CHAPTER 12.

USING THE INDICATORS IN OECD POLICY MODELLING

447. This chapter describes how the OECD uses the indicators in policy simulation modelling. The main purpose of this chapter is to assist other modellers who are, or may be considering, using the support indicators in their models by informing them of OECD practice. Policy modelling is undertaken by the OECD as part of its work to move from analysing the policy effort, as shown by the indicators, to measuring and understanding policy effects, *i.e.* how support policies impact on production, trade, etc. Policy simulations in a sector as complex as agriculture often require a variety of different models. Three different models are currently used by the Secretariat, and this chapter discusses the various modelling techniques as well as some of the main assumptions, limitations and results of each.

12.1. Policy Evaluation Model (PEM)

- The PEM is a partial equilibrium model that was specifically developed to simulate the impact of support on economic variables such as production, trade and welfare, by incorporating (*inter alia*) factor demand and supply equations.
- PEM covers the major cereal and oilseeds crops, milk and beef production in six OECD countries/regions, of which the European Union is one.
- Each PSE category (and some sub-categories) is modelled by price wedges in the output or input market in which they are considered to have first impact or effect.

448. The main purpose of the Policy Evaluation Model (PEM) is to bridge the gap between the PSE information, which categorises and quantifies agricultural support, and the impacts of policies, by providing an analytical instrument to measure the economic effects of support on production, trade, prices, income and welfare. The approach taken is to combine the PSE data with basic information on production technology and assumptions about elasticities of supply and demand, based on an extensive literature review, in order to relate the level of different types of policy transfers as classified in the PSE to the economic effects of interest. The results can be presented in the form of new indicators, such as a production impact ratio (discussed below) or as part of a complete policy scenario analysis, as was done in the case of the study of the EU CAP reform (OECD, 2004b).

449. The key advantage of the PEM approach is that it recognises that the initial incidence of the agricultural policies classified in each of the seven PSE categories based on different implementation criteria is in the various factor (input) and output markets. For example, payments based on area planted affect first the land market, and then the rest of the parts of the production system through the interactions that occur between markets. Market price support enters the commodity market first as a differential between the domestic and world price, and then affects factor markets through derived demands and other commodities through cross-elasticities. Policies providing the same level of

transfer can have very different effects according to what market they impact first, their so-called initial incidence. The PEM contains representations of markets for several important PSE commodities (wheat, coarse grains, oilseeds, rice, milk, beef), and also representations of factor markets including land, labour, purchased inputs, and farm capital. By creating a model that can properly reflect these initial incidences, the PEM captures the most economically significant differences in implementation that the PSE categories are intended to highlight (Table 12.1). The outcome is a model that fits very well the sort of information contained in the PSE database.

Table 12.1. How different PSE categories may be represented in PEM

PSE classification	First incidence of support in price wedge between
A.1. Market price support (MPS)	Domestic (producer and consumer) and world price – MPS. Usually operates in the model as an *ad valorem* tariff, but in some cases input and production quotas are also taken into account.
A.2. Payments based on output	Domestic producer and domestic consumer prices. Payments based on output increase the effective price received by producers over the prevailing market price paid by consumers.
B.1. Payments based on variable input use[1]	Domestic supply price and demand price – not specific to any one commodity. Applies equally to all purchased inputs except fertiliser and hired labour, and designed such that the rate of support for all inputs is equal. Payments based on input use are assumed to reduce the cost to the farmer of using purchased inputs generally, with the exception of fertiliser and labour as mentioned. Only payments without input constraints are included.
C 1. Payments based on current Receipts or Income, production required	Receipts – Not currently modelled. The best way of representing these policies is currently under review. Income – supply and demand price for farm-owned factors of production and land used to produce the affected commodities (individual commodities, groups of commodities or all commodities in the model)[2]. These policies increase the return on the farmer's own factors of production generally, without affecting the relative prices of those factors.
C 2. Payments based on current Area or Animal numbers, production required	Area – supply and demand functions for land used to produce the specific commodity, group of commodities or all commodities in the model. Area payments reduce the cost of using land as a factor of production, and increase the rental rate of land to the suppliers of land (that is, landowners). Animal numbers – supply and demand price for cows (milk) or domestic producer and domestic consumer price (beef), either separately (for individual commodities) or as part of a commodity group. As with area payments, these payments reduce the cost of animals as a factor of production and increase the returns to the owner of the animal by raising the supply price of animals above the demand price.

