# Organic Farming in Europe by 2010: Scenarios for the Future

**Organic Farming in Europe: Economics and Policy**
***Volume 8***

Raffaele Zanoli
Danilo Gambelli
Daniela Vairo

The individual contributions in this publication remain the responsibility of the authors.

Organic Farming in Europe by 2010: Scenarios for the Future /
Raffaele Zanoli, Danilo Gambelli and Daniela Vairo.
Stuttgart-Hohenheim: 2000
(Organic Farming in Europe: Economics and Policy; 8)
ISBN 3-933403-07-3
ISSN 1437-6512

Edited by
Prof Dr Stephan Dabbert
*Department of Farm Economics, University of Hohenheim, Germany*
Dr Nicolas Lampkin
*Welsh Institute of Rural Studies, University of Wales, Aberystwyth, United*
*Kingdom*
Dr Johannes Michelsen
*Department of Political Science and Public Management, University of*
*Southern Denmark, Esbjerg, Denmark*
Dr Hiltrud Nieberg
*Institute of Farm Economics and Rural Studies, Federal Agricultural Research Centre, Braunschweig (FAL), Germany*
Prof Dr Raffaele Zanoli
*Department of Agricultural Economics, University of Ancona, Italy*

Technical editor:
Carolyn Foster

Published by:
Prof Dr Stephan Dabbert
University of Hohenheim
Department of Farm Economics 410A
D-70593 Stuttgart
Germany
Tel: +49 (0)711 459-2543
Fax: +49 (0)711 459-2555
E-mail: ofeurope@uni-hohenheim.de
http://www.uni-hohenheim.de/~i410a/ofeurope/



Cover design and layout by walter+von schickh, Ettlingen, Germany
Printed and bound in Germany by Hago Druck & Medien, Karlsbad-Ittersbach

## *Acknowledgements*

The work underlying this publication has been carried out with financial support from the Commission of the European Communities, Agriculture and Fisheries (FAIR) specific RTD programme, project FAIR3-CT96-1794, "Effects of the CAP-reform and possible further developments on organic farming in the EU". The authors are grateful for this support. This publication does not necessarily reflect the European Commission's views and in no way anticipates the Commission's future policy in this area. Its content is the sole responsibility of the authors. The information contained herein, including any expression of opinion and any projection or forecast, has been obtained from or is based upon sources believed by the authors to be reliable but is not guaranteed as to accuracy or completeness. The information is supplied without obligation and on the understanding that any person who acts upon it or otherwise changes his/her position in reliance thereon does so entirely at his/her own risk.

Raffaele Zanoli, Danilo Gambelli and Daniela Vairo

Department of Agricultural Economics
University of Ancona
Via Brecce Bianche
I-60131 Ancona

Tel: +39-071-220-4929
Fax: +39-071-220-4858
Email: zanoli@agrecon.unian.it

# Executive summary

This report is part of the EU project "Effects of the CAP reform and possible further developments on organic farming in the EU". Its specific aim is to develop consistent scenarios of the possible future developments of organic farming in the EU, in order to provide a range of possible policy options.

The scarcity of statistical data, especially in time series format, has prevented the use of traditional forecasting methods. Qualitative information has been used to integrate missing data, and to develop a scenario approach that uses linguistic variables whose interactions are analysed through fuzzy systems rules.

The information used in this analysis is mainly derived by expert assessment and is generated through interactive brainstorming procedures that have involved all the project's partners in an iterative process, covering almost all the three years of the project period.

Our scenarios are aimed at both policy makers and the private sector, and may be used as a "wind tunnel" for evaluating specific projects and investments in the organic sector: one of the uses of our scenarios has been to provide assumptions for computer-aided sector modelling by other teams participating in the project. In a similar way, our scenarios may be used as "test beds" to evaluate the viability of specific policies or business strategies, as well as a starting point for the design and development of new strategies and/or policies.

## Using scenarios as strategic analysis tools

Scenario analysis has been developed in the managerial literature as a tool for systematic strategic thinking and planning, in order to identify the forces that drive the system and examine the interaction of current trends and uncertainties within a given market domain and time frame. It can be considered as a way of defining a suitable strategy for forecasting problems in complex and rapidly changing social systems.

In this context, scenarios are tools for strategic analysis and summarise different sources of information concerning the future, with special attention to actors, aims, mechanisms, and causes and effects of change. They should not be considered as mere forecasting techniques, but rather as decision making supporting tools, that may anticipate policy options in the presence of different possible future states. Scenarios are, therefore, strategic analysis tools which summarise a large amount of information

regarding the future, with specific reference to actors, goals, tools, causes and effects of change. Multiple scenarios may be used to characterise the range within which the future is likely to evolve.

## The method of fuzzy scenarios

Scenario analysis considers the interactions among a set of variables supposed to be able to depict the relevant aspects of the system whose possible evolutions are to be analysed. Hence, it handles complex interrelations, which can become difficult to manage even when only a few variables are involved. As a second general aspect, scenarios are often based on partial information and/or on linguistically defined variables. In such a context, traditional forecasting procedures might fail to consider properly the relevant mechanism of the analysed systems.

Fuzzy scenarios can be considered as special cases of fuzzy systems, which are typically used for decision analysis purposes in complex systems. The use of fuzzy logic allows the handling of linguistically defined variables/system, whilst at the same time maintaining a strong methodological rigour. As a result, the final effects of the complex interactions describing the organic farming sector system can be presented as a linguistic description of possible future states, presented in detail, but also easily understandable.

## The scenarios

The results show five major possible forms that the European market for organic products may have assumed by 2010. It does so in terms of trends in exogenous and endogenous variables deemed to be key factors in the sector examined. A discussion of the policy implications of specific developments in distinct scenarios, provides policy makers with a powerful tool for devising agricultural policies suited to the circumstances that arise.

Variables assume two or three linguistic states, and the resulting fuzzy sets are defined by triangular membership functions.

The first scenario is labelled "Gloomy liberalisation", whose purpose is to describe the dramatic impact of 'unrestrained' globalisation on organic farming. The slackening of state and EU economic intervention and substantial deregulation have depressive effects on the organic sector, not least because of the removal of income support and the cancelling of agro-environmental programmes. The overall effect is that of organic production deterioration – with lower standards and fewer controls on the supply side – so that organic products are no longer perceived as qualitatively better than conventional ones; as a general effect, this scenario therefore is generally and enduringly deleterious to the development of organic farming, on both the demand and supply sides.

The second scenario is labelled "World Trade Boom" and describes the development of the European agricultural sector in response to a regulated increase in trade-liberalisation. Two hypotheses have been considered concerning consumers reaction to globalisation: in the first one consumers accept the increase in international trade without showing any alarm about imports of GMOs and derived products, while in the second one the use of

controversial technologies in agriculture generates concerns about food safety.

Both variants produce similar results, with a decline in demand for organic products and a depressive effect on the perception of the quality of organic products, compared with conventional ones. There is also a crisis on the supply side, exacerbated by the lack of research and development. In this situation, substitute products (like integrated agriculture products) maintain their market share.

The third scenario is a "Business-as-usual" one, and describes the development of the organic sector on the basis of the Berlin agreement on Agenda 2000: it therefore presupposes no major changes in either the market or the CAP, with a political climate slightly in favour of organic farming. The overall outcome is medium-to-low demand, given the few product or process innovations in the sector, accompanied by medium-to-high consumer prices, given the low level of supply and the inadequate performance of the sector engaged in the processing and marketing of organic products. Compatible with this situation is a slight increase in the supply of substitute products.

The fourth scenario is named "Fortress Europe", and concerns a general policy development in line with that envisaged by Agenda 2000, but with different degrees of market liberalisation. We envisaged two variants of this scenario, according to the hypothesised reactions by the WTO.

In the first variant, there is a shift in the EAGFF budget towards spending for agro-environmental and rural development programmes, and agro-environmental policy is boosted. The profitability of organic farms increases, while R&D stimulates technological progress which in turn stimulates organic production. These various factors increase consumer confidence in the quality of organic products, exerting positive effects on demand. The overall effect is that both demand for and supply of organic products grow, also on account of greater utilisation of organic products by processors and distributors.

In the second variant, domestic European policies on support for agriculture and rural development are not accepted at the WTO negotiations. Consequently, disputes conclude in frequent and increasingly harsh reprisals by foreign trade partners. The general level of farm-gate prices falls – on both the supply and demand, because of greater globalisation. The supply of organic products increases but the organic market continues to be a 'niche' market.

The fifth scenario, "Organic Paradise", presents the best (but still realistic) conditions for the development of organic farming. It also has two variants, according to the level of market globalisation and trade liberalisation assumed. The issue of quality becomes a crucial one, while consumers' economic expectations grow, and they become increasingly interested in the quality of life and in environmental issues. The maximisation of profit is no longer the farmers' only objective, but it is accompanied by numerous other goals, among which is protection of the environment.

Both variants show similar results, where European countries develop new production models which give priority to quality, and this favours organic products. In fact, domestic demand for organic products increases because of a fall in the consumer prices of organic products resulting from the fall in farm-gate prices. Supply increases as well, under the growth in the incentives provided by an agricultural policy very favourable to organic farming and high and generalised support for organic farmers. All the factors able to stimulate the supply of organic products are in place: greater research efforts, better information and technical advice and specific technological innovations. Because of the positive impact of organic farming on the environment, policy-makers are willing to assign organic farming a central role in the achievement of environmental sustainability. Intermediate standard products decline, being no longer competitive either with organic or conventional ones.

The main differences between the two variants are that under higher globalisation, prices of organic products are lower, both on the farm gate and consumer side, and that intermediate standard products maintain their competitiveness.

The issues raised in this report may be useful to different categories of actors.

Indeed, our scenario analysis:

- addresses the question of whether or not organic farmers and other organisations and institutions involved in organic farming are well prepared to face the uncertainties of the future as portrayed in our scenarios;
- helps policy makers realise the potential impact of some decisions on the future of organic farming in Europe, and understand why their decisions could have these effects;
- by identifying the key driving forces which may be used to influence the future development of organic farming in Europe, it offers alternative options to both policy makers and market actors in devising their strategic direction and translating new insights into actions.

Our results support the idea that the crucial determinants of the future development of organic farming in Europe are:

1. the agricultural and agro-environmental policy which will come into effect *after* the implementation of Agenda 2000;
2. the Millennium Round WTO negotiations;
3. the future perception and attitudes of consumers and society towards issues concerning food safety and the use of modern biotechnology in food production.

At the same time, one should always remember that the purpose of scenario analysis is not forecasting the future, but to provide different contrasting images of relevant *possible* futures.

The scenario analysis presented in this report should help the reader shape his/her image of the future development of organic farming in Europe, even though he/she may not even partially agree with any of the assumptions made by our scenario team or the results obtained.

Scenario analysis should be regarded as a learning and iterative process; by providing a range of possible, plausible futures, the effects of actions can be made explicit in a non-threatening way.

Besides, scenarios may promote discussion and build consensus in shaping future policy options; a shared vision of the future of organic farming in Europe is the necessary framework for developing appropriate recommendations for agricultural policy after Agenda 2000.

# List of abbreviations

| | |
|---|---|
| CAP | Common Agricultural Policy |
| EAGFF | European Agricultural Guidance and Guarantee Fund |
| GMO | Genetically Modified Organism |
| WTO | World Trade Organisation |
| CF | Conventional Farming |
| CP | Conventional Product |
| OF | Organic Farming |
| OP | Organic Product |

# Scenario team


DE: Hiltrud Nieberg, Frank Offermann, Institute of Farm Economics and Rural Studies, Federal Agricultural Research Centre (FAL), D-38116 Braunschweig, Germany

Stephan Dabbert, Anna Häring, Matthias Stolze, Department of Farm Economics (410A), University of Hohenheim, D-70593 Stuttgart, Germany.

DK: Johannes Michelsen, Kennet Lynggaard, Birgit Krongaard, Henning Jorgensen, Department of Political Science and Public Management, University of Southern Denmark, Niels Bohrs Vej 9-10, DK-6700 Esbjerg, Denmark.

GB: Peter Midmore, Nic Lampkin, Susanne Padel, Carolyn Foster, Welsh Institute of Rural Studies, University of Wales, Aberystwyth, SY23 3AL, UK.

IT: Raffaele Zanoli, Danilo Gambelli, Daniela Vairo, Department of Agricultural Economics, University of Ancona, Via Brecce Bianche, I-60130 Ancona, Italy.

# Table of contents

# List of tables



# List of figures

# 1 Introduction

The aim of this report is to analyse possible evolution paths of organic farming in Europe, providing tools for anticipating future possible scenarios for policy purposes.

Anticipating organic farming's future development is a difficult task, given the almost total lack of time series data for the sector. Furthermore, organic farming has been until now strongly influenced by agricultural policies, and it may be hard to anticipate future policy options and their impact on the sector. Also, it seems that factors that originally played an active role in the development of organic farming, have been progressively substituted by new factors, like policy options, consumer preferences, social and cultural changes. Hence, the understanding of the development of organic farming is becoming increasingly uncertain, given the scarcity of information about how these "new" variables might reciprocally interact.

Scenarios may be considered as hypothetical images of the future, describing the functioning of a system under different conditions, with a certain degree of uncertainty. Scenario analysis is therefore a decision supporting tool rather than a method for producing precise forecasts.

The main innovative aspect of scenario analysis with respect to standard forecasting techniques is its ability to consider the impact of exogenous external shocks or major structural changes of the analysed system. This result derives from the use of qualitative information, usually provided by expert assessments.

The results of scenario analysis presented in this report are strongly dependent on expert assessments, given the substantial lack of comparable time series data on the organic farming sector in Europe of sufficiently long duration. Repeated iterative brainstorming sessions have provided the necessary information for the analysis: time and spatial frame, relevant variables, relationships among variables, future scenarios to investigate.

The qualitative and linguistic nature of the information obtained has been exploited using a fuzzy logic approach in scenario modelling. Fuzzy sets help to quantify linguistic variables, hence offering a solution to the problem of systems description in the presence of scarce or inaccurate information. As a result, it has been possible to obtain scenario modelling based on a solid methodological foundation, without renouncing the typical flexibility of qualitative approaches.

Scenario analysis was carried out in three main steps: first, all the relevant information were generated[1], matched with available statistical data, and incorporated in the general framework of the scenarios, by defining the key factors assumed to influence the future and the driving forces assumed to trigger the change; then, the linkages between these variables were translated into fuzzy relations, which were analysed and commented by the experts involved; lastly, scenarios were graphically sketched and then translated into narrative forms, by "fine tuning" the model according to experts' comments and evaluations.

Five main scenarios were created (of which three had two variants) in order to cover the principal possible evolution paths of the organic farming sector. The scenarios are the following:

1. Gloomy Liberalisation: describes the dramatic impact of deregulation and globalisation on organic farming;
2. World Trade Boom: describes the development of the European agricultural sector in response to a regulated increase in trade-liberalisation;
3. Business-as-usual: this is a 'surprise-free' scenario, that basically describes the development of the organic sector given no major changes in market conditions and the CAP;
4. Fortress Europe: considers a general policy development in line with that envisaged by Agenda 2000, with different degrees of market liberalisation.
5. Organic Paradise: this scenario provides all positive realistic outcomes that may 'trigger' a major development of organic farming.

The structure of the report is as follows: the second section presents a general introduction to scenario analysis, together with a survey of the different available approaches. The third section describes the methodology used for the scenario analysis, and finally the fourth section contains the analytical description of the scenarios obtained, in a simple, narrative form. Conclusive remarks and three appendices concerning methodological details and variables definitions end the report.

[1] Scenario analysis has been used as an 'umbrella' methodology during the development of the EU FAIR project 'Organic Farming & the CAP'; all information gathered during this project, – and published in the various volumes of the series 'Organic Farming in Europe: Economics and Policy' – as well as in specific brainstorming sessions during the scenario workshops, has formed part of the 'knowledge base' of this report.

# 2 Methods and tools for scenario analysis: a survey

## 2.1 Some definitions

Management consultants and many business organisations have increasingly supported the use of 'scenarios' rather than 'forecasts' for long term planning and strategic analysis. Forecasting is strictly connected with the idea of providing exact future predictions using mathematical manipulations of historical data; due to the failure of time-series and trend analysis methods to provide reasonable forecasts (especially in times of major structural change), scenario analysis has developed as an alternative approach to handle the future and its uncertainties (Bunn and Salo, 1993; Schnaars, 1987).

Scenario analysis differs from other forecasting approaches in two important ways. First, it usually provides a more qualitative and contextual description of how the present will evolve into the future, rather than one that seeks numerical precision. Second, scenario analysis usually tries to identify a set of possible futures, each of whose occurrence is plausible, but not assured and not necessarily probable (Schnaars, 1987) In this way, scenario analysis may be seen as a process of understanding, analysing and describing the behaviour of complex systems consistently and, as far as possible, completely.

In the words of Kahn and Wiener (1968), a scenario is an "hypothetical sequence of events constructed for the purpose of focusing attention on causal processes and decision-points"; Huss (1988)[2] considers that a scenario is a descriptive narrative of a set of relevant factors that describe – from a probabilistic point of view – alternative representations of future economic conditions.

In this context, scenarios are tools for strategic analysis, and summarise different sources of information concerning the future, with special attention to actors, aims, mechanisms, and causes and effects of change. According to Porter (1985), they can not properly be considered as forecasts, but rather as consistent representations of the different possible states of the future.

A scenario-based approach to planning is implemented by a strict interrelation between analysts and decision makers; using scenarios as a planning tool may help to introduce dynamic factors within the strategic management process.

---

[2] For a detailed survey of scenario analysis models see in particular Bunn-Salo (1993), Huss (1988), Martelli (1992) and Schwartz (1992).

Many approaches to scenario analysis exist, and the literature is rather vast; however, most approaches have the following elements in common (Marbach et al., 1991):

- identification of a 'present state', that is a starting point that needs to be understood in terms of its inner structure and functioning;
- identification of several possible future situations, usually referred to as final image (Godet, 1985) or future image (Miles, 1985);
- identification of the path that leads from the present situation to the future ones; this generally implies the analysis of the possible evolution of a set of relevant variables, and the construction of a – generally qualitative – model that guarantees a robust and intrinsically coherent explanation of this path.

## 2.2 Aims of scenario analysis

The basic aim of scenario analysis is not forecasting the future, or fully characterising its uncertainty, but rather *bounding* this uncertainty.

