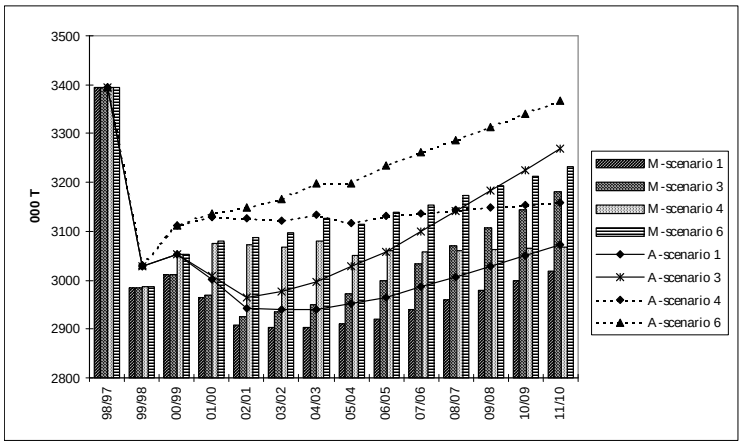


Figure 3. Production of maize under different scenarios

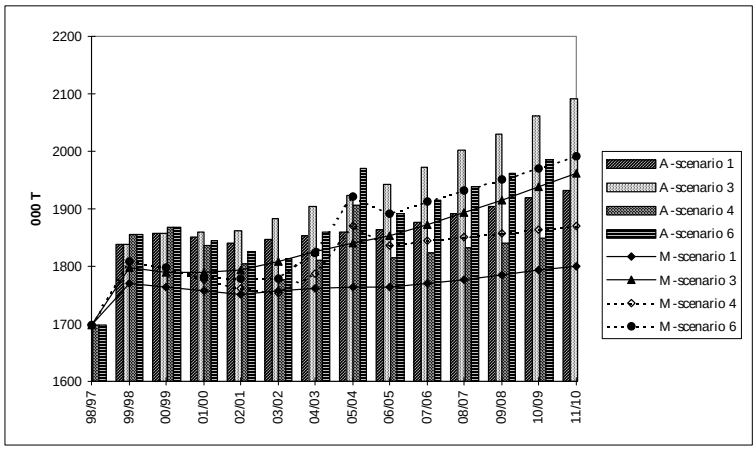


Figure 4. Consumption of maize under different scenarios

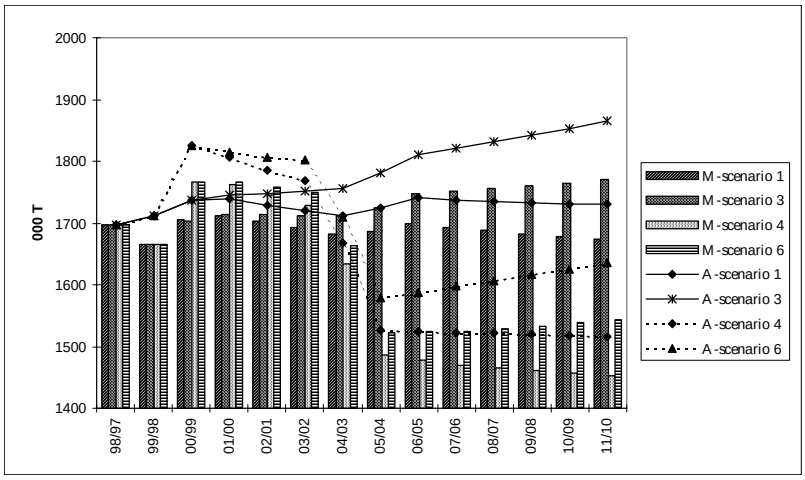


Figure 5. Production of barley under different scenarios

