POSSIBLE AGRICULTURAL, POLICIES OF THE CZECH REPUBLIC SUBJECT TO DIFFERENT ENVIRONMENTAL PROGRAMS 1

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Summary:

This paper deals with possible future policy strategies of the Czech agricultural sector subject to different environmental programmes. As a basis for the linear programming calculations we use an agricultural sector model which particularly considers trade issues and environmental concerns. As a result of the rather impaired natural conditions of the Czech Republic due to intensive agriculture and widespread industrialisation, big parts of the agricultural soil became heavily polluted (MECCA 1990, WORLD CONSERVATION UNION 1991, CARTER 1993). Moreover, the Czech Republic is facing a continuing integration into the European and the world market that brings with it many new challenges in trade and external relations. By using the scenario technique different possible strategies for the Czech Republic are developed and evaluated. The calculations will give us insight into the reciprocative competitiveness of the different farm types that represent the real situation in the model. We will also be able to draw conclusions on the strength of various export-oriented production fields as well as on the environmental situation of each scenario.

Anotace:

Článek pojednává o možných budoucích politických strategiích českého zemědělského sektoru při aplikaci různých programů zaměřených na životní prostředí. Jako základ kalkulací lineárního programování je použit model zemědělského sektoru, který bere částečně v úvahu obchodní problematiku a problematiku životního prostředí. Výsledkem přírodních podmínek České republiky v důsledku intenzivního zemědělství a rozsáhlé industrializace jsou oblasti silného znečištění půd. (MECCA 1990, World Conservation Union 1991, Carter 1993). Navíc Česká republika počítá s kontinuální integrací na evropské a světové trhy, což přinese nové prvky do obchodu a vnějších vztahů. Za pomoci technického scénáře jsou vyvíjeny a hodnoceny možné strategie pro Českou republiku. Kalkulace umožňují pohled do vzájemných konkurenčních vztahů různých typů zemědělských podniků, které v modelu reprezentují reálnou situaci. Je možné učinit závěry o silných stránkách různých exportně orientovaných výrobních oborech stejně jako o ekologické situaci každého scénáře.

Keywords:

sector model, linear programming, environmental instruments, agricultural policy, scenario technique

Klíčová slova:
modelový sektor, lineární programování, ekologické prostředky, agrární politika, technický scénář

Chyba! Záložka není definována. Introduction

At the *Department of Agricultural Economics* of the *Swiss Federal Institute of Technology* in *Zürich* a project has recently been started. It deals with possible future agricultural policies of the Czech Republic taking into account its relation to the European and the world market and incorporates environment-related issues. The investigation will be undertaken in close co-operation with the *Institute of Agricultural Economics and Management* of the *University of Agriculture* in *Prague*.

This project aims to be a scientific contribution to the contradictions between international agricultural trade and the existing and arising environmental issues. We know that the free trade of agricultural commodities presently faces many obstacles. Also the countries of the former Eastern bloc have partly closed their markets to imports (OECD 1994a) - mainly due to interior political reasons. At the same time, on a world-wide basis, environmental problems like erosion, water pollution etc. have reached immense dimensions (RAT DER SACHVERSTÄNDIGEN FÜR UMWELTFRAGEN 1985, CARTER 1993).

The national and international agendas are among others dealing with agricultural protectionism (GATT 1993) as well as with the present environmental issues (Conference of Rio 1992). Our project tries to develop – on the basis of the theory of international agricultural trade and the theory of environmental economics – some optimal strategies for the Czech Republic. The comparably small size of this country taking part in the international trade makes it particularly interesting. Moreover, the Czech Republic is ideal for such an investigation since it presently is in a state of transformation to a market economy and the existing environmental problems that occurred during the last forty years reached a high level (MECCA 1990, GASSER 1993).