Table 12.1. How different PSE categories may be represented in PEM (*cont*.)

PSE classification	First incidence of support in price wedge between
D. Payments based on non-current A/An/R/I, production required	Demand and supply functions for land for all commodities eligible to receive the payment (based on commodity groupings label), calculated such that relative supply prices of land are not changed by the policy. The value of the payment becomes capitalised into the value of the land that receives the payment, irrespective of its use. Like area payments, this lowers the cost of land relative to other factors, and increases the returns to landowners through a higher supply price compared to the demand price of land. However, the payment does not affect the relative prices of land for different uses as it is assumed not to impact the farmers' choice of commodity.
E. Payments based on non-current A/An/R/I, production not required	Demand and supply functions for land for all commodities eligible to receive the payment (based on production exceptions label), calculated such that relative supply prices of land are not changed by the policy[3]. The value of the payment becomes capitalised in the value of the land that receives the payment, irrespective of its use. As with area payments, this lowers the cost of land relative to other factors, and increases the returns to landowners through a higher supply price compared to the demand price of land. However, the payment does not affect the relative prices of land for different uses as it is assumed not to impact the farmers' choice of commodity.
F. Payments based on non-commodity criteria	Not currently modelled. Payments in this category are not connected to commodity markets in such a way that would make representation in the PEM obvious or sensible. As the policies largely deal with non-commodity matters, the value to be derived from evaluating them in the context of the PEM is questionable.
G. Miscellaneous payments	Not currently modelled. This category lacks sufficient information regarding the implementation of the relevant policies, which are also too heterogeneous to be well represented in the model.

1. PSE sub-categories B.2 Payments based on fixed capital formation and B.3 Payments based on-farm services are not included in the model. These are very heterogeneous groups whose effects are not straightforward and cannot be represented in a generic way.

2. These factors are assumed to provide the economic returns to the farmers who own them (though some land may be rented), and so represent the only sources of farm income in the model measured as producer surplus in these factor markets.

3. Payment exceptions exist in many cases, for example where land receiving a payment based on a historical use may not be used to produce fruit or vegetables.

450. PEM provides a stylised representation of production, consumption, and trade of aggregates of major cereal and oilseeds crops, milk, and beef production in six OECD countries or regions: Canada, the European Union[27], Japan, Mexico, Switzerland, and the United States. The commodity modules of PEM were all developed according to a common structure, with some specifics added to deal with dairy quota and pricing systems where they exist. Policy experiments are carried out using a structure where these individual modules are linked through world price and trade effects.

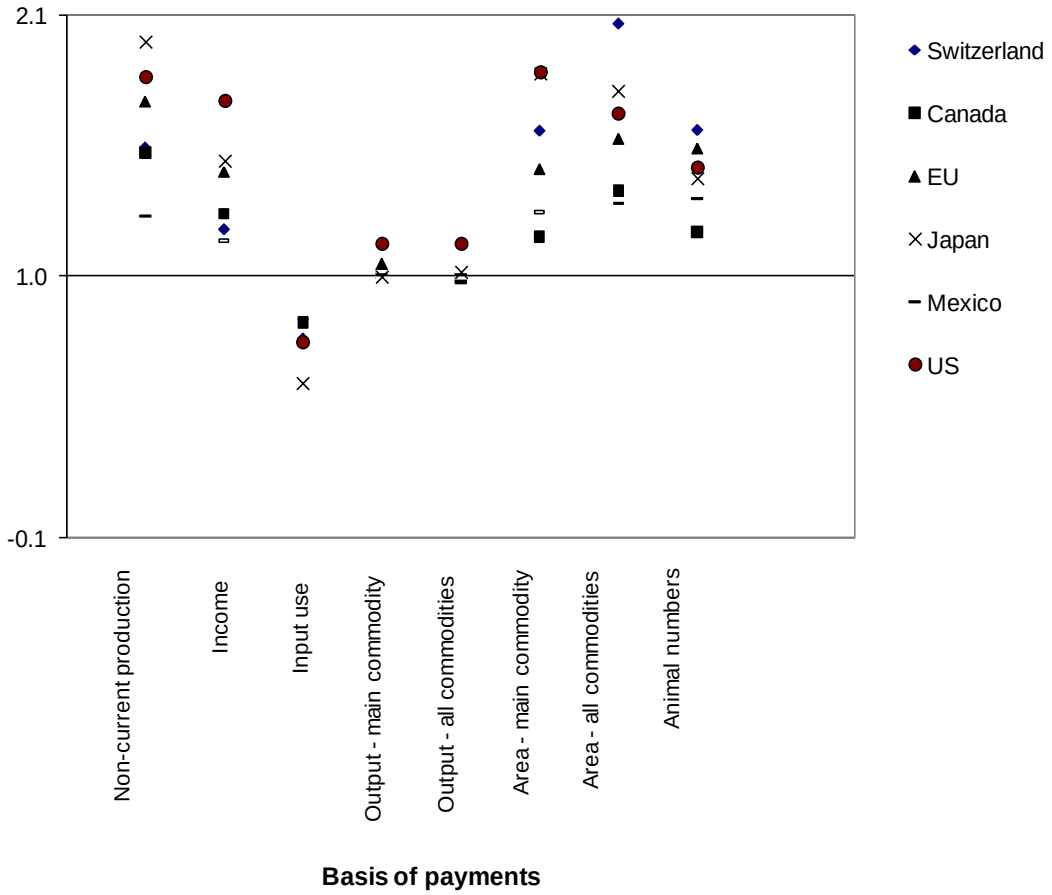
27. The European Union is treated as a single region in PEM, with common market, but production differentiated between the EU-15 and the 12 new Member States.