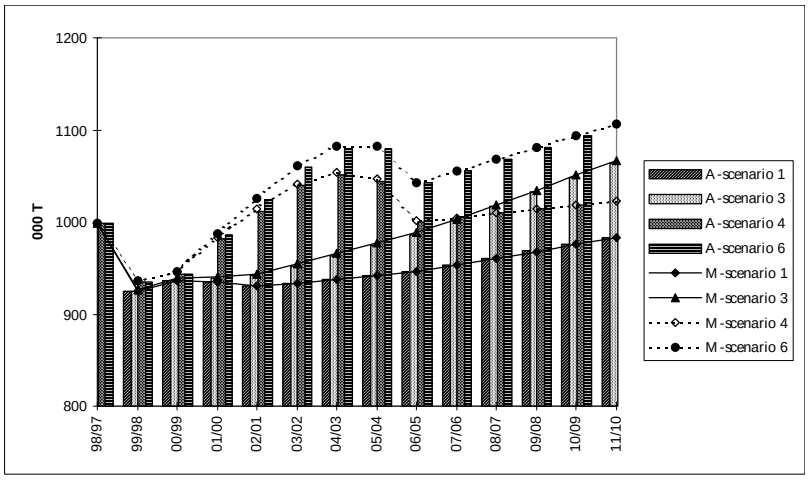


Figure 6. Consumption of barley under different scenarios

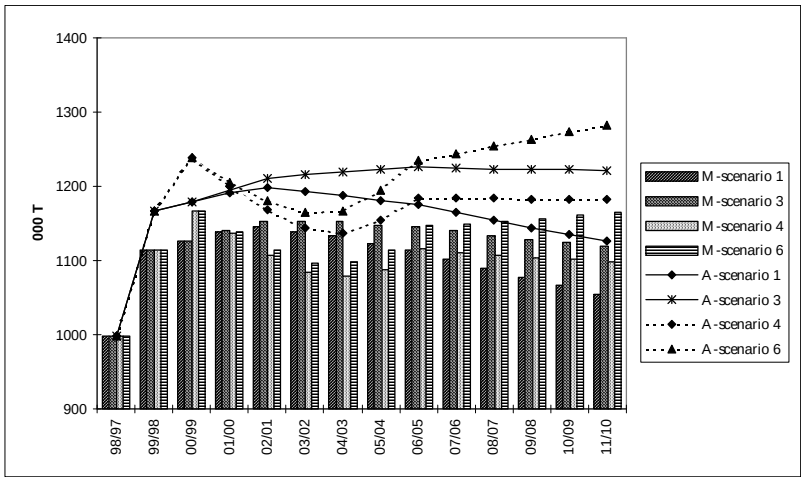


Figure 7. Production of sunflowers under different scenarios

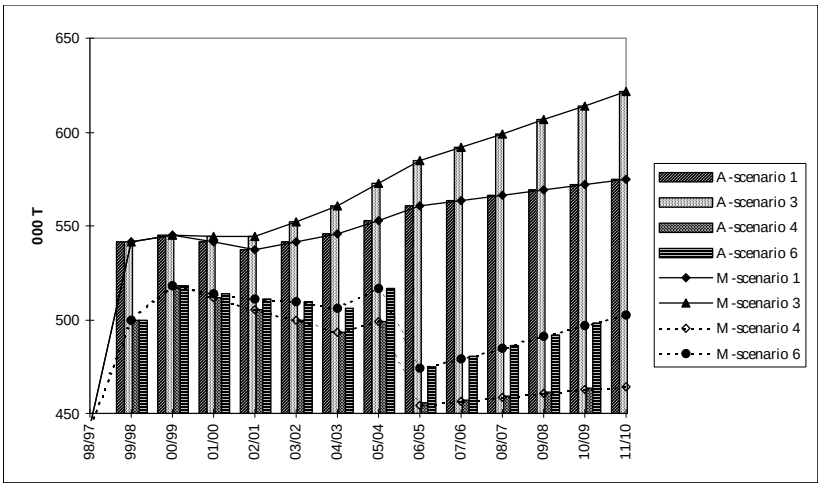
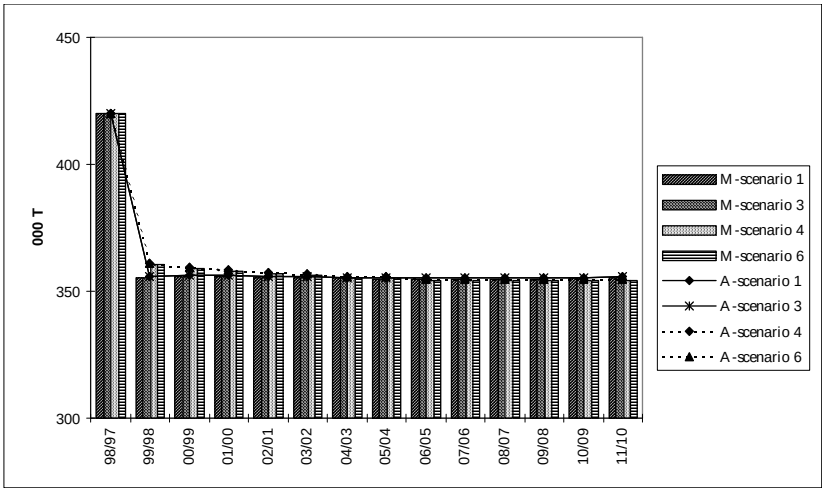