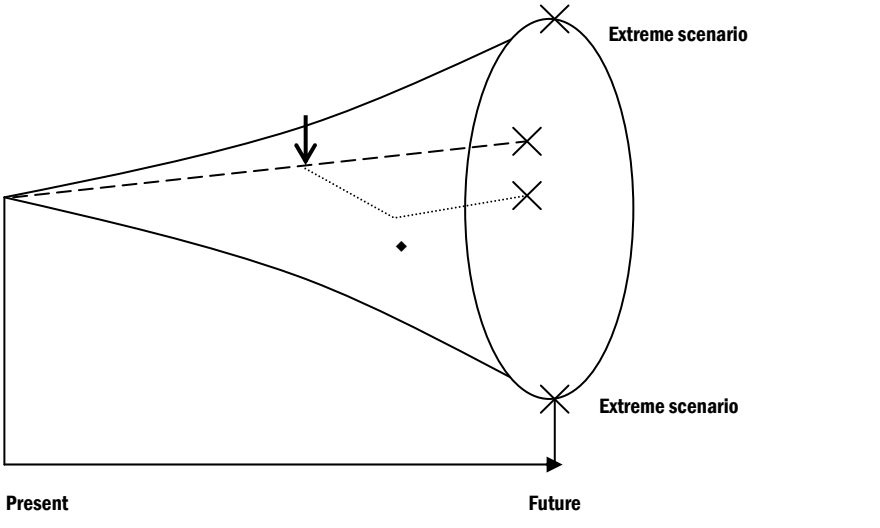
In this sense, scenarios may be seen as complementary to traditional forecasting and simulation techniques, in order to provide a composite picture of future developments for use as the background for policy-making and/or strategic planning.

Different uncertainty definitions can be considered:

- ***risk*/*opportunity***: when it is possible to associate to each event a probability, i.e. a quantification of the likelihood that the event occurs;
- ***structural uncertainty***: when an event is considered possible but there is not enough information to assess the probability of its happening;
- ***unknown***: in some cases events are unimaginable. Of course, this kind of event cannot be predicted and, given their nature, it is not possible to enumerate or define them in any way.

Scenario analysis, unlike other more traditional forecasting techniques, tries to identify the boundaries that will likely "contain" the future, rather than assess the probability of specific events (risks or opportunities) happening. A graphical representation by Von Reibnitz (1988) shows a "funnel scenario" example, where starting from the present situation, different contrasting evolutions can be considered, that can be bounded within the extreme scenarios positions.

***Figure 1 A conceptual model of scenarios***




*Source: Von Reibnitz (1988)*

A set of very contrasting and different scenarios is more likely to contain the actual future than a "single focused" scenario set. More in general, while forecasts can be confirmed or not, depending on the actual event happening, scenarios, given their undetermined nature, cannot be "falsified" in a Popperian sense (Jungermann, 1985; Van der Heijden, 1996).

Millet (1988) considers two basic aims of scenario analysis for firm/company strategy planning:

- to forecast the economic environment within which the firm/company operates, in order to establish its long term goals;
- to evaluate different strategic options. Scenarios can be considered as benchmarks for alternative strategies. In this sense, Van der Heijden (1996) argues that while forecasts are decision making tools, scenarios aim to develop strategies and policies.

Methodology

Following also Bunn and Salo's argumentation (1993), it is possible to summarise the aims of scenarios in three basic categories, reflecting different approaches to scenario analysis:

- ***forecasting and decision making*** – the development of the future's images in order to select a specific strategy among different alternatives. This aim belongs to the general category of strategic planning, requires an analytic approach to decision making and is based on a participatory planning process.
- ***benchmarking*** – the evaluation of a specific strategy with respect to different possible futures. In this case it is necessary to minimise prejudices that make decision making processes inflexible, and to introduce "extreme" or "catastrophic" scenarios that force actors to better visualise their goals and eventually to falsify their basic assumptions.
- ***institutional*** – to analyse possible futures (even the not very probable ones) and to enhance the organisational learning and understanding of external events and reality in general, in order to manage uncertainty. The aim is to train decision-makers to operate within unusual and new situations, and to take decisions in an uncertain context.

In general, scenario analysis can be considered as an anticipatory (or *proactive*) strategic planning tool, and may be used as a support for policy making and public choice.

## 2.3 Criteria for scenarios evaluation

As a general rule, scenarios cannot be evaluated on the basis of their predictive accuracy, as the probability of a single scenario happening completely is close to zero (Van der Heijden, 1996).

As a general criterion, *credibility* can be used in order to evaluate scenarios, which can be considered to have four major determinants, strictly interlinked (Helmer, 1981; Bunn and Salo, 1993):

- ***Comprehensiveness***: the model should be able to take into account all relevant events and trends. General and comprehensive scenarios make the analysis plausible, but they are time consuming and expensive. Actually, there is a trade-off between comprehensiveness and clarity: highly detailed scenarios with wide time horizons are usually hard to understand and to interpret.
- ***Clarity***: this depends mainly on three factors. The first one is the balance between simplicity and realism; the second one is the unbiasedness of procedures translating subjective assessments into 'objective', generally acceptable statements; the third one is the complexity of computing algorithms: if these are too complicated, decision makers and actors might dislike them.
- ***Consistency***: this concerns the validity of the basic information set and how it has been used, specifically with regard to cause-effect

relationships among variables. Nevertheless, too much emphasis on consistency, may favour the elimination of scenarios that look inconsistent only because they represent innovative situations.

- ***Coherence***: a scenario is coherent if it does not violate the basic rules and assumptions of the theory upon which it is based. For instance, a model using probability assessment might have coherence problems if these are generated without respecting basic probability theory rules; similarly, a scenario of economic development should make clear which assumptions are derived from economic theory, and which theory – among the contrasting ones – is used. Coherence is a fundamental requirement, because it provides the conceptual base for the interpretation of results, and favour using scenario techniques with a sound theoretical framework.

## 2.4 Steps in scenario analysis

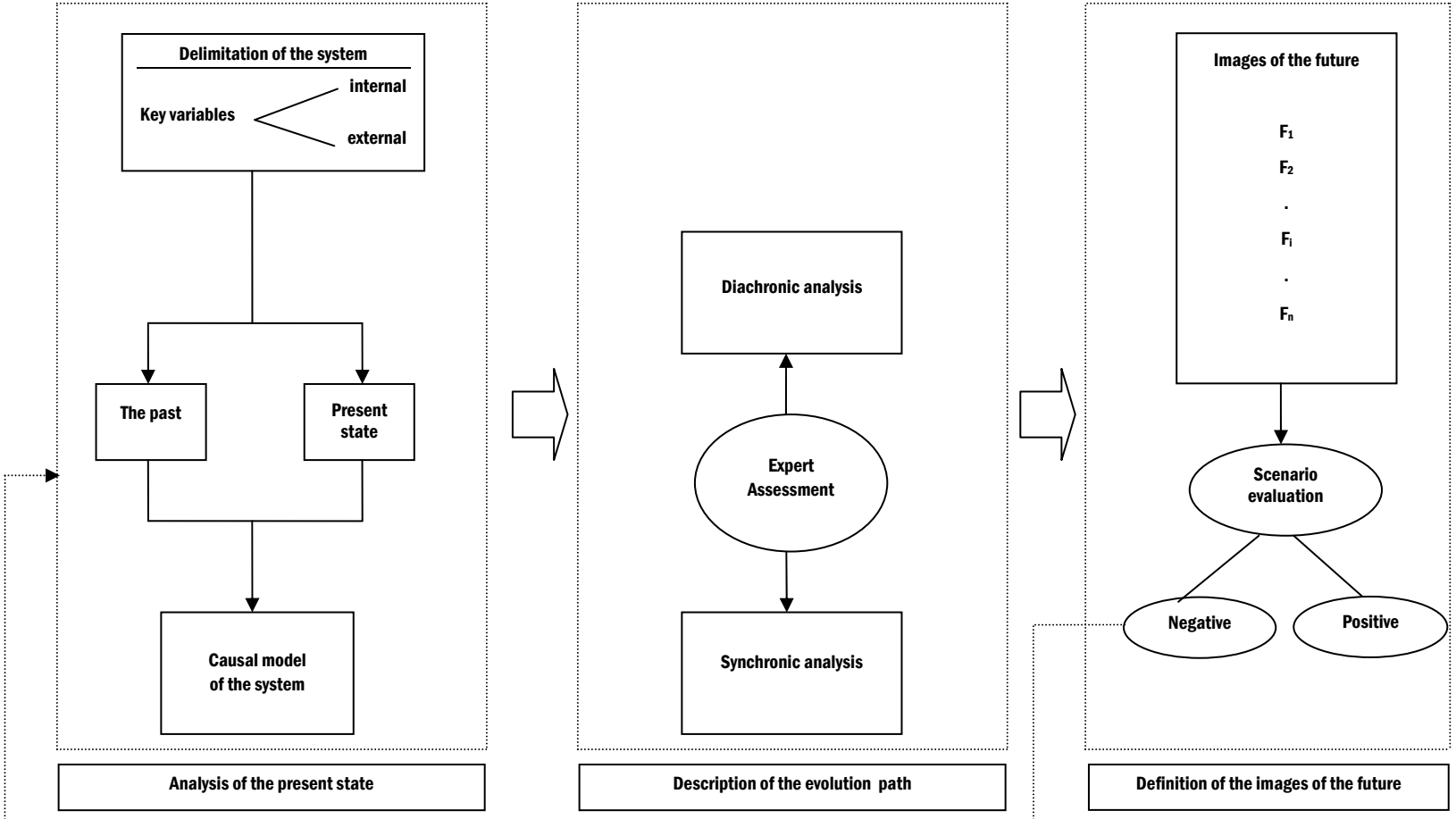
Scenario analysis is based on the understanding of the key factors acting in the analysed system, and of the related complexity and uncertainty. In some sense, trends, uncertainty, risks and opportunities, and a causal model of the analysed system's present state, are the "ingredients" for the development of sound and imaginative scenarios.

Nevertheless, causality links are not necessarily defined in a parametric way, but rather as a set of relationships among relevant variables, usually represented by network graphs or *influence diagrams*. Scenarios can also be modelled using more formal approaches, though still involving a direct and "transparent" participation of experts and actors, sometimes formally organised in a *scenario team*.

Building a plausible scenario is a complex task that requires at least three steps, each representing a basic element of scenario: ***analysis of the present situation, definition of the images of the future, and definition of the "path" linking present and future situations*** (Figure 2). These stages are not necessarily pursued in this order.

These crucial steps, representing a logical approach to scenario construction, should be preceded by a ***preliminary stage***, where the general framework for the analysis is set (definition of the system to be analysed, of time horizon and geographic scope) and a ***final stage***, concerning a narrative description of the scenarios and an evaluation of their plausibility.

*Figure 2* ***Steps of scenario analysis***



### 2.4.1 General framework of analysis

This preliminary step usually considers the following aspects:

- ***key issues*** or relevant aspects defining the system to be analysed, which are relevant for the scenario (e.g. a scenario about the future of organic farming in the EU will consider economic, environmental, policy and social aspects);
- ***time frame*** of the analysis (e.g. ten or twenty years);
- ***geographic frame*** of the analysis (e.g. the World, the EU).

Moreover, it is necessary to make clear how judgmental assessments will be collected, who will provide them and who will process them. In this phase a formal way to collect and process information may be set, by establishing a *scenario team* or panel of experts, and by defining the methodological approach to the construction of scenarios to be used (see below, paragraph 2.5).

### 2.4.2 Analysis of the present state

This step has a crucial role for the entire analysis, as defines all the relevant variables to be considered and the relationships among them.

The following aspects should be considered in this stage:

- ***delimitation of the system***, through an accurate description of *external* and *internal* variables: the former are often referred to as *driving forces* – influencing without being influenced by other variables in the system; the latter are factors influencing and being influenced by other variables in the system;
- ***identification of system's key variables***, taking into account the necessary trade-off between comprehensiveness and clarity.
- ***definition of a causal model***, or another representation of the 'inner mechanism' or reasoning which lead to the present state of the system. This analysis is necessarily based on current and retrospective knowledge, but needs to include all intuitive judgements and imaginative conjectures on how the system has evolved to its present state. In this step of the analysis, the interdependencies among variables are considered, in order to evaluate the nature and strength of the relationships and to better understand possible interactive behaviours. This task is often more easily performed with the aid of some analytical tools, such as network graphs, influence matrices and diagrams, cross-impact tables, etc.

From a cognitive point of view, the generation of scenarios is still poorly understood (Bunn and Salo, 1993). Although most techniques rely heavily on the disciplined intuition of the experts, the mental models or cognitive maps of the reasoning are not always explicit in many scenario analyses. Given the complexity of the systems to be analysed and the cognitive limitation of the human mind (Evans, 1982), it is useful to be as transparent as possible in showing the mental model or reasoning constituting the core causal model underlying the scenarios.

### 2.4.3 Description of possible evolution paths

The results stemming from the analysis of the present state constitutes a test for scenario consistency: *state consistency*, referring to the internal consistency of each scenario, and *dynamic consistency*, referring to consistency between the present state and the images of the future. These two consistency aspects can be considered as elements of synchronic and diachronic analysis. Synchronic analysis investigates the functioning of a system in a single time period, while diachronic analysis describes possible evolution paths linking the present and different future situations.

The aim of this step is to work out projections about the future development of the system as well as the actual dynamic path underlying the prospected change. Again, in this stage is important "to state the reasoning for all future projections that are assumptions rather than facts" (Von Reibnitz, 1988).

### 2.4.4 Definition of the images of the future

Once the basic elements of the systems are defined, and the experts have analysed various conjectures concerning the future changes in the state of the key variables in the system, it becomes possible to define a range of possible future scenarios. If relationships among variables are measured in probabilistic terms, then each scenario will show an overall probability of happening, and it will be possible to rank scenarios according to their probability values.

If scenarios are determined using all possible variables/events combinations, it is likely that their number becomes high, and that there are many similar scenarios. In this case it is necessary to cluster similar scenarios, in order to eliminate redundant information and to offer a more understandable scheme of the future, using a few alternative and highly contrasting scenarios.

Again, analysts should take into account the trade-off between comprehensiveness and clarity, and avoid discarding potentially interesting 'surprise' scenarios only on the basis of reducing redundancy.

### 2.4.5 Narrative description of the scenarios

Once the relevant scenarios are selected, it is necessary to build a storyline of how the system might look in the different scenarios. The scenarios are first drafted in skeleton form, to highlight their main ingredients, linking the uncertainties and showing the effects of different assumptions about the driving forces on the other variables in the system. Then, they should be named and painted in detail, by a verbal narrative describing the events and showing how the future might evolve in that direction.

Scenario names are quite important. The names "act as metaphors so that when we were talking about a scenario we could use the name as an evocative short-cut, to give people an instant and intuitive picture of each scenario, thus providing a framework into which detail could be added" (Ringland, 1998).

The aim of this stage is to provide a way to communicate our ideas about the future, and writing up the narratives is an essential part of this process.

The narrative needs to be "provocative, memorable, eliciting a rich imagery" (Van Der Heijden, 1996). The scenario, indeed, is a story – with a beginning, a middle and an end, a narrative that links historical and present events with hypothetical events taking place in the future.

## 2.5 Methods for developing scenarios

Scenario analysis was originally developed for military strategy purposes (Kahn and Wiener, 1968). Starting from the early 70s it has been variously used as forecasting tool by some multinational companies, mainly for investment strategies and long term planning. Schnaars (1987) argues that most of the scenario techniques available at the time of his paper's publication were still based on those developed by the Rand Corporation during the 50s. At that time, Herman Kahn and Olaf Helmer were employed by the Rand Corporation as analysts for military defence projects development. Kahn's approach is mainly qualitative, as it emphasises subjective aspects in particular, while Helmer's approach has a more methodological characterisation.

In a 1971 paper, Chambers et al. refer to scenarios as "visionary forecasts". The scenario approach was considered quite inexpensive but also unsatisfactory.

Georgoff and Murdick (1986) after more than a decade, show an appreciation of scenario analysis particularly for its little time series data requirement, low mathematical formalisation, etc.

Methodology

The qualitative approach has been probably the more widely used in scenario analysis, while more formalised methods have been less popular, in particular inn the early years, mainly due to the lack of affordable computing tools.

In what follows, three different methodological approaches are briefly discussed: intuitive logic, trend-impact analysis and cross-impact analysis. A scheme of the various approaches is presented in Figure 3.

***Figure 3*** ***Characteristics of main methodological approaches for scenario analysis***

| Methodological approach | Strength | Weakness |
|---|---|---|
| ***Intuitive logic*** | ▪ Flexibility;<br>▪ Simplicity;<br>▪ Intuitive and creative perspective;<br>▪ Combination of traditional and qualitative forecasting techniques. | ▪ High subjectivity;<br>▪ Low methodological formalisation. |
| ***Trend-impact analysis*** | ▪ Combination of traditional and qualitative forecasting techniques;<br>▪ Focus on exogenous shocks/impact factors. | ▪ Low formalisation of exogenous shocks/impacts identification;<br>▪ Requires time series data for rend extrapolations;<br>▪ Does not take into consideration events interaction. |
| ***Cross-impact analysis*** | Takes into account events interaction. | Theoretical and practical problems for changing expert assessments into probabilities. |

### 2.5.1 Intuitive logic

Pierre Wack was a pioneer of scenario analysis, and his models allowed Shell to anticipate the 1973 oil crisis. His approach, based on intuitive logic, represents the less formalised method for scenario analysis, and combines and compares qualitative information with the results of traditional forecasting techniques.

The 'intuitive logic' approach was initially developed by the Stanford Research Institute, and is strictly linked to strategic management methods and to companies' participatory planning processes.

The background of this approach is that firm/company decisions refer to complex relationships involving economic, social, technological, political and environmental aspects. Most of these factors are "external" to the firm/company and their knowledge allows the improvement of strategic decision making. Some of these variables are easy to quantify and to forecast (e.g. demographic aspects), while some others are not (e.g.

consumers attitudes and lifestyles). The Stanford Research Institute considers scenario analysis as a way to evaluate risks, anticipate breakpoints and identify trade-offs among competitive firms' goals.

The strength of the Stanford Research Institute approach is the capacity to create flexible and consistent scenarios from a purely intuitive perspective. Given that it does not use mathematical algorithms, it can be easily adapted to specific cases that might be relevant in different conditions or periods.

Nevertheless, as most of social sciences methods, this approach suffers from scarce repeatability, and different analysts or experts might produce different results using the same method.

Intuitive logic approaches have been used also by Royal Dutch Shell, thanks to Wack (1985a, 1985b). Two kinds of scenarios have been created: the first one is defined by Wack as explorative, and is based on time series macro economic data extrapolation, and on the definition of the main uncertainty sources; the second one is defined as decisional, and tries to modify the mental model of reality of the decision makers involved, in order to maximise innovative attitudes and ideas towards the future.

Many of the most popular books on scenario analysis rely on this approach (Von Reibnitz, 1988; Van Der Heijden, 1996; Ringland, 1998).

### 2.5.2 Trend impact analysis

The second approach is an intermediate one between intuitive logic and cross impact analysis, and represents a *trait d'union* between scenario analysis and traditional forecasting methods.

Its simplest form is a quantitative statistical forecasting model enriched by qualitative assessments, that allows the definition of possible events that might modify the estimated trends.

This approach turns out to be particularly effective for at least two reasons: it combines traditional and qualitative forecasting techniques, and stimulates analysts and experts to take into account possible effects of "unusual" events. Nevertheless, it does not take into account effects of interrelationships among variables.