451. Commodity supply is represented through a system of factor demand and factor supply equations. Except for the rest of world module, where supply functions are directly specified, there are equations representing demand and supply responses for at least four categories of inputs (factors) used to produce these commodities in the studied countries. The factor demand equations reflect the usual assumptions of profit maximisation constrained by the production relationship. Thus, the commodity supply for each of the six OECD countries or regions is embedded in the equations that determine equilibria in these input markets. Supply response corresponding to a medium-term adjustment horizon of around five years is reflected in the values assumed for the price elasticities of factor supplies and the parameters measuring the substitutability of factors in production as well as the factor shares.

452. No factor is assumed to be completely fixed in production, but land and other farm-owned factors are assumed to be relatively more fixed (have lower price elasticities of supply) than purchased inputs. Likewise, no factor is assumed freely mobile, but purchased inputs are assumed to be relatively more mobile (have higher price elasticities of supply) than the farm-owned factors.

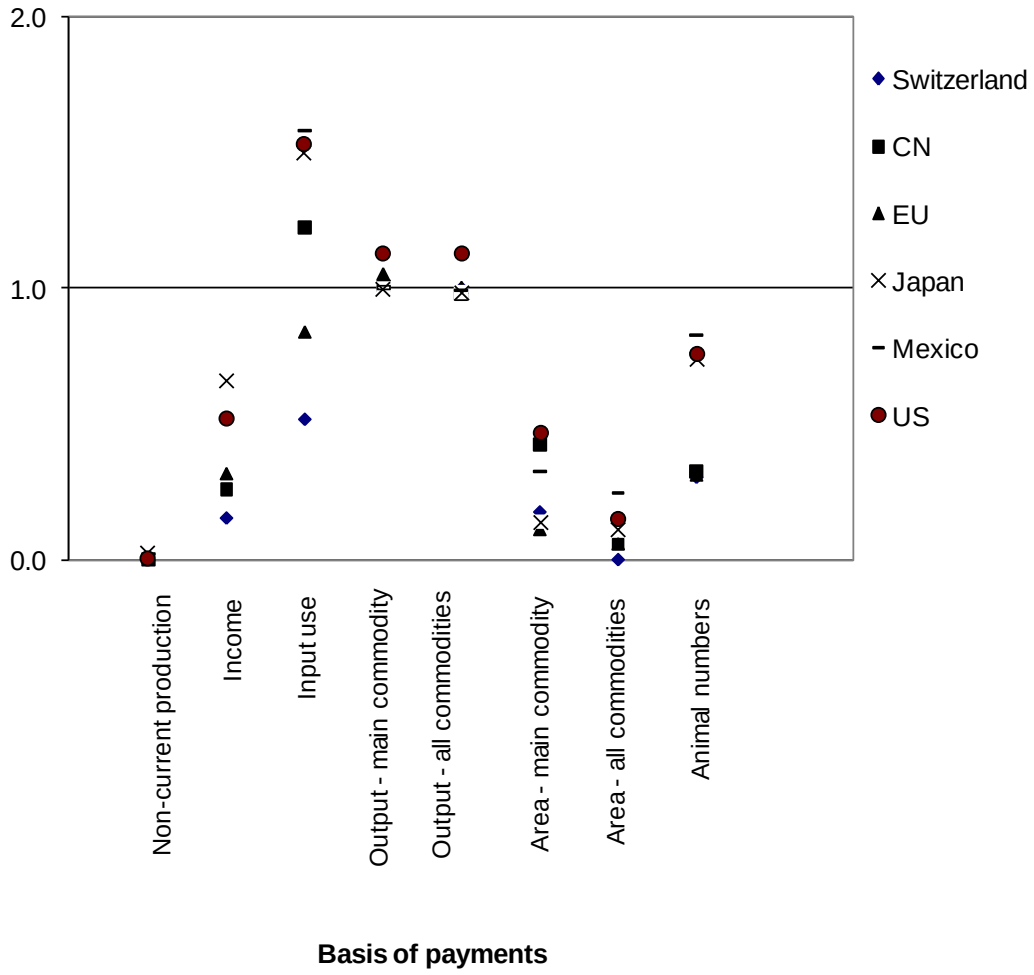
453. While the magnitude of the effects varies by country, PEM shows a certain consistency in the ranking of the potential economic effects of policies in different PSE categories. Using MPS as a basis of comparison (where 1 equals the impact of MPS), payments based on input use (with no constraints attached to their use) or output are generally more distorting of production, while payments based on area, animal numbers or income are less so. Payments based on non-current production are the least distorting (Figure 12.1). This pattern is consistent for relative effects on trade and prices, and inversely so for effects on farm income (Figure 12.2).