Figure 8. Consumption of sunflowers under different scenarios[a]



Note: a: The results for sunflower consumption indicate its non-sensitivity to income growth (differences are less than 1000 T), thus the lines presenting the results from model A could not be picked out on the figure.

Figure 9. Production of potatoes under different scenarios

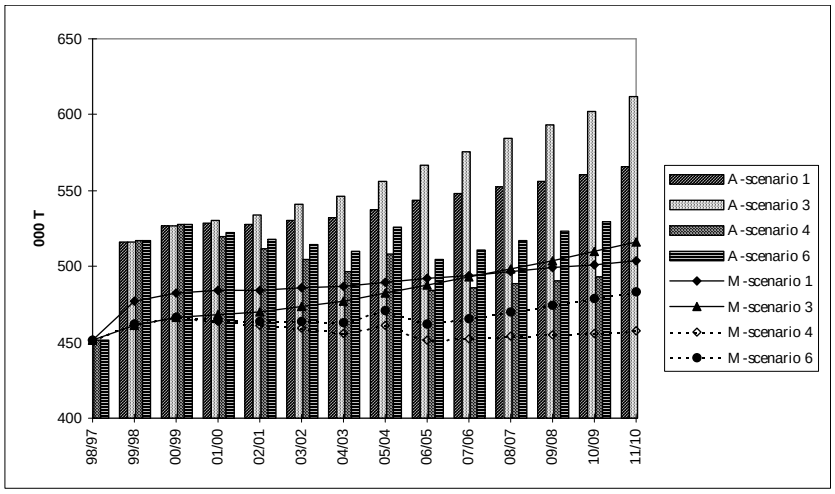
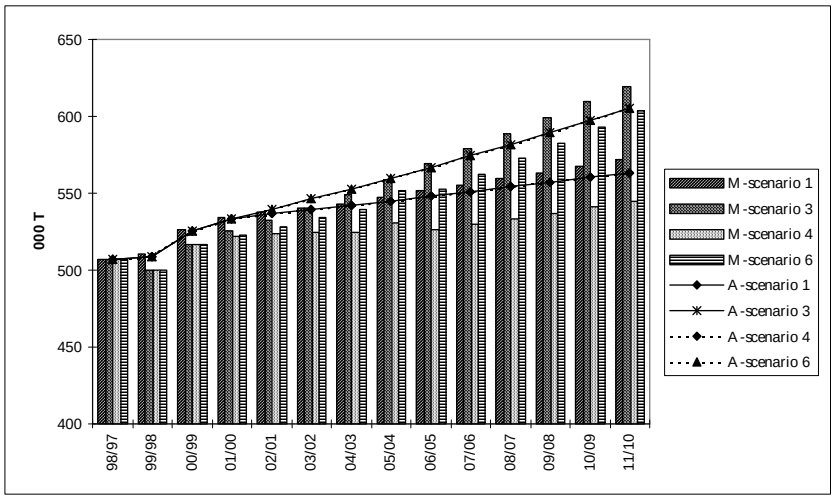


Figure 10. Consumption of potatoes under different scenarios[b]



Note: b: The results for potato consumption in scenarios 3 and 6 from model A and scenarios 1 and 4, model A, are quite close, thus the lines presenting them could not be picked out on figure