Aims

In many regions of the Czech Republic the soil can already be regarded as heavily deteriorated due to erosion (MECCA 1990 and CARTER 1993). Therefore it is vital to show feasible ways for the Czech agricultural sector to stop this process and how improvement is possible. Presumably the rural regions will have to act in the near future as a pool for unemployed manpower. The agricultural sector can only create a sufficient income basis on sustainably cultivated soil. Moreover there is a world-wide trend towards a more environment-friendly agricultural production system. When the Czech population reaches a higher living standard – as we assume in the medium term – the consumers will demand more "ecological" products like in Western European countries.

This project should assist the Czech Republic to develop a medium to long-term agricultural policy. This policy enable it to direct its agricultural sector in an optimal way in respect to the macroeconomy and environmental economics.

Consequently the project has to give answers to the question which environment-related agricultural policy the Czech Republic should pursue, and which Czech agricultural commodities will be competitive on the world market. Such answers should be of high importance in the next ten years. We will also be able to see which farm types will be more competitive than others. This allows us to draw conclusions about the optimal structure of Czech agriculture.

Initial Situation

Due to the existence of the command economy of the former socialist countries, a large-scale agricultural structure was established also in the Czech Republic in the last 45 years. As far as farm economics is concerned there are a lot of inefficiencies in this structure. In the present period of transition, e.g., we can easily recognise that there are too many workers employed in the agricultural sector (OECD 1994a).

The farms are seeking their optimal intensity and size and the appropriate legal form. Apart from the economic problems, many environmental problems occurred in the agricultural sectors previously planned centrally. Some fields were overused, waterways were polluted, erosion problems occurred, the biodiversity was adversely affected, heavy metals were absorbed into the soils etc. (MECCA 1990, CARTER 1993).

In the countries with an already existing market economy, we can generally find a high level of protectionism in the agricultural sectors. As a result of this, surplus production and environmental degradation arose. The Czech Republic, starting to become a market economy, struggles with these protected markets because they are considered to be potential export markets for certain agricultural commodities. In order to protect their own farmers against subsidised products from abroad the Czech government is likely to be inclined to introduce own trade barriers. For the moment such barriers exist only at a very low level (OECD 1994a).

Small countries like the Czech Republic cannot influence the trade relations between big trading partners loke the USA or the European Union. The quantities they buy or sell on the world market don't change the behaviour of this market. On the other hand, the small countries are directly influenced by the rules and regulations of the big trading partners. Therefore bilateral agreements and associating contracts between the small and the big countries are of big importance for the trading possibilities of the small countries.

Methodological Basis

The strategies will be developed using the optimising procedure of the linear programming method. As a basis for this an agricultural sector model will be developed. There were already several research works at our Department creating similar LP models (a.o. KOHLI 1994, BIDEAUX 1991). These might be used for the present project by adapting them to our specific requirements like the environmental issues to be incorporated.

We will use elements of four domains to tackle the study problem. These domains are:

- environmental economics in respect to the optimal environmental policy within a country
- classical theory of external trade
- extension of the theory of external trade in terms of environmental aspects
- knowledge of mathematical modelling

Environmental Economics

In general there are two principal approaches of environmental economics to tackle the study problem. The *first* approach starts on a national, institutional level. It can be applied on environmental problems in the interior of a country. This theory is based on the concept of *public goods, externalities and property rights* (FREY ET AL. 1993, SIEBERT 1987*)*. By means of economic efficiency criteria we search an optimal strategy to solve the occurring environmental problem. Thus, small open economies venture to find acceptable measures for an environment friendly policy. These approaches are based on the concept of estimation of the damage costs of the environmental pollution and its costs of avoiding the damage. However the practical use of this concept is very limited since it is very difficult to estimate realistic figures for these costs.