Figure 12.1. Relative policy impacts on domestic production



Source: OECD PEM model.

Figure 12.2. Relative policy impacts on farm welfare

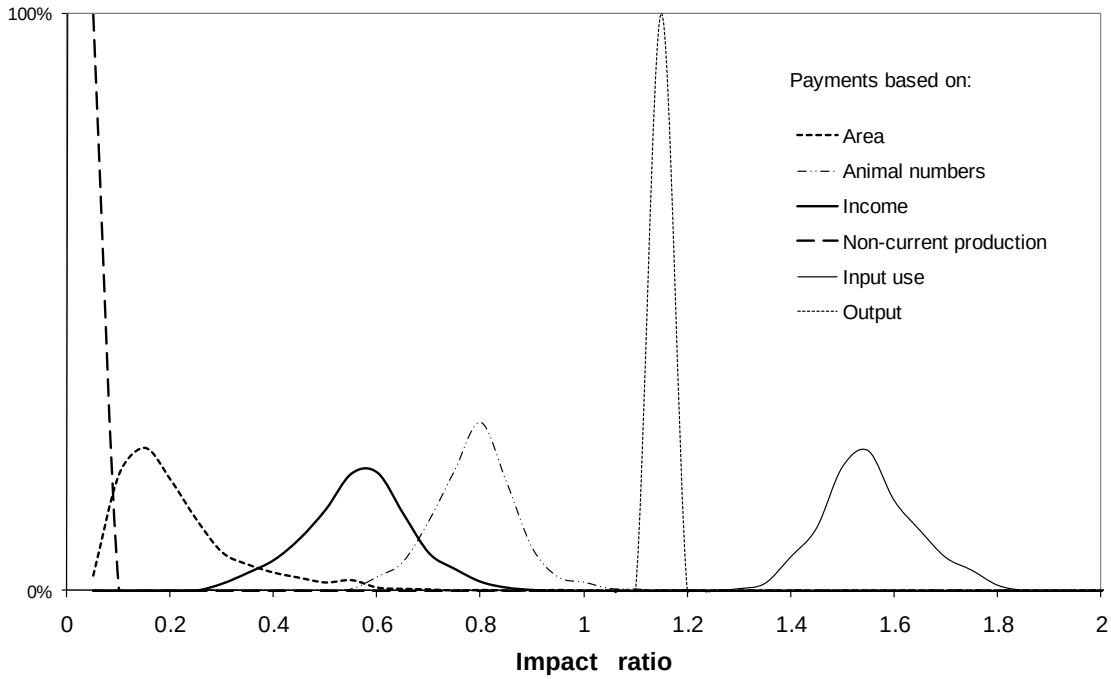


Source: OECD PEM model

454. Since the model is designed to be as agnostic as possible in terms of its structure (using a simple Constant Elasticity of Substitution production function and basic supply and demand functions), the values for the elasticities chosen are the main drivers of these results. This raises the questions of how accurate are the choices made for elasticity parameters, and how misleading is the model if the wrong parameter values are used. The approach taken to answering these questions has been to use a Monte Carlo method, systematically varying these estimates and observing the resulting changes in model results. This identifies both the robustness of the model to parameter choices, and the relative importance of different parameter types in determining the results. This approach produces graphs which show the possible range of impact ratios (as compared with MPS) for each policy. A smaller overlap in the probability distributions of each policy's impact ratio indicates a greater level of robustness of the model.