A further limitation of this method is the low formalisation of the definition and evaluation of the trend impacts. From this point of view, models employing Analytic Hierarchy Process techniques (Wolfe and Flores, 1990; Flores et al, 1992; Saaty and Kearns, 1985; Dennis, 1987; Saaty, 1987) represent valuable progress, though in some cases the use of weights instead of probabilities might be controversial.

### 2.5.3 Cross impact analysis

Cross impact analysis tackles in a systematic way the problem of interdependency among events in scenario building. This approach was

originally an evolution of Delphi method, developed by Gordon and Hayward (Gordon and Hayward 1968), and it has been often criticised. Nevertheless, over the last years it has received a growing interest, specially with the wide diffusion of PC's that facilitates the use of this kind of model.

Basic concepts of cross impact analysis are (Martelli, 1992):

- events are considered as interdependent: reality is described either by the simultaneous happening of independent events, and/or by interactions among independent and conditioned events;
- such interactions may be effectively represented in a matrix form.

In other terms, cross impact analysis tries to assess conditional probabilities, in a highly interconnected system.

This approach allows the generation of a large number of synthetic "future stories", that can be considered as basic schemes, or frameworks, for scenarios.

Cross impact analysis approach has generated a lot of different models, and Martelli (1992) argues that there are as many cross impact models as the number of researchers that adopt it.

As a general scheme, cross impact models can be divided into two categories:

- probabilistic methods: events' interdependency is represented through conditional probabilities, which are determined by a panel of experts;
- non probabilistic methods: only compatibility and coherence of joint events are considered, rather than precise joint events probabilities measurements. This approach is followed, among others, by Porter (1985): he argues that coherent assessment of the whole set of joint events happening (i.e. of each scenario) actually represents a logic evaluation about a scenario's likelihood. Porter's approach is a purely linguistic one, hence following Schnaars' suggestions.

Actually, Schnaars (1987; 1990) warns that cross impact analysis should avoid highly mathematically formalised procedures, as these might reduce scenarios predictive accuracy and clarity of scenarios.

Wright et al. (1988) argue that probabilistic approaches to cross impact analysis might result inconsistent if conditional probabilities are not properly derived from expert assessments, while Bunn and Salo (1993) consider that scenarios should not be evaluated from a forecasting accuracy perspective, as they are long term planning tools and their utility derives mainly from the capacity to widen decision horizons and to generate a better understanding of cause-effect mechanisms generating future events.

Recent contributions to the problem of enhancing coherence between causal relationships and probabilities have been derived from influence diagrams, neural and Bayesian networks.

Some of the most interesting applications of cross impact methods are the BASIC model developed by the Battelle Institute, and the INTERAX model,

developed by the Centre for Futures Research. The BASIC approach considers scenarios forecasting what events are more likely to happen in the future, while the INTERAX model produces also a time frame concerning when the forecasted events will happen.

## 2.6 Methodological framework of the analysis

The wide range of different approaches to scenario analysis demonstrates that there is as yet no consensus about the best method to use. Each method has its own strengths and weakness, and the various solutions proposed to overcome the limitations of specific models limitations have contributed to increase the general confusion about the state of the art of scenario analysis.

Concerning the application of scenario analysis to organic farming in the EU, the lack of detailed quantitative information about the organic products market in Europe, does not allow the adoption of trend-impact models, as they require more detailed data.

In most cases, the only available information are qualitative assessments deriving from a panel of experts. Nevertheless, this situation turns out to be in agreement with a qualitative approach to scenario analysis, that allows innovative and creative inputs from the experts to be taken into account, without focusing excessively on formal issues. Of course, hard data and statistical information, where available, were used as benchmarks in order to enhance consistency and robustness of the expert assessments.

Hence, in the present analysis, an inductive bottom-up approach[3] is used, and a selection of the most important key variables influencing the organic products market in the EU is performed, in order to reduce the otherwise excessively high number of variables to take into account.

Instead of probabilistic evaluation of the events combinations, here we prefer to adopt an approach based on fuzzy logic. Fuzzy theory is in fact a powerful tool for managing qualitative and linguistically defined variables, hence maximising the effectiveness of expert evaluation derived models.

Furthermore, it avoids computation complexity and the risk of violating probability axioms deriving from conditional probabilities determination based on expert assessments.

The concept of fuzziness arises in all those areas in which subjective judgements, assessments and decisions assume a predominant role. Decision-making analysis falls within this category, and so too does scenario analysis, which is characterized by its combining of objective and subjective elements. The literature refers to 'decision-making in a fuzzy environment' – that is, an environment in which the attributes, goals, limitations and

[3] Inductive scenarios are those where it is possible to take into account only a few key factors for forecasting: in these cases all the possible combinations of the key factors are determined (Schnaars, 1987). For a detailed survey of scenario analysis classification see in particular Schnaars (1987); Ducot and Lubben (1980); Martelli (1992); Bunn and Salo (1993).

consequences of actions are not precisely known by the decision-maker or the analyst (Bellman and Zadeh, 1970; Zimmermann, 1991). In scenario analysis, imprecision springs from the 'expert assessments', which display the intrinsic subjectivity or imprecision typical of human behaviour. The linguistic variables used to express these assessments have values which are not numbers but words or judgements expressed in natural language. Their essential feature is that they are less specific than numerical values, given that the words which we use in everyday language are polysemous and therefore imprecise. "The polysemous nature of the most frequently used words entails that imprecision and vagueness are irremovable components of a decision-making process, also because of the prevalent use of natural language, which is much more widespread than formal languages and symbolic logic" (Zanoli, 1996). The theory of fuzzy sets arose from the need to adjust models in a manner such to combine the capacity of natural language to convey polysemy and indeterminacy with the advantages of algebraic formalization and numerical representation.

In our approach, fuzzy rules describe relationships and compatibility among variables, using linguistic variable states definitions, that make the functioning of the described system and the final scenarios easily understandable.

Here we adopt a method of fuzzy scenarios originally introduced by Canarelli (1996), which is described in Annex I.

# 3 Developing interactive fuzzy scenarios for the organic market

Scenarios are a way to communicate our ideas about the future, and ideas are typically fuzzy and notoriously difficult to communicate. Besides, the method used to communicate the scenarios is strictly dependent on who is going to use the scenarios and for what.

Our scenarios are aimed at both business people and policy makers, and may be used as a "wind tunnel" for evaluating specific projects and investments in the organic sector: one the uses of our scenarios was indeed to provide assumptions for computer-aided sector modelling by other teams of the EU funded project "Organic farming & the CAP". In a similar way, our scenarios may be used as "test beds" to evaluate the viability of specific policies or business strategies, as well as a starting point for the development of new strategies and/or policies.

The scenario technique we adopted hinges upon an *inductive, bottom-up and interactive* approach.

We started by delimiting the system, in order to reduce its complexity into a manageable form for the analysis. We defined the *key factors* affecting the reference system (the market for organic products) in order to obtain a more complex representation of the possible futures (or scenarios) towards which the sector will evolve, doing so in tandem with a panel of experts (the *scenario team*) asked to assess the system under analysis.

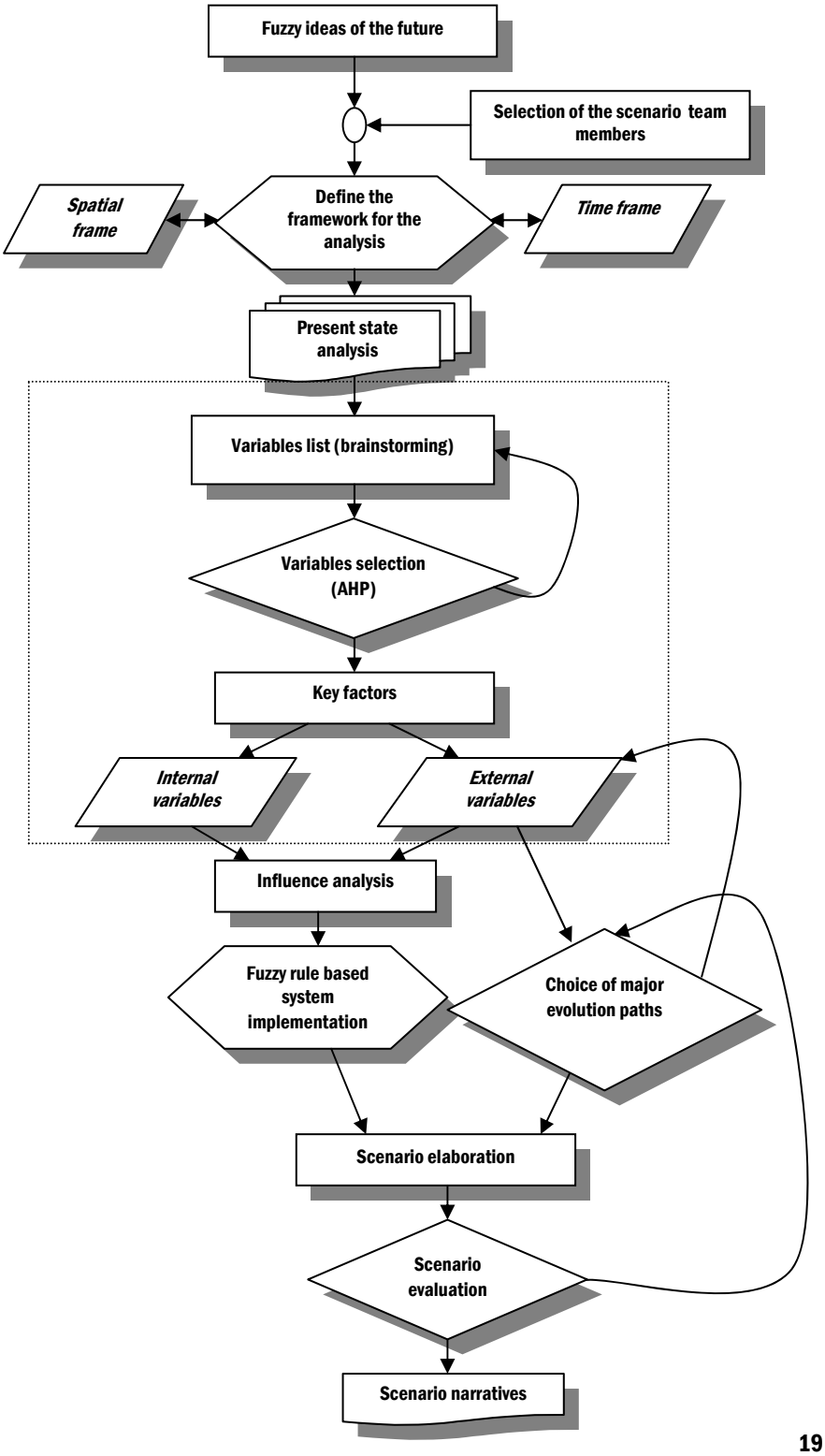
The flow chart below (Figure 4) outlines the process of scenario construction used in this report. Once the decision-making problem to address had been defined, and the panel of experts had been established, the next step was to define the framework for the analysis proper. This involved defining the general objectives of the analysis in terms of spatial and temporal frames. This preliminary phase was followed by analysis of the present state, which took various aspects into consideration. The brainstorming technique was used to draw up an initial list of variables able to describe the system under analysis. Then, in order to analyse the key variables (*key factors*) influencing the sector and thereby plot the reference system, the list was reduced with the help of a formalised decision-support tool – namely the Analytical Hierarchy Process (AHP) developed by Saaty (1980; 1986; 1987; 1989), the aim being to select the variables which describe the system most efficiently.

We then defined the *internal* and *external variables* that mark out the system's boundaries. For this purpose an *influence matrix* was constructed which enabled study of the interdependencies among the variables. On the basis of this matrix it was possible to draw up a system of fuzzy rules which constitute the 'generating mechanism' of the scenarios. Before the scenarios are generated, however, selection must be made of the most important scenarios arising from combination of the various external variables.

Once generated, the scenarios were tested for coherence and, if necessary, revised. The process concluded with the writing-up of the scenario narratives, which are reported in the next chapter.

In what follows, we will explain in more detail the "core" of the "generating mechanism" of the scenarios, that is the actual mental model which helped us to express, confront, process and communicate our collective ideas about the future of organic farming in Europe.

***Figure 4*** ***The process of scenario building***



## 3.1 The "core" model: the generating mechanism of the scenarios

### 3.1.1 Scenario team and the framework of analysis

Scenario analysis is strongly dependent on expert assessments, given the impossibility of using comparable and time series data of sufficiently long duration about the organic farming sector.

We held three scenario workshops in various places in Europe, during the period from January 1998 until the end of 1999. Repeated iterative brainstorming sessions during the scenario workshops provided the necessary information for the analysis: time and spatial frame, relevant variables, relationships among variables, and future scenarios to investigate.

The scenario team consisted of members of the Research Institutes participating the EU project "Organic farming & the CAP", who are mentioned in the list of contributors in the first pages of this book.

The *time frame* of the scenarios was fixed at 2010, as a compromise between the necessity to cover a wide time horizon and that of maintaining as far as possible a certain degree of model "reliability".

The *spatial frame* was – quite obviously – Europe.

### 3.1.2 Key-factors and influence among the variables

The scenario team ended up selecting the following list of key factors influencing the European market for organic products.

External variables: these are key factors acting as driving forces, influencing without being influenced by other variables in the system, and relate to three major domains: Society, Institutions and the Market.

Societal domain:

- Food scares
- Consumer confidence
- Farmers altruistic concerns

Institutional domain:

- Controversial technological change in conventional farming
- Market globalisation
- CAP reform

Market domain:

- Consumer price of conventional products

- Farm-gate price of conventional products

Internal variables: these are key factors influencing and being influenced by other variables in the system, and are grouped in three sets according to the reference domains they relate to:

*Micro-variables*, which broadly refer to the core neo-classical micro-economic model of a competitive market:

- Domestic demand for organic products
- Domestic supply of organic products
- Consumer price of organic products
- Farm-gate price of organic products
- Relative profitability of organic farming
- Intermediate standard products
- Processing & marketing capacity of organic farming

*Meso-variables*, which relate to societal, institutional or market linkages between the micro-economic agents (firms and households) and the macro-environment:

- Organic certification and labelling
- Availability of organic products
- Relative food quality
- Media coverage & profile
- Promotion & advertising of organic products

*Macro-variables*, which refer to the so-called "macro-environment" defining the broad set of rules to which the market operators (firms and households) are bound in their interaction:

- Political climate towards organic farming
- Agro-environmental policy
- Direct producer support for organic farming
- Market development indirect support
- Technological change in organic farming
- Knowledge systems in organic farming

A definition was agreed upon for each of these variables (Annex II), so that all scenario team members shared the same perception of what was being discussed.

During the scenario workshops – with the help of the scenario team – we then modelled the direct relations among the internal variables and between the internal and external variables.

Influence matrices and influence diagrams were the results of such modelling efforts, which are reported in Table 1 and Table 2 and in Figure 5, Figure 6 and Figure 7. A general overview of the scenario model is given in Figure 8.

The matrices report the positive and negative direct relations among the variables. Positive relations are identified by a 'plus' (+) sign, negative relations by a 'minus' (-) sign. At this stage it was essential to verify the indirect relationships that emerged among the variables and eliminate redundant information in order to create a manageable model. However, it was decided to keep some of the cyclical links (loops) identified in order to emphasise the importance of certain interrelationships among the variables, connected by both direct links and indirect links. The problem is that there are no theoretical criteria to guide the selection of which redundant links to retain and which to discard. The choice was, therefore, guided by common sense, in order to retain the maximum amount of information while still keeping the number of rules at a manageable level.

Figure 5 is an influence diagram which exhibits a subset of relationships derived from the matrices. It shows the most important links between the external variables and the micro-variables, the modelled relationships among the micro-variables themselves, and includes some other relevant links as well. Basically, it is a competitive market model, where domestic (i.e. European) demand for organic products is supposed to influence positively the supply of these products by means of the (producer) price effect, which has direct influence on relative profitability between organic and conventional production. The virtuous circle is completed by domestic primary supply having a positive linkage with the processing and marketing capacity of the organic industry, which has an inverse relationship with consumer prices of organic products and, therefore, positively influences further expansion of domestic demand. The role of substitute products (i.e. integrated products and other intermediate standards products), is also taken into account. All these micro-relationships are represented in ***blue***.

Another virtuous circle on domestic market demand is shown via the meso-level: the increase in supply of organic products pushes up the demand for organic certification services and labelling, which positively influence domestic demand by increasing the level of information to consumers as well as their confidence in organic products. This link is shown in ***green***.

The most relevant links to micro-variables from the macro variables subsystem are represented in ***black***. Technological change favouring organic farming as well as direct producer support increase the relative profitability of organic farming systems, while support to market development influences positively the processing and marketing capacity of the organic industry. A general political climate in favour of organic farming reduces the competition from substitute (intermediate standards) products, while an expansion of agro-environmental policy is neutral, giving rise to

both an increase in the relative profitability of organic farming as well as in the supply of substitute products.

All external variables have one or more direct effect on the micro-variables. Domestic demand is the internal variable most influenced by these driving forces. In particular, the societal domain affects both the demand for organic products and the supply of substitute products, while the institutional domain is specially linked with the relative profitability of organic farming. External market variables influence both demand and supply of organic products. It is worth noting the links between controversial technological change in conventional farming – a variable summarising all innovations controversial to society and farmers, including GMOs – and the demand and supply of organic products (the latter via the relative profitability variable). Our model considers that an increase in the diffusion of such innovations (e.g. GMOs) will increase the demand for 'innovation free' products with positive effects on organic products, but will reduce the relative profitability of 'innovation free' productions systems such as organic farming. All these links are shown in ***red***.

Figure 6 shows the most important links among the meso-variables, including some other relevant links as well. It can be seen that external variables have a reduced impact on this subset of internal variables, mainly depicted by the impact of societal and institutional influences on the media. External market driving forces have no influence on the meso sub-system.

This sub-model is quite simple. Organic certification and labelling has a positive link on the level of communication on organic products, represented by both the promotion and advertising variable and the media and coverage profile. All these have a positive effect on the availability of organic products, which is strongly linked with the domestic demand. Among micro-variables, the processing and marketing capacity of the organic industry has positive impacts on the level of promotion and advertising as well as on the general availability of the products. Macro-variables – namely political climate, technological change in favour of organic farming and knowledge systems – influence the meso-system via the level of organic certification services as well as by improving the relative food quality of organic products, which emphasises the virtuous cycle of product availability and media coverage. All the meso-relationships are represented in ***green***, while micro and macro influences are shown in blue and black, respectively.

Figure 7 is a summary of our model of the "macro-environment", and shows the strong impact of the external variables (particularly 'CAP reform') in defining the broad set of rules to which the organic market operators should conform. The reform of the Common Agricultural Policy is expected to directly influence all variables in the macro sub-system, excluding technical change in organic farming. Apart from CAP reform, the macro-environment is particularly influenced by Societal factors, with all other external institutional and market variables having no direct influence on this sub-system.