Figure 11. Production of beef and veal under different scenarios

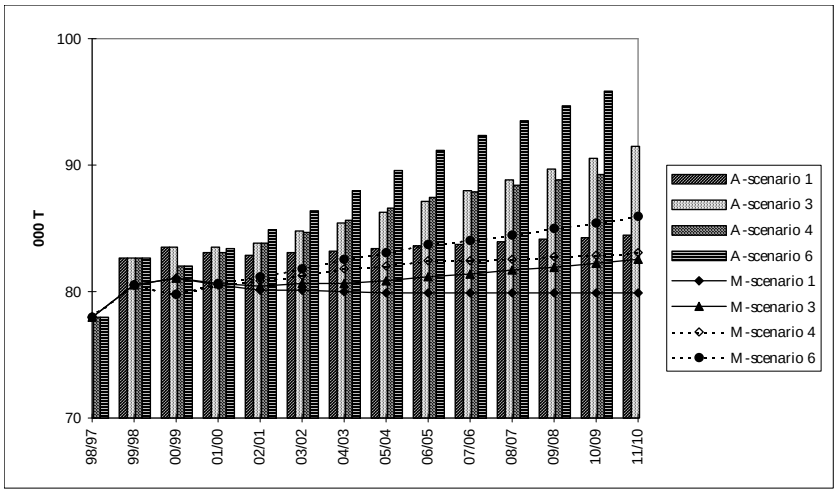


Figure 12. Consumption of beef and veal under different scenarios

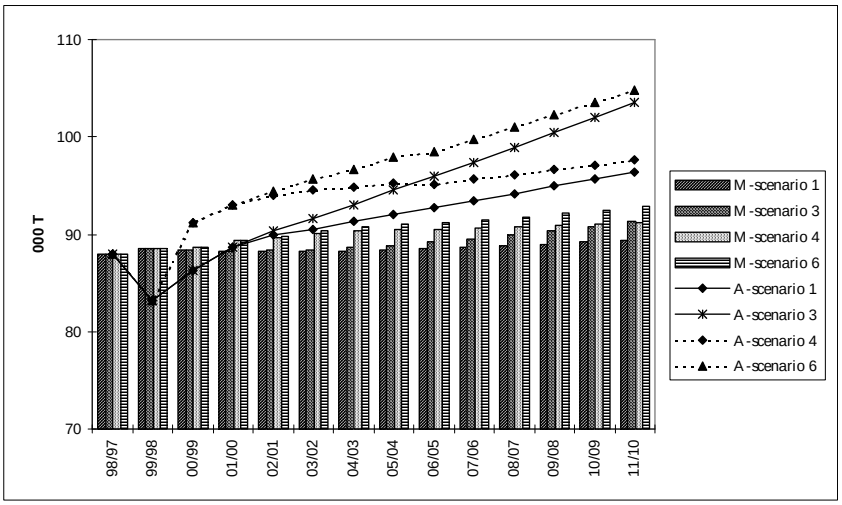


Figure 13. Production of pork under different scenarios

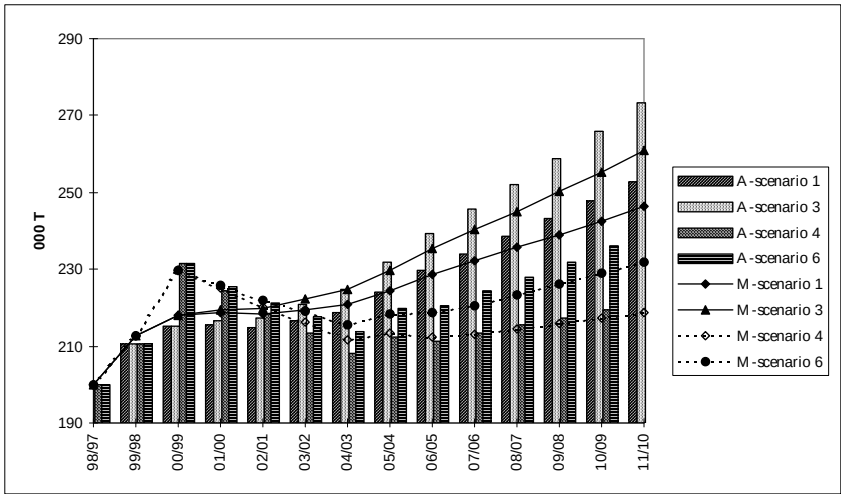