455. Figure 12.3 shows these graphs for the case of the United States, as an example. These results indicate that, in the case of the United States, the effects of input support and historical entitlements are all very likely different from each other, while the effects of payments based on area or farm income or animal numbers could conceivably be the same.

Figure 12.3. Probability distribution of impact ratios for production quantity – United States



Source: OECD PEM model.

12.2. GTAPEM

- GTAPEM is a general equilibrium model that is based on GTAP and incorporates key features of PEM, notably the more complete representation of agricultural land markets.
- Market price support estimates are not included in GTAPEM as they are already included through tariffs, export subsidies, etc.
- PSE payments are incorporated into the GTAP model by the Secretariat who reclassifies them into four GTAP categories.

456. GTAPEM is based on a modified version of the Global Trade Analysis Project (GTAP) model that incorporates key features of PEM; hence the combination name. Unlike PEM, which is a partial equilibrium model that focuses exclusively on the agricultural sector, GTAPEM is a general equilibrium model with coverage of all other sectors in the economy, including the backward and forward linkages between sectors through an input-output structure; it also contains coverage of all regions in the world. These additional elements are necessary for a global evaluation of the impact of multilateral liberalization of agricultural policies, including trade measures.

457. Various refinements to the agricultural supply side have been made to the standard GTAP model formulation.[28] First, the modelling of production technology has been significantly improved to: (a) include a new land allocation system developed in the most recent version of the PEM; and (b) allow substitution between farm-owned and purchased inputs. These modifications are crucial to fully exploit the information in the indicator database. Second, factors of production are segmented

28. The starting point for GTAPEM was the TABLO code of GTAP model version 6.2, September 2003.

between agricultural and non-agricultural uses. To ensure consistency with PEM, the revised model has been validated by calculating the relative impact of various agricultural policies.

458. The segmentation of factor markets and the distinction between farm-owned and purchased inputs follow the approach taken by Hertel and Keeney (2003). The OECD's specific contribution is the more complete representation of agricultural land markets. This is a necessary requirement to analyse agricultural policy reform where it involves a shift from commodity specific policies towards wider categories of commodities. This issue is at the heart of the debate on "decoupling". Agricultural policies in some OECD countries contain instruments that are less targeted at specific products through output market interventions, but are instead based on the idea that farmers should receive direct income support with minimal impact on their production decisions. In practice, this is achieved through payments linked to land use or animal numbers.

459. Like PEM, GTAPEM uses the indicator database as the source of information on government payments in support of producers in OECD and selected non-OECD countries. However, the MPS component of the PSE is not needed because the GTAP database explicitly includes tariffs, tariff equivalents of quotas and TRQs, and export subsidies. Budgetary payments within the PSE are regrouped by the Secretariat into the GTAP database into the following four categories:[29]

- Output payments
- Intermediate input payments
- Land-based payments
- Capital-based payments

460. For each of these categories, the GTAP (and the GTAPEM) model contains policy variables that can be altered in simulation experiments. In GTAPEM, the payments are translated into price wedges that create a difference between the purchaser's price and the seller's price for the item in question. Except for output payments, the policy variables all affect factors of production.

461. In the GTAP database, the treatment of land and capital subsidies differs somewhat depending on whether the commodity is crop- or animal-based. For crop commodities, payments based on area planted and fixed input constraints are allocated to land-based subsidies. For animal product commodities, payments based on animal numbers and fixed input constraints are allocated to capital-based subsidies.

462. Incorporating the PSE budgetary support data into the GTAP database leads to a practical problem of consistency that needs to be solved. Given the different sources of data, there is a slight discrepancy between the values of agricultural production recorded in GTAP and the values of production reported in the indicator database. Hence, simply using the budgetary support data from the PSE would result in incorrect levels of support expressed as a ratio of support to production values. Since the rate of support and its effects on the relative price system are the most important from an economic modelling perspective, the following approach has been taken to reconcile the two sources.