Political climate towards organic farming is the macro-variable that is influenced most by the external driving forces, and it is also central in our model of the macro-environment surrounding the organic sector. It influences ***directly*** all the other macro-variables (excluding technological change). Another key variable is that representing R&D, farmers education & training, information, etc. in the organic sector (knowledge systems), which has cyclic influences with the political climate as well as with the meso-variable relating to organic certification and labelling. It indirectly influences the micro sub-system via technological change in organic farming. The other macro-variables (agro-environmental policy, market development, indirect support and direct producer support) – as already mentioned – influence internal variables in the micro sub-system and, therefore, transfer the effect of an increase in political support to organic farmers in this other system. All macro-variables internal links are shown in ***black***.

*Figure 5* *Micro variables sub-system*

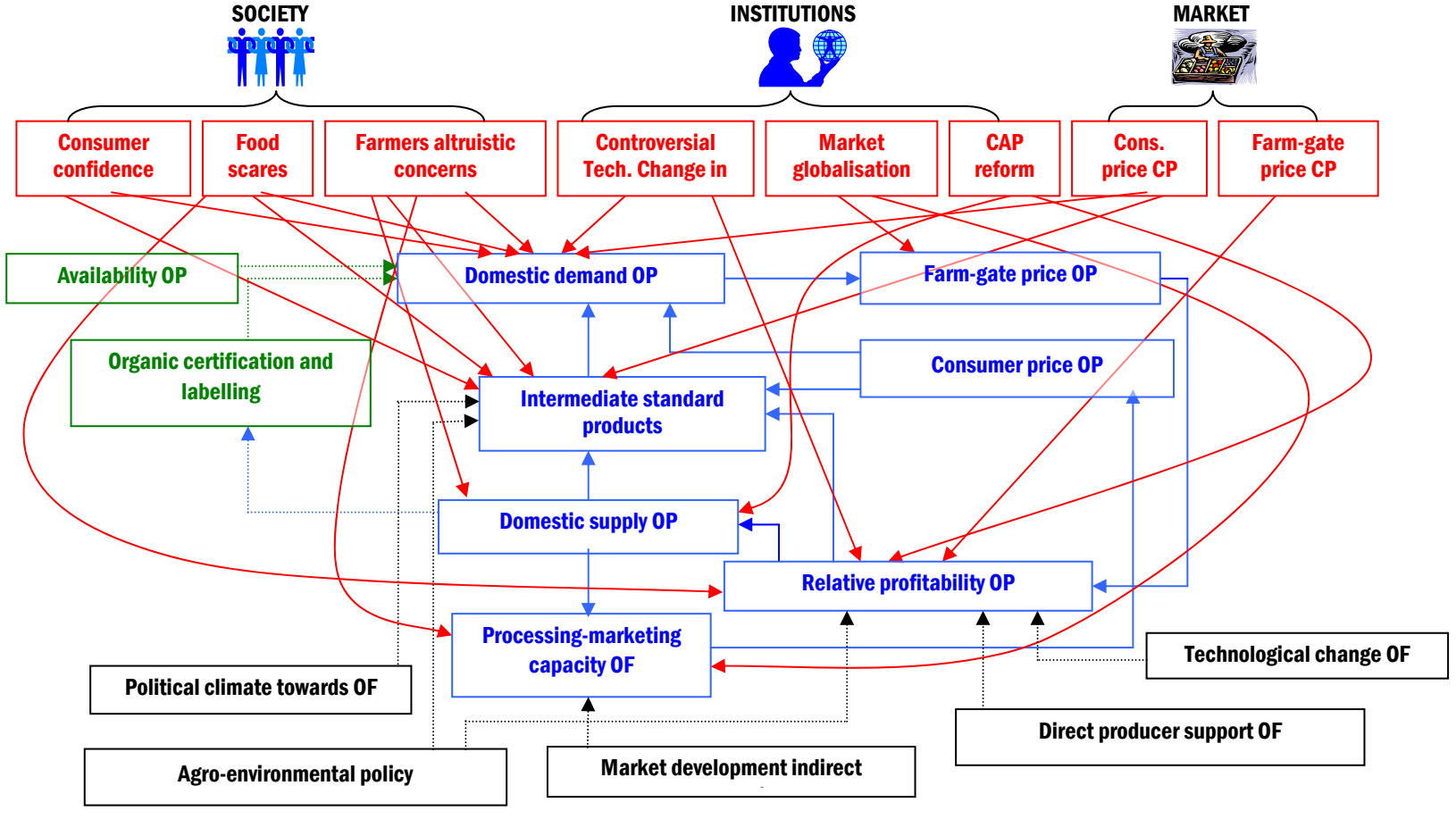


*Figure 6* *Meso variables sub-system*

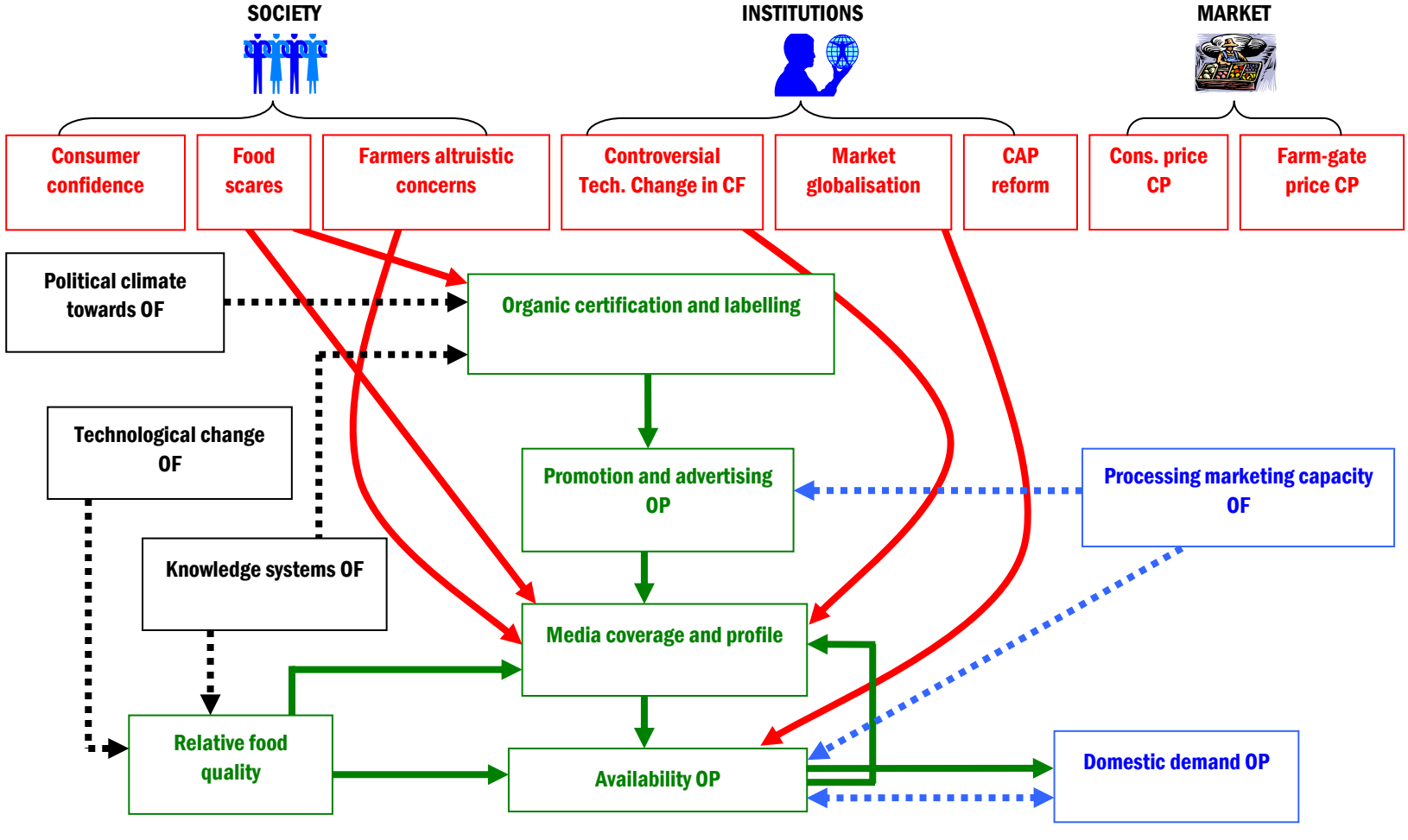


*Figure 7* *Macro variables sub-system*

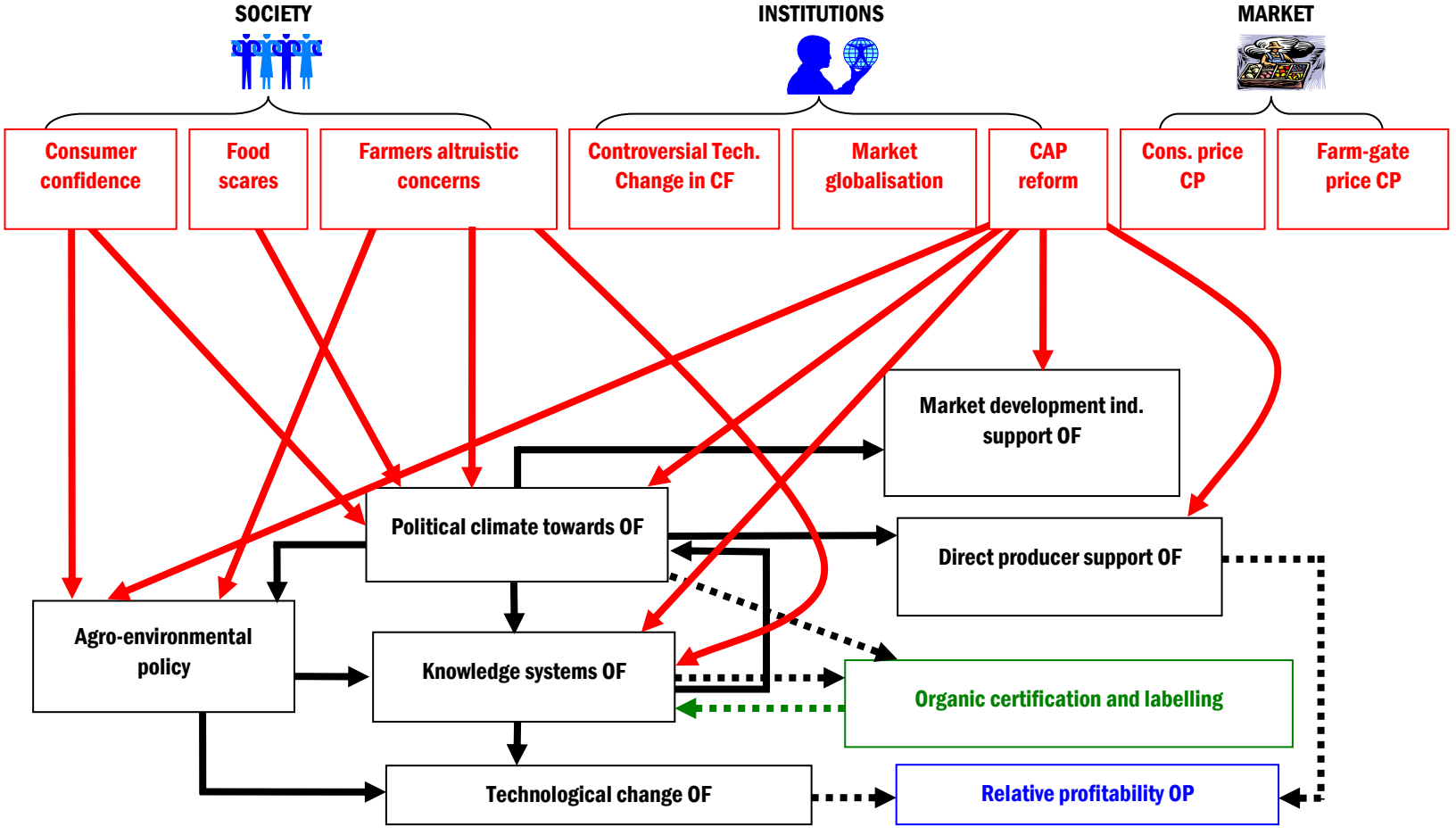
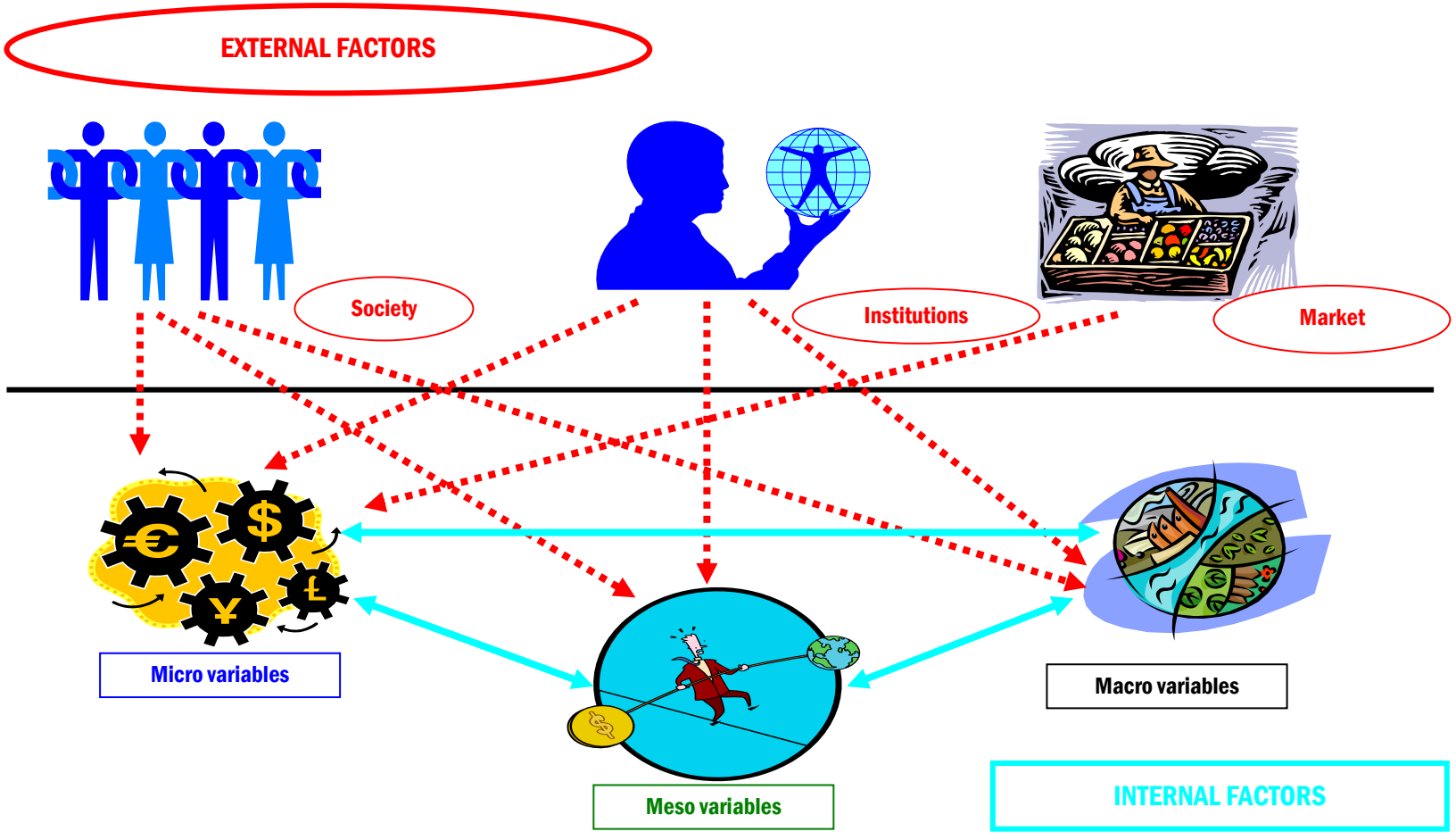


*Figure 8* *General framework of the organic farming scenario model*



### 3.1.3 Description of the possible evolution paths

Once all the information relative to the way that the variables interacted with each other had been made explicit, the next phase of the analysis involved translating the interdependencies shown by the influence matrices into a fuzzy system of rules able to represent the workings of the market for organic products in Europe. To this end, the scenario team was asked to give a qualitative definition of the states that each variable could assume, following the fuzzy scenario approach (see Annex I). In general, each variable was assigned two or three different possible states (e.g. high, low; or, high, medium, low), associated to different 'linguistic' levels or degrees of the variable.

Annex III contains the set of fuzzy rules linking the states of the variables which were the basis of the scenario generation.

***Table 1 Influence matrix: external variables***

| | Domestic demand for OP | Domestic supply of OP | Organic certification and labelling | Availability of OP | Consumer price of OP | Farm gate price of OP | Relative profitability of OP | Relative food quality | Media coverage & profile | Promotion & advertising of OP | Political climate towards OF | Technological change in OF | Intermediate standards products | Agro environmental policy | Processing & marketing capacity of OF | Direct producer support for OF | Market development indirect support in OF | Knowledge systems in OF | Total relations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Consumer confidence** | + | | | | | | | | | | + | | + | + | | | | | 4 |
| **Food scares** | + | | + | | | | + | | + | | + | | + | | | | | | 6 |
| **Farmers altruistic concerns** | + | + | | | | | | | + | | + | | + | + | + | | | + | 8 |
| **Controversial technological change in CF** | + | | | | | | - | | + | | | | | | | | | | 3 |
| **Market globalisation** | | | | + | | - | | | | | | | | | + | | | | 3 |
| **CAP reform** | | + | | | | | + | | | | + | | | + | | + | + | + | 7 |
| **Consumer price of CP** | + | | | | | | | | | | | | + | | | | | | 2 |
| **Farm-gate price of CP** | | | | | | | - | | | | | | | | | | | | 1 |

Legend: CP = conventional product OP = organic product
CF = conventional farming OF = organic farming

***Table 2*** ***Influence matrix: internal variables***

| | Domestic demand for OP | Domestic supply of OP | Organic certification and labelling | Availability of OP | Consumer price of OP | Farm gate price of OP | Relative profitability of OP | Relative food quality | Media coverage & profile | Promotion & advertising of OP | Political climate towards OF | Technological change in OF | Intermediate standards products | Agro-environmental policy | Processing & marketing capacity of OF | Direct producer support for OF | Market development indirect support in OF | Knowledge systems in OF | Total relations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Domestic demand for OP** | | | | + | | + | | | + | | + | | | | | | | | 4 |
| **Domestic supply of OP** | | | + | + | | | | | | | + | | - | | + | | + | + | 7 |
| **Organic certification labelling** | + | | | | | | | | | + | | | | | | | | + | 3 |
| **Availability of OP** | + | | | | | | | | + | | | | | | | | | | 2 |
| **Consumer price of OP** | - | | | | | | | | | | | | + | | | | | | 2 |
| **Farm gate price of OP** | | | | | + | | + | | | | | | | | | | | | 2 |
| **Relative profitability of OP** | | + | | | | | | | + | | | | - | | | | | + | 4 |
| **Relative food quality** | | | | + | | | | | + | | + | | | | | | | | 3 |
| **Media coverage & profile** | + | + | | + | | | | | | | + | | | | | | | | 4 |
| **Promotion & advertising of OP** | + | | | | | | | | + | | | | | | | | | | 2 |
| **Political climate towards OF** | | | + | | | | | | + | | | | - | + | | + | + | + | 7 |
| **Technological change in OF** | | + | | + | | | + | + | | | | | | | | | | | 4 |
| **Intermediate standards products** | - | | | | | | | | | | | | | | | | | + | 2 |
| **Agro-environmental policy** | | | | | | | + | | + | | | + | + | | | | | + | 5 |
| **Processing & marketing capacity of OF** | | | | + | - | | | | | + | | | | | | | | | 3 |
| **Direct producer support for OF** | | | | | | | + | | | | | | | | | | | | 1 |
| **Market development indirect support in OF** | | + | | | | | | | | | | | | | + | | | | 2 |
| **Knowledge systems in OF** | | | + | | | | | + | | | + | + | | | | | | | 4 |
| **Total relations** | *6* | *4* | *3* | *6* | *2* | *1* | *4* | *2* | *7* | *2* | *5* | *2* | *5* | *1* | *2* | *2* | *1* | *6* | |

Legend: CP = conventional product OP = organic product
CF = conventional farming OF = organic farming

### 3.1.4 Definition of the different possible representations of the future

As already mentioned, the scenarios were constructed on the basis of hypothesised states associated with the external variables which are the 'driving forces' of the system.