Due to these difficulties in gathering confident data there are some more pragmatic and practical approaches of environmental policy which are already described (a.o. FREY ET AL. 1993). In the present study only such pragmatic instruments will be used. In the context of agricultural economics there are for instance (not concluding):

- *direct payments:*

  - subsidising of production factors

- compensation payments for statutory production regulations
- farm payments

- *statutory production regulations:*
  - raising of prices of production factors
  - statutory management regulations

This set of instruments can now be considered as the practical realisation of the theoretical approach mentioned above. Let's take for instance the raising of the prices for production factors (e.g. nitrogen fertiliser). This measure operates as an *internalisation of external effects* (e.g. nitrate in groundwater) because farmers will use less of the production factor (BIDEAUX 1991, LEHMANN 1993). With such market signals the farmers are motivated to avoid damaging the environment and produce environmental (public) goods (e.g. clean water) instead. Economically speaking the raising of the prices of production factors leads to a change in the structure of the marginal costs of the producers.

Other possible measures are statutory production regulations that generally are maximum restrictions, e.g. max. animal units per ha, limited number of mowing of an extensive meadow per season etc. As long as the producer is within these limits he can freely make use of the public good (groundwater, meadows etc.). In fact,he can act like the owner of these environmental goods. Above the marginal value the environment belongs to the public (FREY ET AL. 1993, SIEBERT 1987). The violation of the production regulations leads to the practice of the causer principle. The damage causer (i.e. the farmer in our example) is liable for the occurring (negative) externality. Therefore this consideration corresponds to the transfer of the property rights from one party (producer) to another (public).

Due to the tight financial situation of the Czech Republic in the present state of restructuring and stabilisation programmes, not a lot of money is available to invest (e.g. direct payments) in above-mentioned instruments (OECD 1994a). This budget restriction will presumably only lead to a relatively low level of environment-friendly production strategies.

Theory of External Trade

The classical theory of external trade gives us the basics on the trade of two countries which are endowed with a different set of production factors, but otherwise show comparable primary conditions. Already David Ricardo formulated the basis of this theory with the concept of comparative cost advantages. In the neo-classical theory this concept was extended by the *Hecksch-Ohlin*-Model in which the technology is held constant but the two countries show different commodity prices without trade (DEUKER 1974). Only the trade between the two countries leads to the harmonisation of the prices. The extent of the trade depends on the relative prices when there is no trade and the supply and demand elasticities. As a consequence of this, trade leads to specialisation of the countries and to an increase in welfare in the countries that take part in the trade (RIEDER 1983). Moreover this theory shows how

trade instruments can affect export and import, which rent allocation there will be between producers, consumers and taxpayers, and how other countries not involved in the trading are affected. The effect of the allocation depends to a big extent on the nature of instruments that are used.

Extension of the Theory of External Trade

This section deals with the interaction between trade and environment. ANDERSON/BLACKHURST (1992) and FREY ET AL. (1993) show in detail the different issues that occur when environmental economic aspects are taken into consideration in the theory of external trade.

The main points of consideration are:

- What effects do trade policy measures of individual countries have on the environment of other countries?
- What effects do environmental economic measures of individual countries have on the trade and the environment of other countries?
- What effects do international trade policy agreements have on the trade and the environment of other countries?
- What effects do international environmental agreements have on the trade and the environment of other countries?

In all these questions we have to distinguish between small and big countries since small countries generally cannot influence the development (prices) on the world market. Furthermore there are also the global effects of international environmental measures, e.g. climate change, international water pollution etc.

Mathematical Modelling

Generally, we could use two different approaches to tackle our problem: mathematical programming or econometric models. **Chyba! Neznámý argument přepínače.** shows how these two approaches differ according to RIEDER (1972).