29. This information is incorporated in the GTAP version 6 database and is made available to a wide group of researchers throughout the world. Currently, the size of the world-wide GTAP network is estimated at more than 5 000 researchers, policy analysts and academics. The details of the allocation for each country in the GTAP database are reported in the GTAP database documentation, www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=1820.

463. For each commodity, the aggregate rate of budgetary support is calculated by dividing the total value of payments by the value of production as published by OECD. The rate of budgetary support multiplied by the corresponding GTAP value of production (at market prices) gives the GTAP total value of payments. The value shares of output, input, land and capital-based payments are then used to allocate these payments to the corresponding tax wedges in GTAP.

464. The procedure described above also allocates payments to GTAP commodities, which was easily possible in the PSE classification system used up to 2007 (see Table A2.1). The new classification system does not allow for a straightforward allocation of payments to individual commodities since it distinguishes single commodity transfers (about 10% of the total payments) from those allocated to groups of commodities. Future releases of the GTAP database will have to rely on the new PSE classification system, and discussion is still underway to achieve a good match between the new PSE data and the needs of modellers.

12.3. Modelling environmental policies

- Since PEM has a high level of spatial aggregation, a Stylised Agri-environmental Policy Impact Modelling (SAPIM) framework has been developed to simulate the environmental impacts of a broader range of policies at the farm level, with heterogeneous land quality and environmental sensitiveness of land. However, SAPIM does not include policy price effects.
- Successful modelling of agri-environmental policies, such as environmental cross-compliance, agri-environmental payments and conservation auctions, requires additional information to that contained within the support indicator database.

465. In addition to modelling the economic effects of policies on farm production, farm income, trade, etc., economic simulation models can also be used to capture the complex linkages between agricultural policies and their environmental effects. The OECD modelling toolkit provides two options for doing this.

466. PEM can be used to analyse the environmental effects of agricultural support policies, since it already contains several stylised PSE-related policies and allows treatment of land use and input use (such as fertiliser) at a sector level. The effectiveness of PEM as a tool to carry out this kind of analysis is determined by the policy question addressed and by the ability to link environmental impact to commodities included in the model.

467. The main difficulty in carrying out analysis of environmental impacts with PEM is the high level of spatial aggregation of the model. Both agricultural productivity and the site-specificity of many environmental effects, such as biodiversity, water pollution and soil erosion, show significant heterogeneity due to spatial variation in the natural resource base and conditions.

468. In this regard, farm-level models can provide an excellent basis for examining farmer's input use and land allocation choices under heterogeneous land productivity and heterogeneous environmental sensitiveness of land. Consequently, the Secretariat has developed a Stylised Agri-environmental Policy Impact Modelling (SAPIM) framework – a farm-level model that analyzes joint production of commodity and non-commodity outputs as well as negative externalities under heterogeneous land quality. The set of agricultural policies that can be analyzed is broader with SAPIM than with PEM, ranging from existing policy instruments such as crop area payments, environmental cross-compliance schemes and agri-environmental payments. It can also model the delivery mechanism for policies, such as for example whether a flat-rate payment is used or price discrimination is used by having farmers bid into a programme. The disadvantage of SAPIM relative

to PEM is that, being a farm-level model, price effects of policies are not taken into consideration endogenously.

469. The information on support measures contained within the indicator database is useful in determining the environmental impact of agricultural support policies. For example, in both PEM and SAPIM, an area payment will be associated to land as a factor of production, and may or may not be specified on the basis of commodity production on the land. A reduction in area payments will then have a different impact on the environment than would a reduction in market price support associated with prices paid to farmers for a specific commodity.

470. However, the indicator database in its current version does not lend itself to modelling agri-environmental policies. While these policies are characterized by an "input constraint" label, they can be classified under categories B through to F depending on the implementation criteria for provision. The input constraint may be linked to an environmental goal or not. Even if the modeller knows that a programme is agri-environmental, the input constraint label provides no information on the type of input being constrained and on the level of constraint. Consequently, the analyst cannot distinguish between a policy limiting the stocking rate on pasture and one limiting fertiliser use. Furthermore, for modelling purposes one would need to quantify the constraints to determine their environmental impact, which cannot be done.

471. In conclusion, information contained in the PSE can be used as a starting point to model the impact of agricultural policies on the environment, either at the sector level (PEM) or at the farm level (SAPIM). However, additional information on implementation details is required to model the impact of agri-environmental policies on the environment.