The scenario team was then able to delineate a group of scenarios on the basis of hypothesised trends in the external variables. Each expert was asked to express his/her subjective assessment of the possible development of the market for organic products in Europe by means of a coherent combination of the eight external variables previously defined. The result was a set of 15 scenarios, some of which were very similar to each other. To avoid redundancy and reduce the number of scenarios, the most similar of them were clustered, while the markedly contrasting scenarios were singled out, in order to cover the wider range of possible future evolutions

Five scenarios (of which three had two variants) emerged from this further scenario session. They are presented in Table 3 as combinations of the various states associated with the external variables. The first column shows the present state of the variables according to the scenario team.

***Table 3 The final scenarios and the states of the external variables***

| | **Scenarios** | Current State | Business as usual | Gloomy liberalisation | World Trade Boom | | Fortress Europe | | Organic Paradise | |
|---|---|---|---|---|---|---|---|---|---|---|
| **External variables** | **States** | | | | consumers lose | consumers win | open to trade | barriers to trade | open to trade | barriers to trade |
| **Consumer confidence** | low | | (✓) | ✓ | | | | | | |
| | average | ✓ | (✓) | | | | (✓) | ✓ | | |
| | high | | | | ✓ | ✓ | (✓) | | ✓ | ✓ |
| Food scares | low | | | | | ✓ | | ✓ | ✓ | ✓ |
| | high | ✓ | ✓ | ✓ | ✓ | | ✓ | | | |
| Farmers altruistic concerns | low | ✓ | ✓ | ✓ | ✓ | ✓ | | | | |
| | high | | | | | | ✓ | ✓ | ✓ | ✓ |
| Controversial TC in CF | decreasing | ✓ | | ✓ | | ✓ | | ✓ | | |
| | increasing | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Market globalisation | low | | | | | | | ✓ | | (✓) |
| | average | ✓ | (✓) | | | | ✓ | | (✓) | (✓) |
| | high | | (✓) | ✓ | ✓ | ✓ | | | (✓) | |
| CAP reform | unfavourable | | | ✓ | ✓ | ✓ | | | | |
| | slightly favourable | ✓ | ✓ | | | | | | | |
| | highly favourable | | | | | | ✓ | ✓ | ✓ | ✓ |
| Consumer price of CP | low | | | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| | average | | (✓) | | | | | | ✓ | |
| | high | ✓ | (✓) | | | | | | | ✓ |
| Farm Gate price of CP | low | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| | average | | ✓ | | | | | | | ✓ |
| | high | ✓ | | | | | | | | |

Note: When a value is intermediate between two states these are both indicated with (✓).
Legend:
CP = conventional product OP = organic product
CF = conventional farming OF = organic farming
TC = technical change

# 4 The scenarios

This chapter describes the distinctive features of the five possible forms – plus some variants – that the European market for organic products may have assumed by 2010. It does so in terms of trends in exogenous and endogenous variables deemed to be key factors in the sector examined. Each scenario is illustrated through a narrative describing the underlying external variables hypothesis, and the consequences on internal variables by the year 2010.

Also, graphical illustrations of major variables are provided, in order to better appreciate time dynamics and the extent of scenarios different behaviours.

## 4.1 Scenario narratives

The scenario narratives are illustrated in a reader-friendly style, by means of the considerations of three hypothetical subjects:

***Agronews Broadcast***, that is a network mainly specialising in themes concerning EU agriculture, and transmits periodical short analyses about conjuncture in the agricultural sector, with some specific attention to environmental issues.

***Mr John Dairy*** is a farmer and represents the average farmer's opinion, though he shows a certain interest in issues concerning organic farming.

***Mrs Maggie Pie*** is a consumer who comments on the problems and opportunities she faces when shopping for food.

Jointly these three actors offer a view of the scenarios from three distinct perspectives: the "institutional" one, given by the broadcast, that reflects the hypothesis concerning the external variables underlying each scenario; and the consumer and farmer ones, that consider the effects of the different hypotheses on external variables on the market of organic products, as viewed from the demand and supply side respectively.

### 4.1.1 Gloomy liberalisation

The purpose of this scenario is to describe the impact of deregulation and globalisation on organic farming, where the EU experiences a deep economic crisis and a generally austere economic environment.

***Agronews Broadcast*** says… "We are experiencing a reduction of trade barriers for agricultural commodities, that increases competition among farmers, among others because of the strong development of innovations concerning new products and processes in agriculture. Such a situation determines increasing managerial difficulties for farmers, who in some cases can be forced out of the market.

From the demand side, the news is bad as well: consumer confidence is low, while concerns about food quality consequences on health are increasing, given the difficulty and confusion concerning the identification and traceability of foodstuffs.

The current approach to agricultural and trade policy leads to a substantial reduction in farming support, accompanied by a general price reduction in agricultural commodities, deriving from growing global competition. Organic farmers cannot escape the negative trend for agricultural commodities, and their only choice of maintaining a market share depends on their ability to adopt marketing strategies that can justify a price premium for organic products. The negative situation for agricultural environment in general, is emphasised by the augmented propensity of farmers to focus on economic aspects rather than on environmentally friendly agricultural practices, which becomes of secondary importance given farmers severe economic difficulties."

***Mr J. Dairy***: "I am quite worried about the strong reduction in policy intervention for supporting agriculture, and I wonder how farmers can face the removal of income support: competition with non EU countries is growing rapidly: I fear that many colleagues of mine could not stand the low prices without some financial support. Well, in this context it is really difficult to think something other than trying to maintain income as much as possible at the previous levels. It is really hard to imagine adopting some agro-environmental practices, especially as the EU does not support them anymore. Furthermore, even if I wanted to do it all by myself, I do not think I could: it's difficult to find somebody that can give me some advice or training about how to adopt organic farming techniques, and technical innovations for organic farming are very few. Consumers too have their own problems dealing with the negative economic trend, and do not seem very interested in the more expensive organic products.

***Mrs M. Pie*** agrees: "Under these conditions I'm afraid I cannot worry too much about the quality of the food I eat. In fact, I see lots of consumers that fear their income will be reduced in the near future, and others who are no longer sure of keeping their jobs because of the increasing competition and instability of the economic systems. Furthermore, the issue of environment in general seems to be nearly forgotten: nobody talks about it anymore, there is less news in the media concerning the environment or organic farming, and politicians are usually more involved in solving other social and macro economic problems. Who knows, maybe environment and quality of food are not big problems anymore… Anyway, even if I wanted to buy some organic food, it's getting difficult to find it in the shops, as it is not well advertised, and there is not so much choice, as the range of organic products is quite poor".

***Mr J. Dairy*** "The reason for the poor availability of organic products depends a lot on the low demand for them: you know, only rich households can afford to eat organic. Prices are in fact quite a bit higher than those of conventional products, not only because of the difficulties of farming organically, but also because of the high processing and distribution costs involved. At the end of the day, the farmer gets a very low price for organic

products, but the consumer has to pay much more. Believe me, it would not be very convenient for me and for my colleagues to farm organically, so you cannot expect a great variety of organic products. Why don't you try some of those intermediate standard products? It seems that those who produce them can take some advantage from the confusion and the poor control on organic products, and sell them as organic: anyway, I think you will hardly be able to notice the difference…with your own senses."

### 4.1.2 World trade boom

This scenario describes the development of the European agricultural sector in response to a regulated increase in free trade, where only rules necessary for assuring correct competition and food safety are adopted.

Two variants have been considered, according to consumer reactions to the adoption of a free-trade model for the economy. The first variant (named "consumers lose") delineates a situation where consumers display confidence in agricultural product quality and show no suspicion or resistance to technological changes in the agricultural sector, especially in the field of biotechnology and genetically modified organisms. The second variant ("consumers win") is a scenario in which European consumers become increasingly aware of the importance of the quality of the food they eat, and of the health implications of its consumption, given the high visibility of food safety issues in society. Likewise, consumers are more concerned about the effects of (bio-)technological innovations in agriculture, which gives rise to a broad debate with the chemicals and seed producing multinationals on one side, and consumers on the other.

The results of the fuzzy rule-base reasoning show that actually the two versions are very similar, apart some slight differences concerning agro-environmental policy, mass media coverage and intermediate standard products performance.

***Agronews broadcast*** says… "Trade liberalisation looks to be the key factor in economic growth, given that its effect in terms of the expansion of markets, and hence increased competition, heightens the efficiency of economic systems. The shift of the global demand function and higher productivity generates a growth of GDP in Europe and stimulates consumers' confidence concerning their future welfare.

In this environment, profit maximisation is the goal pursued by all economic actors, and farmers are no exception. The importance given to economic issues weakens the environmental concerns of farmers, who may view organic methods as hampering efficient farm management. In general, the dominant cultural paradigm is oriented more towards utilitarian matters than towards altruistic concerns.

The globalisation of markets facilitates the introduction of new technologies, notably biotechnologies and GMOs, which become crucial factors in the achievement of greater economic efficiency. The prices of agricultural products are closely influenced by the competition raised by extra-European

products. The consequence is a substantial fall in the prices of conventional agricultural products, which is reflected in lower farm-gate prices. Thus, liberalisation leads to the almost total elimination of the external protection provided by the CAP, with the consequence that farm-gate prices are compelled to align themselves with those prevailing on world markets. The move towards free-trade and the reduction of policy support under the CAP also has consequences for organic farming, which suffers large cutbacks in its economic support."

***Mr J. Dairy:*** "CAP has changed so much over the last years! Once farmers discussed about prices or direct income subsidies, but now the only important thing seems to be the market. Now you can sell your products or buy whatever you need for your farm almost everywhere and very easily, but you can not expect any help from the EU. Prices are so low that you must be extremely efficient in managing your farm, and there is no room for "non marketable" activities. Anyway, the EU has cut down a lot on all the agro-environmental measures and it is clear that they pay no attention at all to organic farming: in fact, they have drastically reduced any kind of support for organic farmers. Furthermore, the level of research and technological change in organic farming has reduced a lot, and this prevents farmers from adopting or continuing organic practices. At the end of the day, farming has become just like any other economic activity, and the only thing farmers must think of is maximising profit, using all the new technologies for agriculture that are now available, which are exclusively applicable to conventional farming".

***Mrs M. Pie:*** "I have to say that this globalisation has widened a lot the range of food products: now they are coming from all over the world, and many of them are produced with the new GMO techniques: it seems they work well! I have noticed that in this situation the only thing missing is organic products: it is getting difficult to find them, and in any case their range is not at all comparable to that of the other products. Anyway, this is a minor problem, as I do not believe that organic products are better than the others: if they were, I think the media would say so sometimes, wouldn't they?"

***Mr J. Dairy*** realises that the general conditions of agricultural markets are not favourable to organic farming: "Given that consumers incomes have increased, I would expect that they can spend more money on organic products, but I can see that they are not at all interested in them. Maybe it is because they trust the new technology products, or maybe just because they also are only concerned about money, who knows... What I do know is that under these conditions organic farming has no opportunity to take off: consumers do not want organic products, farmers are dissuaded from entering the sector, both by the removal of direct economic support and by the fall of farm-gate prices of organic products brought about by marked globalisation and stagnant demand, and also the marketing capacity for these products is quite low. Believe me, now that profit is the only goal, you'd rather go for conventional farming. "

***Mrs M. Pie***: "Maybe, if people changed their mind about biotechnologies and GMOs, then organic products might benefit…"

***Mr J. Dairy***: "Hum, I do not think so. It is likely that the only things happening would be some more talk-shows on the argument. No, without any concrete policy support, organic farming cannot develop. Probably, only intermediate standard products would benefit more from food scares, since they do not require big production changes from the conventional standards, and are therefore less dependent on policy support."

### 4.1.3 'Surprise-free' scenario (business-as-usual)

This scenario describes the development of the organic sector on the assumption that no significant change is made to the decisions arising from the Berlin agreement on Agenda 2000, so that the general policy attitude towards organic farming is a slightly positive one, supporting the sector mainly through the application of EC Reg. 1257/99.

***Agronews Broadcast*** says… "The underlying assumption of policy makers seems to be that European agriculture needs to increase its competitiveness, hence getting in the condition to face international competition with lower supporting measures. The globalisation of agricultural markets increases as a consequence of the lowering of barriers against free trade: the result is a fall in farm-gate prices which is only partially transferred to consumer prices.

Farmers perceive this situation as potentially negative for their income, and their concerns are mainly of maintaining as much of their competitiveness as possible, even if this means that environmental issues might be sacrificed. No changes are envisaged in the social perception of food safety or in the goals pursued by farmers

Increasing globalisation on one side and the ageing population on the other, leads to reduced consumer confidence in economic and social welfare, but the population is extremely worried about the long-term effects of genetically modified food products and about other controversial technological changes in agriculture."

***Mr J. Dairy: "***Well, things have not changed a lot over the last years, and from what I see farmers have the same problems as ever. Prices are now much lower, because of the gradual reduction in EU support, and there is growing competition from products coming from other countries. In this situation organic farming cannot help, I'm afraid. I can see that there could be some potential demand for organic products, and still some CAP measures can be of help for organic farming, but I think it's not enough. In fact, the situation of the organic sector is quite depressing: there are no product or process innovations in organic farming that might stimulate improvements in its production techniques or raise the quality of organic products over that of conventional ones. This situation implies that there is an almost total absence of research, information and training for organic farmers. Besides, farm gate prices are much lower than those paid by

consumers, because the marketing sector is still underdeveloped, and the agro-food industry seems to have little interest in processing organic products. Maybe it is because they do not believe in a positive evolution of the sector."

***Mrs M. Pie:*** "I would buy some organic food, because I really do not like all those strange genetically modified products coming from who-knows-where, but the problem is that their price is quite a bit higher than other products, and, you know, nowadays money is an issue! It seems that only rich people have the right to eat good food… Anyway, I have to say that even if I had more money, organic food would not be as appealing as it should, because there are so few products to choose, and they are not advertised at all: sometimes it is difficult to identify them or to distinguish them from other products."

***Mr J. Dairy:*** "Dear Mrs Pie, you are right, I think this depends on the scarce information on labelling and certification for organic products: it is already difficult enough to farm organically, and at the end of the day, if you cannot sell your products as organic, well, it turns out to be a nonsense, given that we do not even get any extra money. Under these conditions, organic farming is not a good option: after all, we farm to make a living from our activity and not to take care of the environment!"

***Mrs M. Pie:*** "Well, given all these difficulties with organic products, I can try some of those from integrated agriculture: they look just as good as the organic ones, and are probably better than the GM ones."

### 4.1.4 Fortress Europe

This scenario considers a general policy development in line with that envisaged by Agenda 2000, but with a general attitude in favour regulation concerning trade and globalisation.

It divides into two variants, according to hypothesised reactions by the World Trade Organisation (WTO) due to the cautious behaviour of the EU about market liberalisation. In the first variant, a compromise is reached between the EU and the other countries (mainly USA), while in the second no agreement is reached. The second scenario therefore envisages a slowdown in market liberalisation, closer control on technological innovations in agriculture, and therefore less concern about their possible harmful effects on health.

***Fortress Europe open to trade***

***Agronews Broadcast*** says… "The European Commission's policy, which defends a culturally and environmentally-based reform appropriate to the specific circumstances of the European countries, is accepted as the basis for further WTO trade agreements. Given that an agreement has been reached between EU and WTO members, some market globalisation for agricultural products is achieved anyway, which is accompanied by the spread of new farming technologies – biotechnologies in particular.

In exchange for openness to imports and the lowering of domestic prices, support is given to small family-run farm businesses, following the blueprint of the current version of the 'Green box'. Given that this is a compromise, agriculture achieves relatively modest growth, although the consumer and farm-gate prices of food products decrease.

The commodities price reduction, and a general positive effect of globalisation on the entire EU economic and social system, determine a moderate upturn in consumer expectations concerning economic growth. A drawback in this globally positive scenario is that the wide adoption of controversial technological innovation in agriculture increases consumer fears about the quality of food and its implications for human health, which becomes a central issue."

***Mr J. Dairy*** considers this as a very favourable situation for agriculture in general, and for organic farming in particular: "I appreciate that the EU realises our difficulties in facing international competition, and maintains some measures for protecting our products. Also, I like that many farmers try to manage farming environmental problems somehow. I think I too will take advantage of some of the numerous opportunities that the CAP provides for agro-environmental issues, probably one of those that refer to organic farming: the direct support for organic farmers is definitely something that helps a lot. Apart from financial measures, organic farming seems a good option anyway, because there are now good advisory services for farmers converting or already converted, and there is also a continuous flow of innovations concerning new techniques, machinery, etc. specifically aimed to organic farming. Now it is possible to produce more and better products and also the distribution channels for organic products have improved their efficiency".

***Mrs M. Pie:*** "There is much ado about these organic products: I see a lot of advertising, and it seems that also the mass media are very interested in them. Actually, I think that they are worth the higher price you have to pay, since I really prefer spending some more money for having good quality food. In fact, I am really scared of those hormone-treated beef or of cereals grown from genetically modified seeds: I fear they are no good at all for our health! Anyway, there is a wide variety of organic food, so that for almost any kind of product you can find the organic version, and you can be sure of the organic quality of the food, since labels are easily recognisable and advertised".

***Mr J. Dairy:*** "You know, Mrs. Pie, now that so many farmers have converted to organic practices, it is easier to meet the requirements of you customers, and I am glad to hear that you understand that good quality food can cost a little more. I have to say that organic products seem to be a good bargain: if you consider that prices are higher than for the conventional products, that now much more people want to eat organic, and that there is also financial support from the EU, well, unless you own a very large and high-tech farm, you'd rather go for organic farming. And then, last but not least, I am really happy to know that I can run my farm properly and also do something to protect the environment. I think it is right that those who can stay competitively on the international market stick with

conventional farming, but it is a wise thing that smaller farmers have the opportunity to maintain their activity offering alternative good organic products while safeguarding the countryside".