Figure 14. Consumption of pork under different scenarios

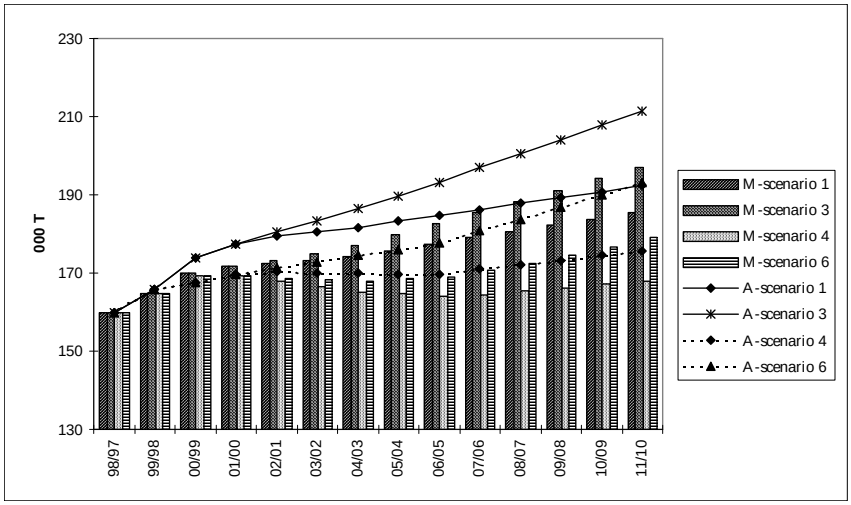


Figure 15. Production of poultry meat under different scenarios

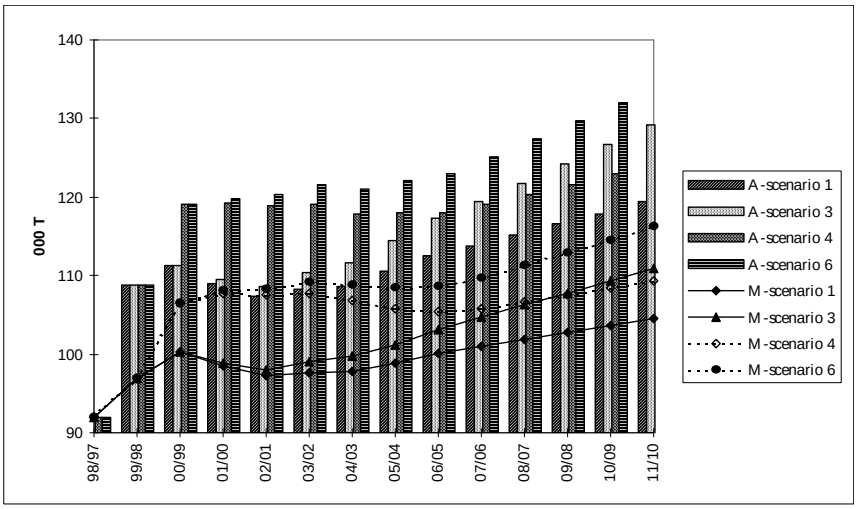


Figure 16. Consumption of poultry meat under different scenarios

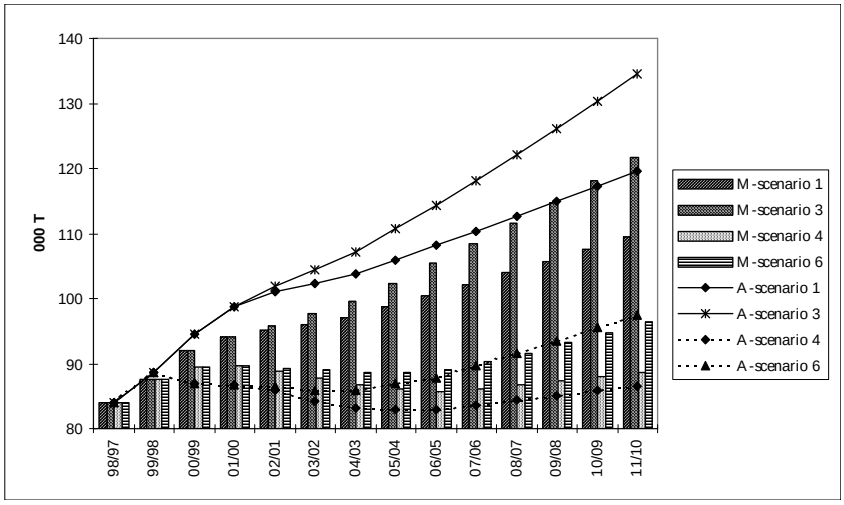