Table 1: Mathematical programming versus econometric models

Econometric methods	*Mathematical programming*
· Statistical methods	· Equation systems
· Structure analysis	· Optimisation
· Explanation of the present situation	· Normative procedure
· Forecasting	· Desired structural adjustment
· Short-term statements	· Long-term statements

Source: RIEDER (1972)

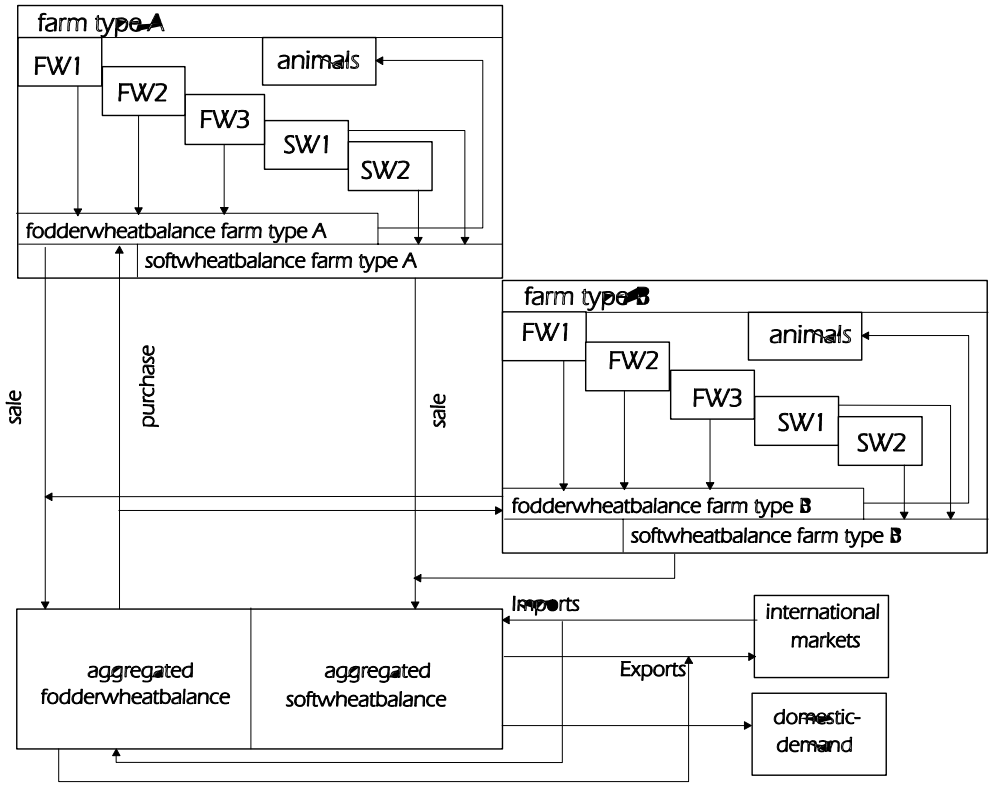
In order to display the production and cost relations in the agricultural sector of the Czech Republic we need an agricultural sector model. Such a model allows us to drop the assumption of a fixed technology set, thus enabling us to explicitly introduce different levels of environment-friendly production techniques into the model. This way, we can show on the production side in details the cost differences between "conventional" and "environment-friendly" production systems. Due to the given possibilities of disaggregation of the supply side in the linear programming method we can perfectly display different production intensities and different technologies (HAZELL/NORTON 1986). Moreover, the duality (dual structure of the LP results) of the LP method allows us to make intensive economic valuation calculations of the activities and restrictions of the model, thus enabling us to assess a better judgement on the scarce factors (JONASSON 1986).

As the basis for the linear calculation we will develop an *agricultural sector model*. shows the procedure of the aggregation of the sector model to be used. With this we can explain the procedure of explicitly introducing environmental instruments into the model. The model should be built in such a way as to incorporate the most important agricultural activities while taking account of the interdependencies of these activities. To fulfill these requirements we choose the approach of *representative farm types* as units of the model. On the regional level their products will be summed up to regional market. On the national level the regional activities will be summed up to the national market.