***Fortress Europe with barriers to trade***

***Agronews Broadcast*** says… "Although domestic European policies on support for agriculture and rural development remain constant, they are not accepted at the WTO negotiations. Consequently, the Uruguay Round agreement is the only basis for definition of agricultural trade, and disputes conclude in frequent and increasingly harsh reprisals by foreign trade partners (above all the USA). As a consequence, trade globalisation takes place at a lower rate, causing a consistent but slow reduction in farm-gate prices.

The EU still plays a significant role in agricultural policy in general, hence also in agro-environmental terms, facilitating the control of controversial technological change innovation in agriculture. Furthermore, public opinion is quite interested in food safety issues, though the lower consumer confidence about economic growth does not "pull" the demand for organic farming products."

***Mr J. Dairy*** is a little confused about the situation of agriculture in general, and of organic farming in particular: "I would say that this could be a nice situation for farmers, and organic farmers in particular, since the EU has maintained some measures for helping farmers to help international competition and for supporting their income. Furthermore, in recent years they have improved the specific aids for supporting organic farmers incomes, as well as those for developing the distribution and marketing of organic products. Also considering what is going on outside the "umbrella" of EU measures, the circumstances for organic farming could be considered as favourable, as there are many new technical solutions and in general the know-how of organic farmers has increased a lot. Nevertheless, I would not say that the situation of the organic sector is entirely positive as the results in terms of market growth are not encouraging. It looks like consumers, after all, are not so interested in organic products, or in other intermediate standards products".

***Mrs M. Pie:*** "Maybe you are right, Mr Dairy. Personally I have nothing against organic products: on the contrary, I think they are good, and maybe better than the conventional ones, but honestly I do not believe that the latter are low quality products, or even dangerous for our health: the EU has prohibited the import of GMOs and other "strange" products for a long time now, so I think that now the choice between conventional and organic product is mainly a matter of taste. And from this point of view, organic products are not so appealing to consumers: the range of organic products is poorer than the conventional one, and there is not much information about them. Also, I have started noticing some advertising for organic products only over the last few years, so you can understand, dear Mr Dairy, why these products happen to be in my shopping baskets only occasionally. Furthermore, they are not so cheap, and price is not a secondary issue nowadays."

***Mr J. Dairy:*** "Dear Mrs Pie, prices are not very low because competition is not that high, but this is not necessarily a bad thing: it allows many farmers, specially those with small farms, to maintain their income. Besides, I can make quite good profit by producing organically, because I am paid higher prices than producing conventionally, and there is also the EU direct producer support to take into account. In this situation, I believe that if organic products have not reached high market shares, well, much of the responsibility is on the consumers side: it seems that unless TV news say that there is some "food safety crisis", you do not worry too much about what you eat."

### 4.1.5 Organic paradise

This scenario depicts the conditions that are considered optimal – though realistic – for the development of organic farming in Europe. Two variants have been considered, one with a low degree of market liberalisation and higher price levels for agricultural commodities, and the other with a slightly higher market liberalisation, and lower prices level. Results have shown negligible differences between the two versions, if we exclude intermediate standards and, to a lesser extent, organic products prices.

***Agronews Broadcast*** says… "Europe is experiencing a period of prosperity and economic stability which has increased the level of consumer welfare and confidence. Consumer expectations concerning economic growth are higher, and their propensity to consume consequently increases. Owing to their higher standard of living, consumers are more interested in the quality of life, and this generates greater interest in quality food products and in environmental issues.

The concept of quality assumes a broader connotation. It now concerns not only the nutritional and health-related aspects of the products, but also their ability to meet and satisfy consumers' needs. The safety of food increases, and so too does the confidence of consumers in what they eat. Worries about genetically modified products and other controversial technological

changes induces growing numbers of consumers to buy organic products, which they perceive as safe and guaranteed.

Farmers, for their part, increasingly participate in the debate on the ethical, cultural and environmental implications of productive processes. The maximisation of profit is no longer their only objective, and it is accompanied by numerous other goals, among which is protection of the environment."

***Mr J. Dairy:*** "I am pleased to see that all the factors able to stimulate the supply of organic products are available: greater research efforts, better information and technical advice, and specific technological innovations, and I am proud to say that this positive situation has developed pretty much thanks to the significant involvement of farmers in changing the shape of the agricultural business in Europe. Really, farmers can now be considered to be playing an active role in the environment. But it would be unfair not to acknowledge the great support of EU institutions and the essential role played by the consumers. Actually, these three elements have jointly worked to produce what it is not an exaggeration to describe a 'paradise' for organic farming. CAP has thoroughly supported agro-environmental measures, with specific attention to organic farming. Lots of measures have been proposed, not only financial, like direct income aids or marketing development measures, but also managerial, and many activities which exert a positive impact on the environment, such as agro-tourism and rural development, have been encouraged. Consumers, on the other side, have shown such an interest in organic products, that even farmers that have long been sceptical about organic farming have decided to convert."

***Mrs M. Pie:*** "You know Mr Dairy, I really do not see any good reason why I should not buy organic products: their quality has increased a lot in recent times, and now the product range is really large. There are a lot of good advertisements for organic products, and also labelling has improved, so that now it is easy to find them and to distinguish them from conventional products. By the way, I have to say that I do not really like all the new technologies they are using for ordinary food products: I do not think they are either ethical or healthy. Well, conventional products are a little cheaper than organic ones, but money is not the only thing in life!"

***Mr J. Dairy:*** "Well, conventional products are cheaper, but organic products are not expensive anyway: now that supply has increased so much, prices have dropped. Nevertheless, organic farming is certainly a good bargain, and I would say that it is much more profitable than conventional farming, because of the high demand and EU support. Also, it is much easier to sell organic products to the processing industry or to distribution channels, as now we farmers have reached a good production level, which is also quite stable both quantitatively and qualitatively, while the processing and marketing sectors have greatly improved their capacity to deal with organic products.

I notice that the greater attention being paid to environmental issues and health has also benefited products from integrated agriculture, that have more or less maintained their market share, despite the success of organic

products: the only losers seem to be the conventional producers. Organic farming is indeed the most efficient and innovative way of farming!"

***Mrs M. Pie***: "Do you think that the positive situation for organic products could be maintained even if the EU adopted a more liberal trade policy?

***Mr J. Dairy***: "Yes, I think so, also because presently barriers-to-trade have been substantially reduced compared to some years ago, so things would not change a lot. Simply, I would expect prices to drop a little, also for organic products, but this will be a further advantage for you consumers. The only major change I can imagine, is that under these conditions farmers producing intermediate standard products may have some troubles: consumers who really care about environment and health have now lots of organic products at reasonable prices, while the others feel protected anyway by the overall improvement in the hygiene and safety of foodstuffs in Europe."

## 4.2 Scenarios graphical representations

Figures 9 to 20 provide a graphical illustration of a variables selection for each scenario. The necessity of a selection derives from the high number of variables involved in the system, which would complicate too much the graphical representation. Hence, referring to the theoretical distinction among macro, meso and micro sub-systems (see previous chapter), all variables of the micro sub-system have been selected, as they are probably the most directly related to the market and production sectors of organic farming, while for the two other subsystems, we have chosen those presenting the most discriminating trends, and/or those that have been considered as best representing the sub-system they belong to. Anyway, most of the selected variables show, for the various scenarios, trends very similar to those of the non-selected variables of the same subsystem. For example, in the macro sub-system, the variable 'Technological change in organic farming' shows a behaviour similar to that of "Knowledge systems in organic farming", from which it is influenced, while 'Agro-environmental policy' behaves pretty similarly to 'Political climate towards organic farming'. Again, in the meso sub-system, the variable 'Promotion and advertising for organic products' has similar trends to that of 'Organic certification and labelling'. This is an index of redundancy of some links, but – as we said before – we have preferred to allow for some redundancy in the model in order to avoid leaving out important information and for the sake of the clarity of exposition.

The list of the selected variables for graphical representation is as follows:

| | |
|---|---|
| ***Macro variables***: | Political climate towards organic farming |
| | Direct producer support for organic farming |
| | Knowledge systems in organic farming |
| ***Meso variables***: | Organic certification and labelling |
| | Availability of organic products |
| ***Micro variables***: | Domestic supply of organic products |
| | Domestic demand for organic products |
| | Relative profitability of organic farming |
| | Processing and marketing capacity for organic products |
| | Farm gate price of organic products |
| | Consumer price of organic products |
| | Intermediate standards products |

Care should be taken in reading the graphs, because they refer to scenarios described in terms of fuzzy logic. Defined verbally, every variable assumes two or three linguistic states (see Annex II); each of these fuzzy sets (or fuzzy numbers) is defined by a membership function (as mentioned, all the functions in our model are triangular in form). Defined for each variable, therefore, is a specific initial value which is 'transformed' by its corresponding membership function into degrees of membership, i.e. the degree of compatibility between the value assumed by the variable and the linguistic expression with which the variable was previously defined. After defuzzification, a real number is obtained by transforming each output obtained at the inference stage and expressed in terms of a fuzzy sub-set (deriving from the combination of all the rules). However, in order to avoid errors of interpretation, the numbers along the y-axis should be read in qualitative and lexical terms, so that '0' stands for 'minimum value' and '1' for 'maximum value', rather than as conventional numerical values. Moreover, the trends of certain variables in a particular graph – for example, those relative to 'agricultural price' variables – cannot be compared against each other; if the consumer price line is below the farm-gate price line, this does not entail that consumer prices are lower than farm-gate prices, given that their numerical definition changes from one situation to another. The linguistic state 'low' relative to the consumer price variable may be associated with numerical values which, in the case of the farm-gate price variable, fall within the linguistic state 'high'.

A group of scenarios formed by "Gloomy liberalisation", "World trade boom" in the two versions, and "Business as usual" show similar trends for all the internal variables, describing an overall unfavourable situation for organic farming.

On the opposite side, the two variants of the "Organic paradise" and the "Fortress Europe – open to trade" jointly show a favourable development for organic farming, and again similar trends for all the internal variables.

An intermediate situation is that described by the "Fortress Europe – with barriers to trade" scenario, which for some variables shows similar dynamics as those of the first group, while for some others it is much closer to the second group.