Figure 17. Production of milk under different scenarios

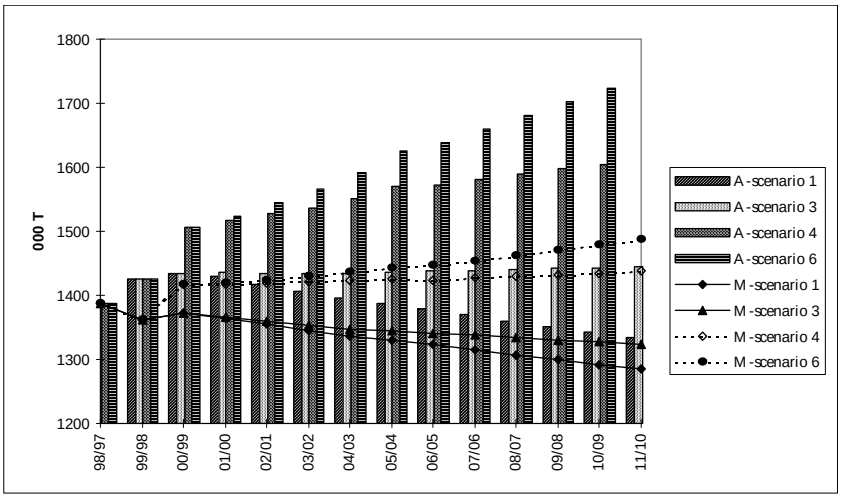


Figure 18. Consumption of milk under different scenarios

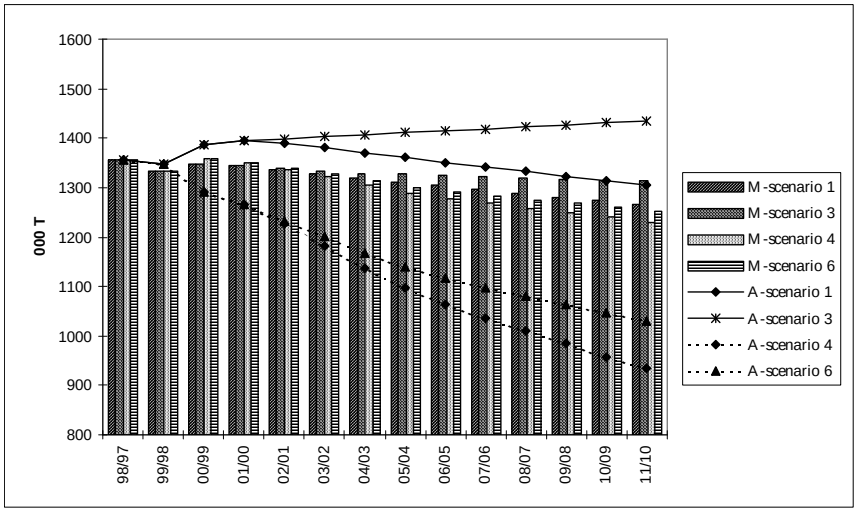


Figure 19. Developments of subsistence maize production

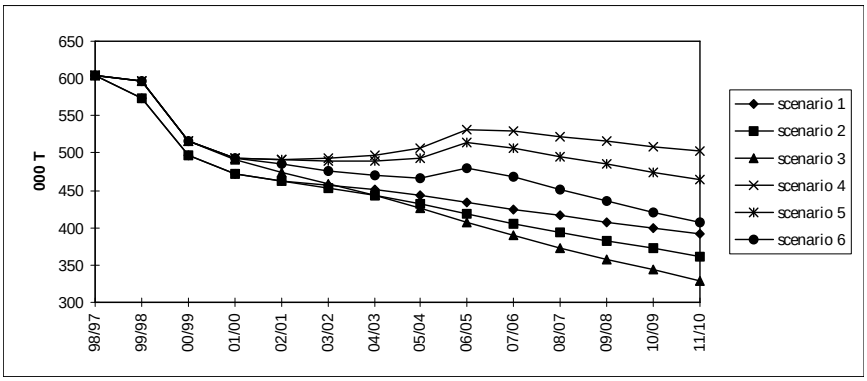
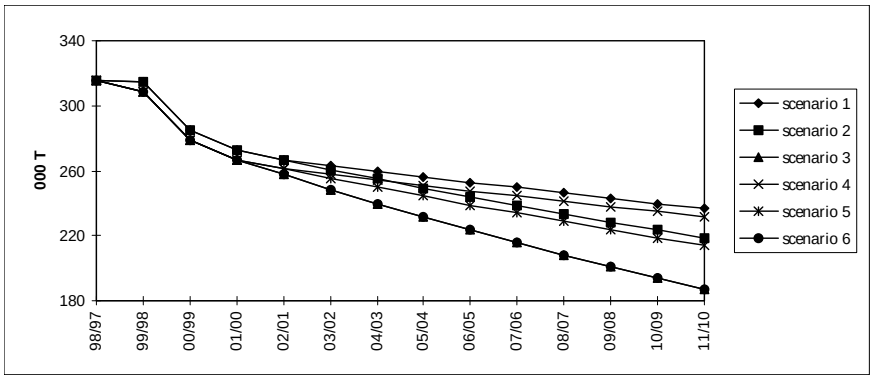