As already mentioned, the elements of the sector model will be a set of different representative farm types that differ by their factor endowment and by their production possibilities of their location. They are a combination of permanent manpower, agricultural surface, buildings and mechanisation. They have different productivities and specific intensities. These relations – within defined limits – are part of the optimisation process. The model optimises the combination of different farm types and their production branches (JONASSON 1993). The different factor endowments of the farms occur due to regional specifications and production dispositions. For the Czech Republic, we will distinguish three main kind of farms. First, there are the large-scale farms that used to be the cooperative and state farms during the communist time. Secondly, we have the newly-created smaller-scale private farms. The third main type is a relatively intensive medium-scale farm. These farms compete with each other in the model. Depending on the scenario specifications (cf. below), distinct farm types will manage to be more competitive than others. Deficit-producing farm types won't even appear in the solution.

A representative farm type corresponds to a linear model in which are given – by means of restrictions – the natural and technical limitations of the region where it can occur. Therefore the final solution of the entire model determines at the same time whether a farm type is competitive against others as well as its optimal structure.

Figure 1: Aggregation of farm type level balances in a sector model



Source: KOHLI (1994)

shows the formal relations between farm type and sector level for two farm types A and B on the grounds of soft (for bread) and fodder wheat production. FW1 to FW3 are varying fodder wheat activities (e.g. different yields due to different soil quality). Accordingly, SW1 and SW2 are different soft wheat activities. On the farm type level the activities are summed up to create farm type balances (soft and fodder wheat balances). Soft wheat is sold and leaves the farms. The soft wheat production of the individual farms are summarised in a sectoral soft wheat balance. The aggregated soft wheat supply is compared with the domestic demand for soft wheat. If the supply is bigger than the demand the excess will be exported. On the contrary, if the demand is bigger the missing quantity will be imported. Starting from the fodder wheat balance on the farm type level the animal activities will be supplied with wheat. When the need for fodder wheat on the farm is bigger than the farm production the farm buys fodder wheat from the sectoral fodder wheat balance. If the contrary is the case, fodder wheat will be sold.

The needs for a commodity can be different depending on whether it will be used as fodder or as soft (bread) wheat. In case of food the demand side is determined by empirical consumption data. In case of fodder the demand will be determined endogenously according

to the number of animals on the farm types. Moreover, there are some products that are only used within the farm types (e.g. grass); therefore they are not traded or balanced on a regional level. There is no external trade for such products (grass, silage etc.). The adjustment of the farm-level and sectoral balances follow a market mechanism which can be used to display price elasticities – supposing that the necessary data are available. Thus, the prices are the determining factors for the physical and monetary transfers between the farm-level and sectoral balances, the internal and the external demands.

The *ecological restrictions* are introduced for instance in the form of production regulations and intensity limits within the various activities on the farm type or sectoral level. Any financial compensation for these regulations (additional coefficients of the objective function) can be directly linked to the desired activities (e.g. surface) either within a production type or even within a farm type (e.g. direct payment to the farm). The production intensity can be displayed by means of balances (animal balances, nutrient balances etc.) on the farm type as well as on the sector level (WOSSINK 1993). We can set intensity limits by implementing upper-bounds in the respective balances. The shadow price of such an upper-bound allows us to make an evaluation about the cost of this environmental instrument.

Conditions of the agricultural framework are subject to changes. These conditions cannot be forecast, only estimated and assumed. Such possible conditions are called *scenarios*. They should be realistic, plausible and consistent. The framework conditions of the scenarios can be incorporated in the LP model as a kind of exogenous status description. Various parameters can be used to distinguish between the different scenarios: agricultural surface, manpower, production method, intensity, different policy strategies, self-sufficiency rate etc. With the scenario technique we can investigate the effects of different sets of policy measures. In one scenario the agricultural policy might just require a maximal animal density per surface unit in order to minimise the nutrient load. In another, more austere scenario, however, the policy might require the entire agriculture of the Czech Republic to comply with the principles of integrated management or organic farming.

As mentioned above, this study tries to generate sustainable strategies for the Czech agriculture. These strategies will differ depending on the political guidelines that are given. We will know which farm type will be the most competitive in each scenario, which commodities will be produced and which structure is – according to the final solution of the calculations – the most optimal one. Moreover, we will gain insight into the environmental situation in each scenario.

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