***Figure 9*** ***Political climate towards organic farming***

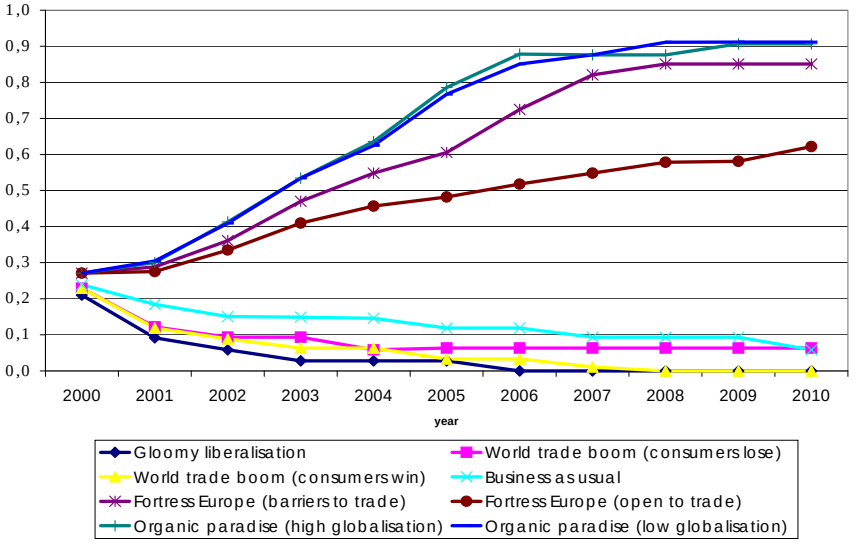



***Figure 10*** ***Direct producer support for organic farming***

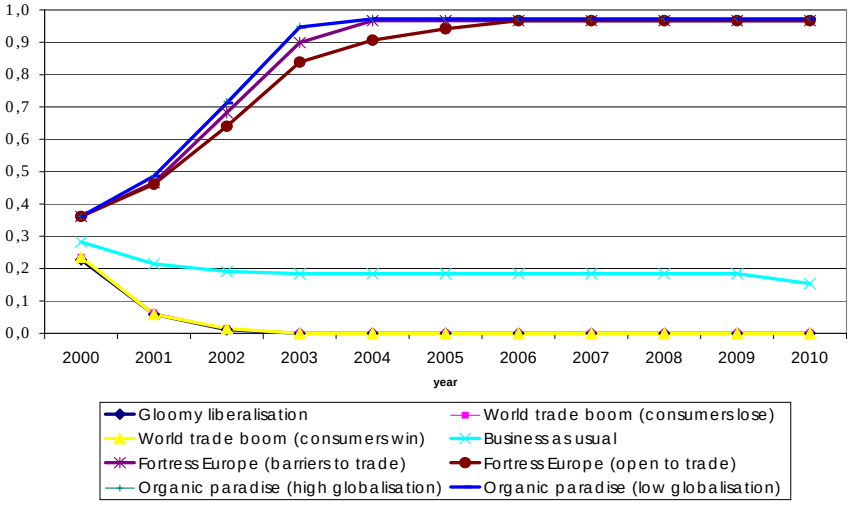


***Figure 11*** ***Knowledge systems in organic farming***

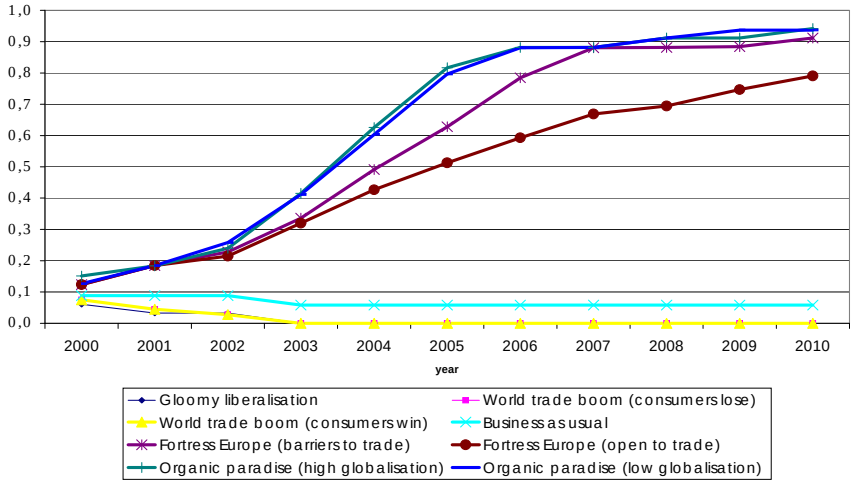



***Figure 12*** ***Organic certification and labelling***

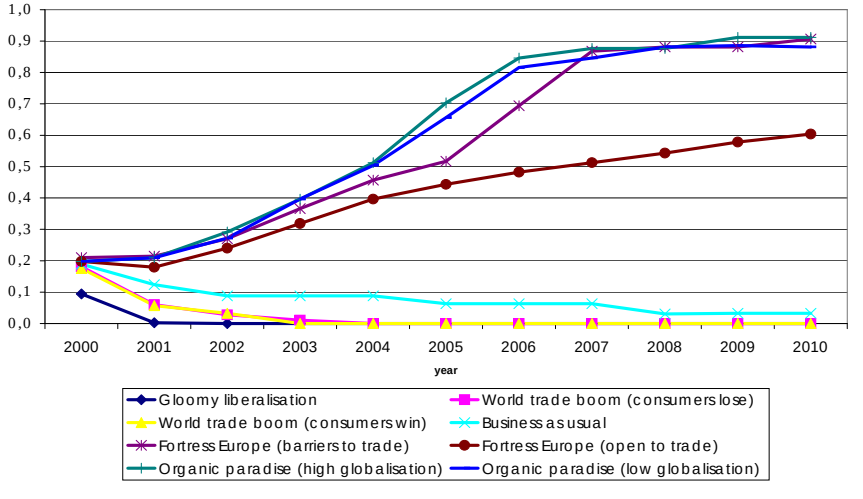


***Figure 13*** ***Availability of organic products***

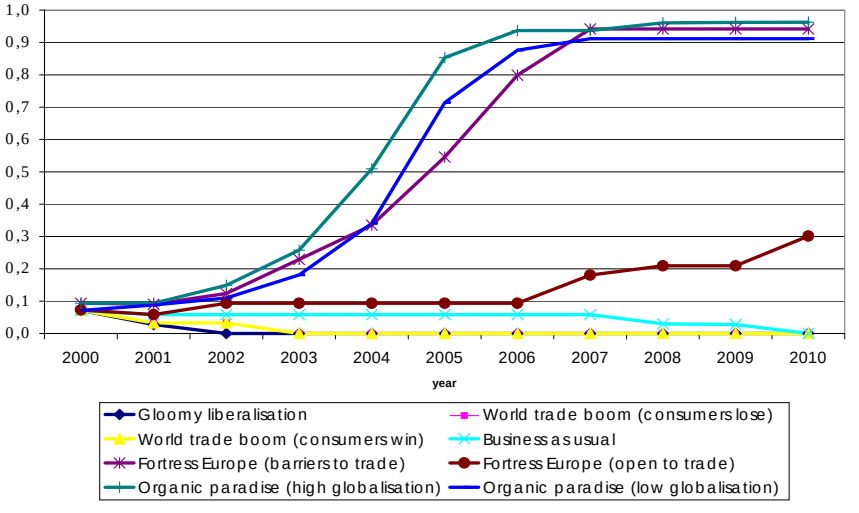



***Figure 14*** ***Domestic demand for organic products***

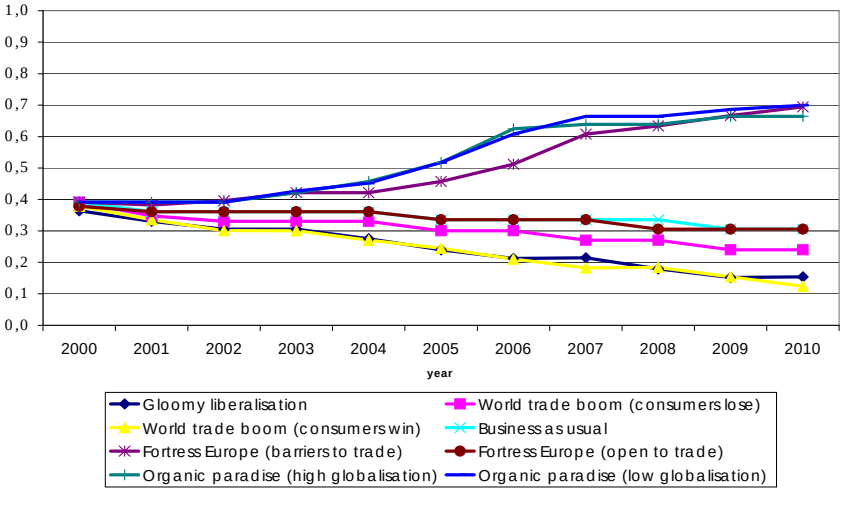


***Figure 15*** ***Domestic supply of organic products***

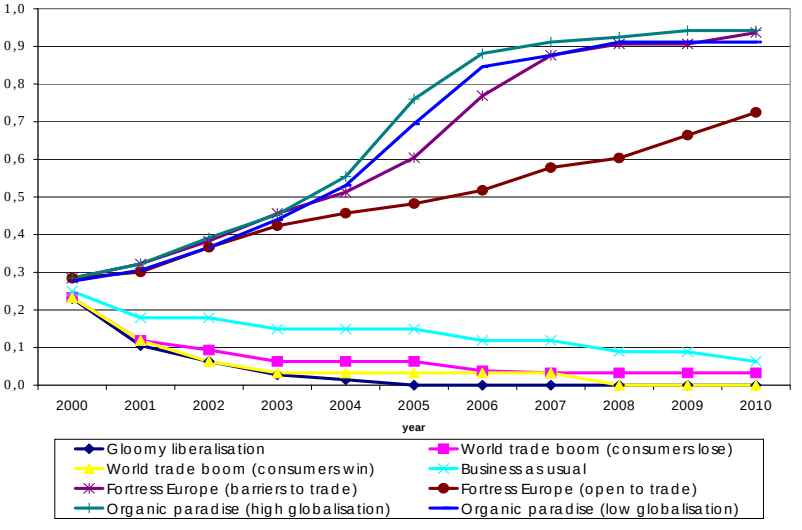



***Figure 16*** ***Relative profitability of organic farming***

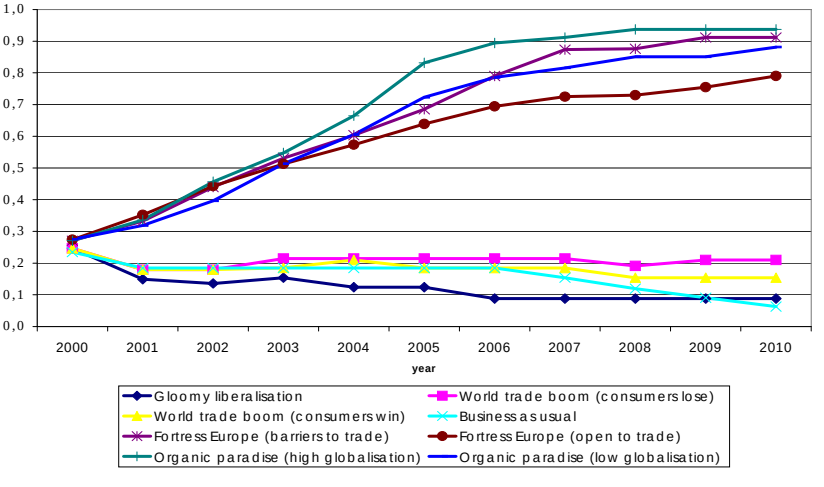


***Figure 17 Processing and marketing capacity for organic products***

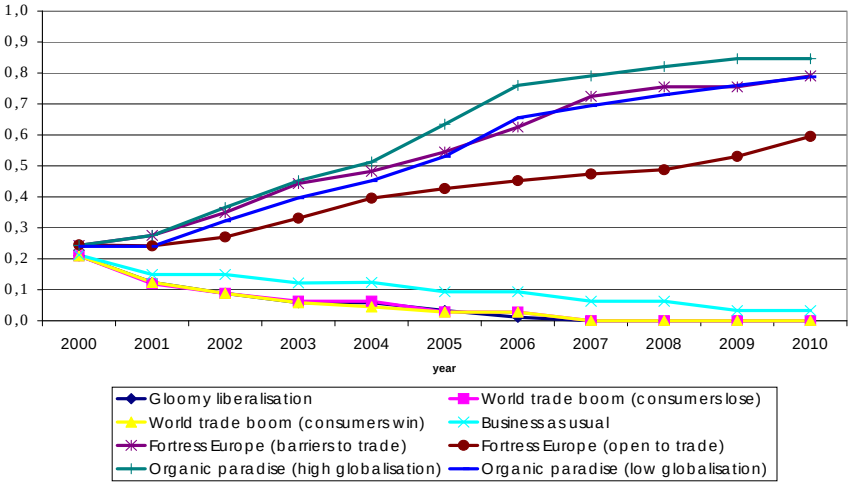



***Figure 18 Farm gate price of organic products***

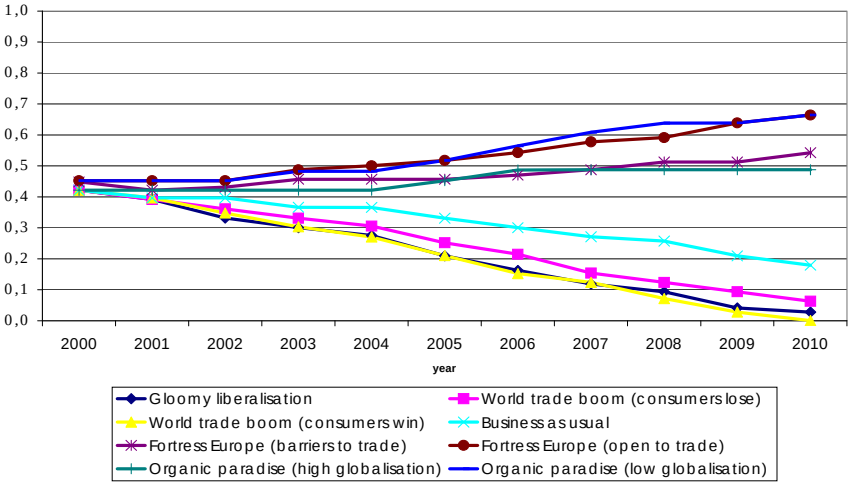


***Figure 19*** ***Consumer price of organic products***

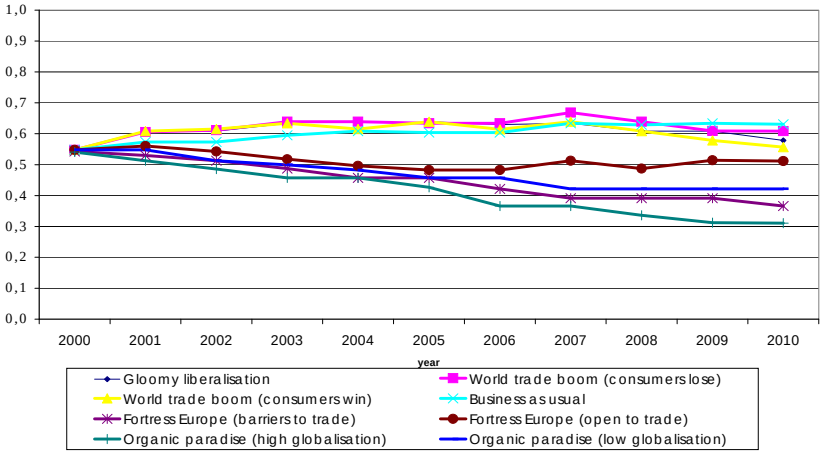
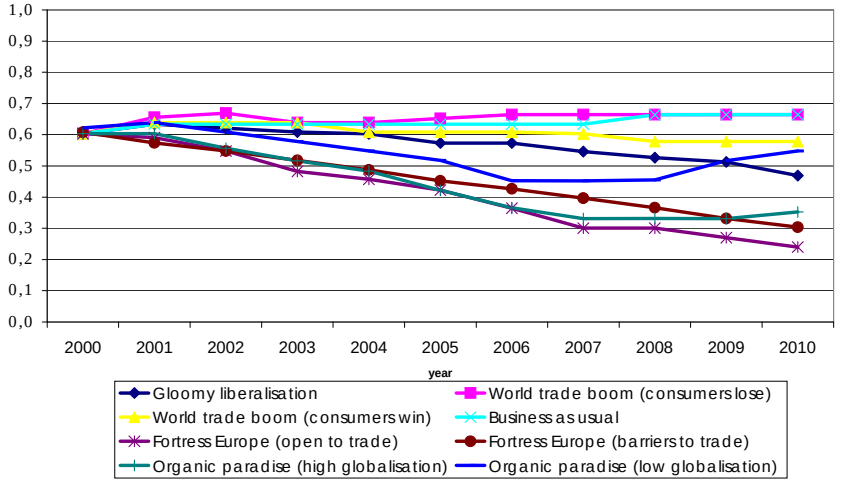



***Figure 20*** ***Intermediate standards products***



# 5 Concluding remarks

This report aims to communicate our efforts in describing consistent 'future images' of the development of organic farming in Europe till the year 2010.

From a cognitive perspective, it is still not very clear how human beings react to these images of the future (Bunn and Salo, 1993), although 'thinking about the future' is a fundamental characteristic of all humans, and one that distinguishes our species from other species.

In any case, the very process of thinking about the future and exploring the implications of alternative futures can have a strong impact on the actual future; decision making and strategic option generation (including policy formation) are all activities which are directly influenced by scenarios of the future.

The issues raised in this report may be useful to different categories of actors. For example, our scenario analysis:

- addresses the question of whether or not organic farmers and other organisations and institutions involved in organic farming are well prepared to face the uncertainties of the future as portrayed in our scenarios;
- helps policy makers realise the potential impact of decisions on the future of organic farming in Europe, and why their decisions could have these effects;
- by identifying the key driving forces which may be used to influence the future development of organic farming in Europe, it offers alternative options to both policy makers and market actors in devising their strategic direction and translating new insights into actions.

Our scenarios may be used to perform an *internal* assessment of the organisational capability of organic market actors to survive and develop in any of the multiple equally plausible future environments that we have envisaged.

At the same time, scenarios may be used to 'test' the validity of the organisation's 'mission' or Business Idea in the whole range of future environments it may face; this *external* perspective is useful for generating new options for action, using traditional brainstorming sessions or other idea generation tools to review the current and new strategies against the different depicted scenarios.

In Figure 21 we summarise the main results of the scenarios, showing for each one the performance of the organic sector and the underlying assumptions about the macroeconomic situation and economic policy.

"Organic Paradise" and "Fortress Europe" are the two scenarios showing the best results in terms of organic farming development, and they share a similar approach to economic policy and international trade policy, where European Union institutions maintain an active role concerning agricultural

policy. Nevertheless, they differ substantially as far as the hypotheses about the economic cycle are concerned: these are positive in the first case and negative in the second.

On the other hand, the other 'extreme' scenarios –"World trade boom" and "Gloomy Liberalisation"– sharing the common hypothesis of deregulated economic policy, show the worst performance of both organic demand and supply, although they differ in terms of the hypotheses concerning the economic cycle.

The "Business-as-usual" scenario is also not particularly favourable for organic farming, though it is neutral and surprise-free in terms of both the economic cycle and economic policy.

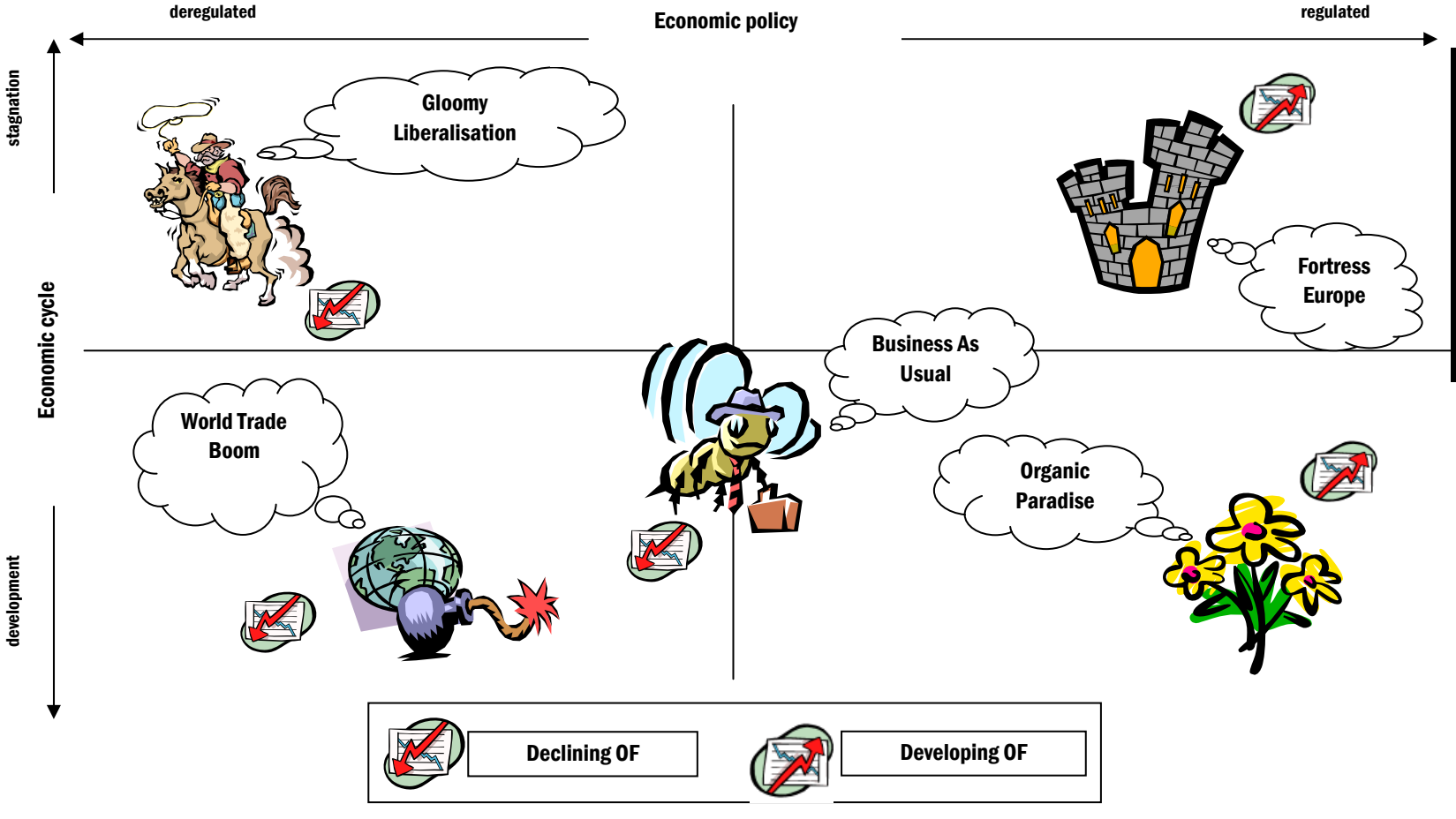
At first glance, it is therefore clear that the political environment is a crucial element for the organic farming sector, that might overcome the effects of the basic macroeconomic conditions such as consumer confidence and general economic trend.

A more detailed analysis of the basic assumptions and 'starting states' of each scenario shows that the crucial and most influential determinants of the future development of organic farming in Europe are:

1. the agricultural and agro-environmental policy which will come into effect *after* the implementation of Agenda 2000;
2. the Millennium Round WTO negotiations;
3. the future perception and attitudes of consumers and society towards issues concerning food safety and the use of modern biotechnology in food production.

Concerning the first point, we think there is a need to further consider the impact of the budget cuts on agro-environmental measures arising from the fact that in the rural development plans implemented after the EC Regs. 1257/99 and 1750/99 they have to 'compete' with other measures such as farm investments, compensatory allowances, and forestry measures. This fact, combined with the principle of subsidiarity, may substantially reduce the amount of subsidies given to support the conversion/maintenance of organic farming in many regions. Besides, it is also important to verify the impact of the modulation of supplemental aid deriving from savings of mainstream CAP support at the national level. Again, this modulation (as from EC Reg. 1259/99) may be very different in the various countries.

*Figure 21* *Performance of Main Scenarios for Organic Farming in Europe*






55

We, therefore, recommend continued monitoring of the policy and regulatory environment for organic farming in Europe, given the fact that substantial institutional changes are foreseen, especially at the regional level. These issues, concerning the probable outcome of the implementation of Agenda 2000, need to be addressed in the future if an enduring growth of the organic sector is seen as desirable.

As far as the impact of WTO negotiations on the market for organic products is concerned, it is quite clear from what happened in Seattle that the crucial political issues are: the globalisation of the food market; and the kind of international regulatory environment that will be set up. This point relates also to the third point – consumers and societal perceptions and attitudes – especially as far as GMOs are concerned.

Scenario analysis has shown that the future development of the market for organic products is heavily influenced by what will happen to global food markets and how consumers will respond to this globalisation.

Market and consumers issues are therefore very important, though at the moment we lack a lot of relevant information concerning the market of organic products, particularly in-depth studies of consumer perceptions and attitudes, as well as better knowledge of institutional linkages in the organic business.

A recommendation is to enhance the transparency and information on this market, through further studies and better institutional collection of data at the national/regional level. Almost no quantitative information is collected at the moment and qualitative information based on in-depth interviews of consumers and other actors in the market is also necessary to provide the firms concerned with tools to develop the organic market beyond the 'niche' level. A preliminary study of the European market for organic products has appeared in Volume 7 of the series 'Organic Farming in Europe: Economics and Policy'.

Market transparency, in particular, could be further enhanced by increasing controls and standards for the inspection bodies (more than for farmers) to avoid free-riding practices by increasingly commercial service organisations. A direction towards market transparency is surely the recent approval of the European logo for organic products, but the linkages between organic farming and consumers could be further increased by a Pan-European campaign showing the positive impact of organic farming and processing on the environment and on health. Health related issues should be further explored by targeted research.

Other conclusions may be drawn as a result of the prospective work described in this report.

The first is that we believe that the scenario analysis presented in this report can help the reader shape his/her image of the future development of organic farming in Europe, even though he/she may not even partially agree with any of the assumptions made by our scenario team or the results obtained. Planned action is based on a definition of a current position, of a desired future state and on the necessary steps to make the transition from

the current to the future state (Van Der Hejden, 1996). Therefore, ***any*** image of the future helps define the desirable future vision of an individual/organisation, even if it is trivial and particularly if it challenges his/her view of the future.

The second conclusion is that scenarios help to 'unfreeze' our brains, and are therefore essential in any *proactive* approach to planning. Even though some of our narrative may seem anecdotal and – sometimes – even naive compared to some 'serious' forecasts based on more sophisticated models, no one knows what the future will bring and therefore the capacity to stimulate and impress – albeit negatively – the reader is an important part of the method of scenario analysis.

The third conclusion is that the successes of scenario analysis are hard to pinpoint and cannot be linked at all with the ability of our scenarios to capture what indeed *will* happen in the future. One should always remember that the purpose of scenario analysis is ***not*** forecasting the future, but to provide different contrasting images of some *possible* futures. Which futures are relevant is strictly dependent on the context of the analysis. We will regard our exercise as a success if – with the help of our scenarios – farmers, policy-makers and other actors on the organic scene are able to create new ideas, identify new opportunities for action, re-think current behaviour and react swiftly to the changing conditions of a new environment. Only by developing our imaginative capabilities will we be able to deal with the world (and particularly the marketplace) of the future.