Figure 20. Developments of subsistence potato production[c]



Note: c: The subsistence production of potatoes in scenario 3 is equal to subsistence production in scenario 6.

Figure 21. Developments of subsistence beef production

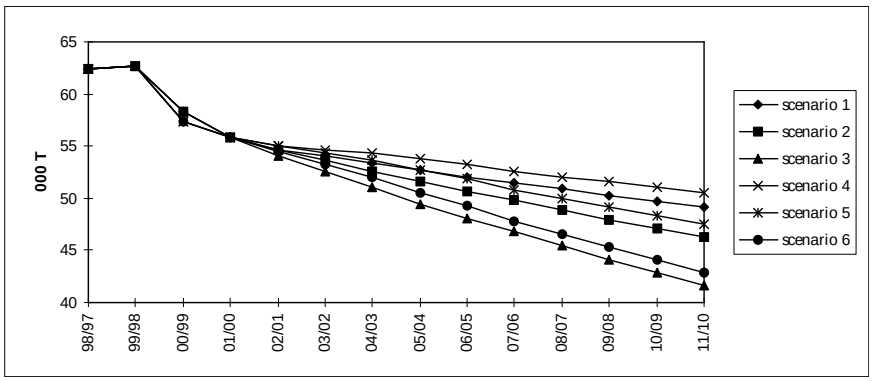


Figure 22. Developments of subsistence pork production

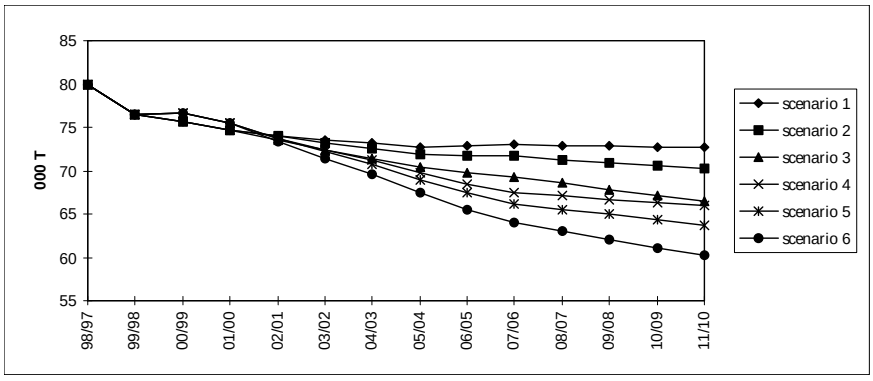


Figure 23. Developments of subsistence poultry production

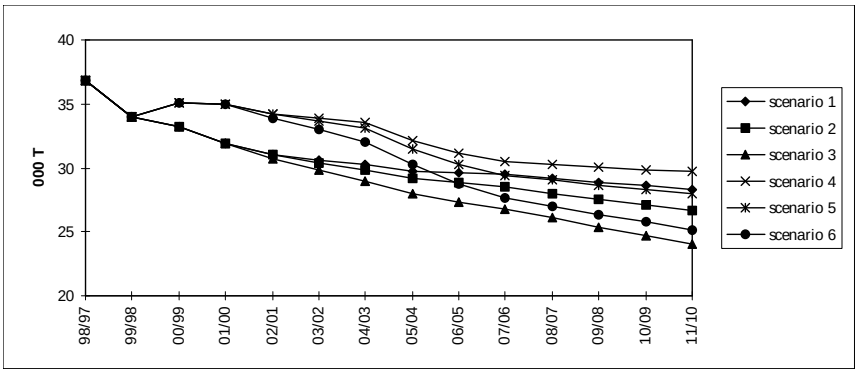


Figure 24. Developments of subsistence milk production