References

# 6 References

***BELLMAN R., ZADEH L.A. (1970):*** "Decision-making in a fuzzy environment", Management Science, 17: 141-164.

***BUNN D.W., SALO A.A. (1993):*** "Forecasting with scenarios", European Journal of Operational Research, 68: 291-303.

***CANARELLI P. (1996):*** The Method of Fuzzy Scenarios: Principle and Application to the Future of Congestion in Urban Centres, European Commission, Institute for Prospective Technological Studies (IPTS), Seville.

***CHAMBERS J.D., SATINDEV K.M., DONALD D.S. (1971):*** "How to choose the right forecasting technique", Harvard Business Review, July-August: 45-74.

***DENNIS S.Y. (1987):*** "A probabilistic model for the assignment of priorities in hierarchically structured decision problems", Mathematical Modelling, 9 (3-5): 335-343.

***DUCOT C., LUBBEN G.J. (1980):*** "A typology for scenarios", Futures, 12 (1): 51-57.

***EVANS J.S.T.B. (1982):*** "Psychological pitfalls in forecasting", Futures, 14(4): 258-265.

***FLORES B.E., OLSON D.L. (1992):*** "Judgmental adjustment of forecasts: a comparison of methods", International Journal of Forecasting, 7: 421-433.

***GEORGOFF D.M., MURDICK R.G. (1986):*** "Manager's guide to forecasting", Harvard Business Review, Jan.-Feb., 110-120.

***GODET M. (1985):*** Scenari e gestione strategica, Ipsoa, Milano.

***GORDON T.J., HAYWARD H. (1968):*** "Initial Experiments with the Cross-Impact Matrix Method of Forecasting", Futures, 1(2).

***HELMER O. (1981):*** "Reassessment of cross-impact analysis", Futures, 13 (5): 389-400.

***HUSS W.R. (1988):*** "A move toward scenario analysis", International Journal of Forecasting, 4: 377-388.

***JUNGERMANN H. (1985):*** "Inferential processes in the construction of scenarios", Journal of Forecasting, 4: 321-327.

***KAHN H., WIENER A.J. (1968):*** The year 2000: a framework for speculation on the next thirty-three years, Macmillan, New York.

***KLIR G.J., YUAN B. (1995):*** Fuzzy sets and fuzzy logic: theory and applications, Prentice Hall PTR, Upper Saddle River, New Jersey.

***KOSKO B. (1993):*** Fuzzy Thinking: The New Science of Fuzzy Logic, Hyperion (trad. it. Il fuzzy-pensiero: teoria e applicazioni della logica fuzzy, Milano, Baldini & Castoldi, 1995).

***MARBACH G., MAZZIOTTA C., RIZZI A. (1991):*** Le previsioni. Fondamenti logici e basi statistiche, Etas, Milano.

***MARTELLI A. (1992):*** Analisi strategica mediante scenari. Dal macro al microambiente: teorie e metodi, Etas, Milano.

***MILES I. (1985):*** Scenario analysis, contrasting visions of the future, in Miles I. et al., Manuel de perspective pour l'Afrique.

***MILLET S.M. (1988):*** "How scenarios trigger strategic thinking", Long Range Planning, 21 (5): 61-68.

***PORTER M.E. (1985):*** Il vantaggio competitivo, Edizioni di Comunità, Milano.

***RINGLAND G. (1998):*** Scenario planning: managing for the future, Wiley, England.

***SAATY T.L. (1980):*** The Analytic Hierarchy Process, McGrawHill, NewYork.

***SAATY T.L. (1986):*** "Axiomatic foundation of the Analytic Hierarchy Process", Management Science, 32: 841-855.

***SAATY T.L. (1987):*** "A new macroeconomic forecasting and policy evaluation method using the analytic hierarchy process", Mathematical Modelling, 9(3-5): 219-231.

***SAATY T.L., KEARNS K.P. (1985):*** Analytical Planning. The organization of systems, Pergamon, Oxford.

***SCHNAARS S.P. (1987):*** "How to develop and use scenarios", Long Range Planning, 20 (1): 105-114.

***SAATY T.L., and VARGAS L.G. (1994):*** Decision Making in Economic., Political, Social and Technological Environments: The Analytic Hierarchy Process, RWS Publications, Pittsburgh.

***SCHNAARS S.P. (1990):*** "A look at the year and decade ahead", International Journal of Forecasting, 6: 1-2.

***SCHWARTZ P. (1992):*** The art of the long view: scenario planning – protecting your company against an uncertain future, Century Business, London.

***VAN DER HEIJDEN K. (1996):*** Scenarios. The art of strategic conversation, Wiley, New York.

***VON REIBNITZ U. (1988):*** Scenario Techniques, McGraw Hill, New York.

***WACK P. (1985a):*** "Scenarios: shooting the rapids", Harvard Business Review, 63 (6): 139-150.

***WACK P. (1985b):*** "Scenarios: uncharted waters ahead", Harvard Business Review, 63 (5): 73-89.

***WOLFE C., FLORES B.E. (1990):*** "Judgmental adjustment of earnings forecasts", Journal of Forecasting, 9 (4): 389-405.

***WRIGHT G., SAUNDERS C., AYTON P. (1988):*** "The consistency, coherence and calibration of holistic, decomposed and recomposed judgmental probability forecasts", Journal of Forecasting, 7: 185-199.

***ZADEH L.A. (1965):*** "Fuzzy Sets", Information and Control, 8: 338-353.

***ZADEH L.A. (1968):*** "Probability Measures of Fuzzy Events", Journal of Mathematical Analysis and Applications, 10: 421-427.

***ZADEH L.A. (1973):*** "Outline of a new approach to the analysis of complex systems and decision processes", IEEE Transactions on Systems, Man and Cybernetics, vol. SMC-3, nr. 1: 28-44.

***ZADEH L.A. (1978):*** "Fuzzy Sets as A Basis for a Theory of Possibility", Fuzzy Sets and Systems, 1: 3-28.

***ZANOLI R. (1996):*** "L'uso della logica fuzzy nella valutazione d'impatto ambientale", Genio Rurale, 4: 45-51.

***ZIMMERMANN H.J. (1991):*** Fuzzy sets theory and its applications, (2nd ed.), Boston, Kluwer.

Annex I

# Annex I: A primer on fuzzy systems

Scenario analysis considers the interactions among a set of variables that are supposed to be able to depict the relevant aspects of the system whose possible evolutions are to be analysed. Hence, it handles complex interrelations, which can get difficult to manage even when only a few variables are involved. As a second general aspect, scenarios are often based on partial information and/or on linguistically defined variables. In such a context, traditional forecasting procedures might fail to consider properly the relevant mechanism of the analysed systems.

At present, most of the relevant studies concerning complex systems use decision analysis theories as a general framework for managing models involving several interacting variables, while fuzzy logic is often used for handling linguistically defined variables/system.

The proposed model for scenario analysis makes a conjunct use of both these approaches.

In what follows, we present a description of decision analysis basic concepts, and the way they can be used for scenario analysis through fuzzy rule based systems, together with a concise preview of basic fuzzy concepts (for more details about fuzzy logic and fuzzy variables see Zadeh, 1965, 1978, Kosko, 1993, Zimermann 1991).

## Decision analysis

Decision analysis is the art and practice of decision theory, an axiomatic theory prescribing how decisions should be made. It is based on the premise that humans are reasonably capable of framing a decision problem, listing possible decision options, determining relevant factors, and quantifying uncertainty and preferences, but are rather weak in combining this information into a rational decision.

Decision analysis comes with a set of empirically tested tools for framing decisions, structuring decision problems, quantifying uncertainty and preferences, discovering those factors in a decision model that are critical for the decision, and computing the value of information that reduces uncertainty. Probability theory and decision theory supply tools for combining observations and optimising decisions.

While decision analysis is based on two quantitative theories, probability theory and decision theory, its foundations are qualitative and based on axioms of rational choice. The purpose of decision analysis is to gain insight into a decision and not to obtain a recommendation.

Decision analysis hinges upon the definition of a relevant set of variables and relationships among variables, whose different combinations might produce different decision options.

Usually, variables are defined according to certain domains, that is, a range of values or states that they can assume according to a certain degree of probability or possibility.

For example, when considering future scenarios for organic products markets, a relevant variable might be "supply of organic wheat" whose domain might be defined as [low, average, high], or as [less than 120.000 T; between 120.000 and 150.000 T; more than 150.000 T].

While there is an infinite number of possible domains, there are two basic types leading to two basic classes of variables: discrete and continuous.

While the distinction between discrete and continuous variables is crisp, the distinction between discrete and continuous quantities is rather vague. Many quantities can be represented as both discrete and continuous. Discrete variables are usually convenient approximations of real world quantities, sufficient for the purpose of reasoning.

Once a suitable set of variables and the respective domain is defined, it is necessary to define a proper rule system, describing the way variables interact with one another.

A rule is an expression of the form

if A then B

where A is an assertion and B can be either an action or another assertion. For instance the following two rules could be part of a larger set of rules for organic farming products:

1. *If* "CAP reform" is *favourable to organic farming*, *then* "organic farming profitability" is *high*
2. *If* "organic farming profitability" is *high*, *then* "organic products supply" is *high*

A rule based system consists of a library of such rules. These rules reflect essential relationships within the domain, or rather: they reflect ways to reason about the domain.

When specific information about the domain comes in, the rules are used to draw conclusions and to point out appropriate actions. This is called inference. The inference takes place as a kind of chain reaction.

Often the connections reflected by the rules are not absolutely certain, and similarly the gathered information is often subject to uncertainty. In such cases, a certainty measure is added to the premises as well as the conclusions in the rules of the system. Now, a rule gives a function that describes how much a change in the certainty of the premise will change the certainty of the conclusion. In its simplest form, this looks like:

If A (with certainty *x*) then B (with certainty f(*x*))

There are many schemes for treating uncertainty in rule based systems. The most common are fuzzy logic and Bayesian Belief Networks. Common to all of these schemes is that uncertainty is treated locally. That is, the treatment is connected directly to the incoming rules and the uncertainty of their elements. Imagine, for example, that in addition to the former we have the rule

If C (with certainty *x*) then B (with certainty g(*x*))

If we now get the information that A holds with certainty *a* and C holds with certainty *c*, what is the certainty of B?

There are different algebras for such a combination of uncertainty, depending on the scheme. Common to all these algebras is that in many cases they come to incorrect conclusions. This is because the combination of uncertainty is not a local phenomenon, but it is strongly dependent on the entire situation (in principle a global matter).

## Fuzzy systems

As a general definition, a fuzzy system is any system containing variables ranging over states that are fuzzy sets (Klir and Yuan, 1995). Here, we discuss about fuzzy sets that are fuzzy numbers, and that are associated to linguistic variables.

Fuzzy logic was first introduced by Zadeh [1965]. It offers a generalisation of the notion of elements of a set from bivalued membership (i. e. is / is not member of a set) to that of multivalued membership (i. e. various degrees of membership) and continuous degrees of membership.

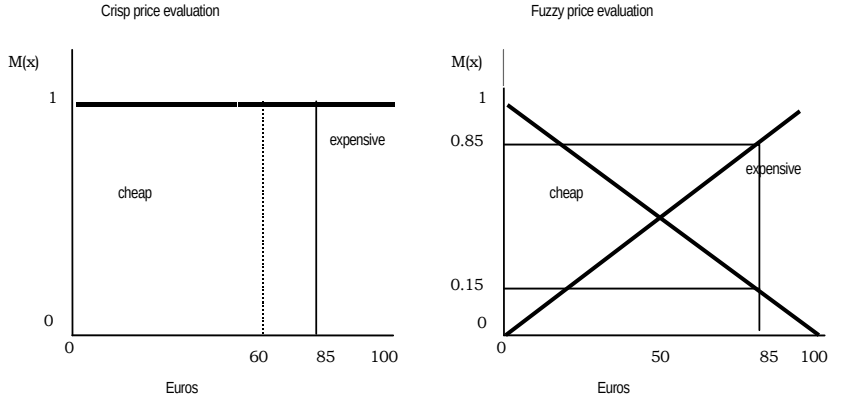
The difference between classic logic and fuzzy logic is illustrated in Figure 22. Let us try to describe the variable *Price* using 2 subsets, described by labels *cheap* and *expensive*, defined by their respective membership functions. For instance, in the case of classic logic, we can say that a price for a pair of shoes below 60 Euro can be considered as cheap while those above 60 Euro are expensive. A price of 85 Euro is *expensive* and not at all *cheap*. When we consider small price variations close to the value of 60 Euro, the difficulty of classic logic to provide sensible results becomes evident: at 59.99 Euro a price is still fully considered as *cheap* while at 60.01 Euro, it is considered as fully expensive.

Fuzzy logic has been introduced in order to deal with this issue. If the membership functions vary monotonically, it is then possible to define partial degrees of membership. Hence, a given value can be described by

several labels at the same time. Let us take the example of price evaluation. A price of 85 Euro is thus 15% *cheap* and 85% *expensive* (Figure 22). More generally, it can been seen that classic logic is just a special case of the more general fuzzy logic [Kosko, 1993].

Hence, fuzzy logic appears to be more suitable than classic logic for describing the evolution of variables by means of linguistic labels.

***Figure 22 Classic and fuzzy logic: example of price evaluation.***




Fuzzy sets help to quantify linguistic variables, hence offering a solution to the problem of systems description in presence of scarce or inaccurate information. Different actual variable values are associated to different variable states according to a certain uncertainty degree (forced uncertainty). Measurement uncertainty is a result of information deficiency, and derives from the general inability of any measuring instrument to overcome its limiting finite resolution.

Besides problems concerning measurement uncertainty, when handling continuous variables a further difficulty is the wide range of values to consider. When the number of variables is high, the resulting complexity might increase excessively. In complex systems, it is necessary to reduce complexity when using the system for a given task. For example, to understand all the relevant variables necessary to drive a motorbike (throttle opening, road conditions, cornering angle, tyres temperatures, etc.,) it would not be wise to specify all these factors with high precision. As an example, it would be much easier (and safer) to learn the following rule: "do not open too rudely the throttle if you are cornering hard and tyres are not warm" instead of: "open throttle less than 25% if the corner angle is more than 30 degrees and your tyres temperature is under 40 °C". A description of this procedure in approximate linguistic terms would be much more efficient and effective. The important role of uncertainty in reducing system complexity is well described by Zadeh (1973):

"In our view, it is this fuzzy, […] logic that plays a basic role in what may well be one of the most important facets of human thinking, namely, the

ability to summarise information – to extract from the collection of masses of data impinging upon the human brain those and only those subcollections which are relevant to the presence of the task at hand. […]. The human brain takes advantage of this tolerance form imprecision by encoding approximate relation to the primary data."

## Fuzzy modelling

Fuzzy modelling may be considered as a special case of expert system implementation. It incorporates a knowledge base, containing the relevant inference rules, and an inference engine, whose aim is to determine the final effect of rules functioning in specific conditions (Canarelli, 1996; Klir and Yuan, 1995).

The exclusive characteristic of fuzzy modelling is that it is capable of using knowledge elicited from human operators, or experts. This is crucial when it is difficult or even impossible to construct precise mathematical models, or for which the available models are difficult or expensive to use. Difficulties may arise from non linearities, time varying nature of the processes to be controlled, large unpredictable environmental disturbances etc. In these conditions, the knowledge of a human expert might be used as a feasible alternative to a "precise" model.

Fuzzy modelling is capable of articulating imprecise linguistic descriptions quite easily through fuzzy rules. As an example, a typical form of these rules is:

IF CAP reform is favourable to organic farming

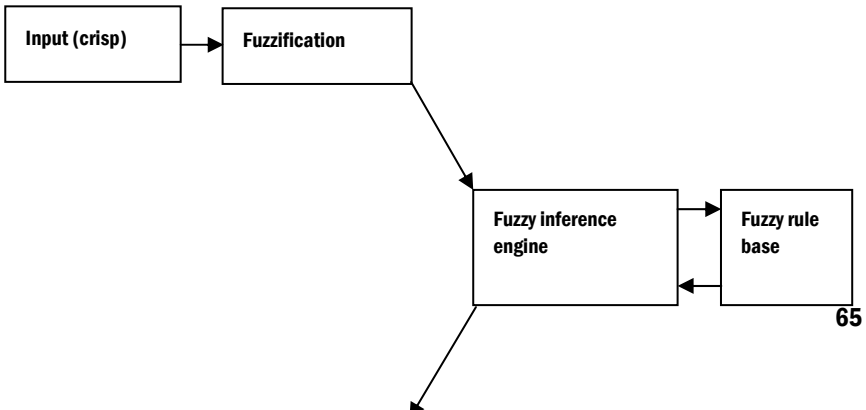
AND organic product prices are high

THEN the supply of organic products increases

where the linguistic definitions of the variables (CAP reform, Prices, Supply) can be easily managed with fuzzy logic.

A general scheme of fuzzy modelling is as follows (Figure 23):

***Figure 23 A general scheme of fuzzy modelling***



Fuzzy modelling can be schematised in five elements: definition of variables linguistic states, fuzzification function, fuzzy inference rules, inference engine fuzzy rule base, fuzzy inference engine, defuzzification method.

## Definition of variable states

Once the relevant variables of the system have been identified, and eventually distinguished in exogenous (or external) and endogenous (or internal)variables, it is necessary to select meaningful linguistic states for each one, and to define an appropriate fuzzy membership function.

For the purposes of the present analysis, it is necessary to point out that the choice of one of the various available membership function shapes does not influence significantly the overall model functioning.

## Fuzzification function

Once membership functions are defined for each variable, initial values are introduced into the model after being fuzzified. The purpose of fuzzification is to interpret measurements of input variables (expressed by a real number), as more realistic fuzzy approximations. Stepping back to the price example, suppose that the variable *price* assumes the value of 85 Euro: the fuzzification phase will "transform" this real number into linguistic fuzzy labels, according to the appropriate degree of uncertainty described by the membership function. That is, a price of 85 Euro will be considered in the model as *expensive* with a degree of relevance of 85%, and *cheap* with a degree of relevance of 15%.

## Fuzzy rule base

The interactions among different variable states are described by fuzzy inference rules, like those previously described. Fuzzy rules may be derived from expert assessments, or they may be defined through an empirical analysis. In the present scenario, all rules are derived from expert assessments.

Fuzzy rules should describe the system behaviour considering all the combinations of variable states. For example, considering an oversimplified

market model with three variables, price, marketing policies and demand, each described by three states (low intermediate and high), the rule base could be of the form:

IF the price is *cheap* AND the marketing support is *strong*, THEN the demand is *high*;

IF the price is *expensive* AND the marketing support is *weak*, THEN the demand is *moderate*;

IF the price is expensive, AND the marketing support is weak, THEN the demand is *low*;

…and so on, for all the possible combinations of the nine variable states …;

Of course, when the number of variables and/or of variable states increases, the complexity of the fuzzy rule base becomes critical. It could therefore be preferable not to consider all the possible combinations, but only those considered more relevant or the more extreme ones.

## Inference engine

The role of the fuzzy inference engine is to combine fuzzified variable inputs and fuzzy rule base, in order to obtain a final, predominant result about the state of the analysed system.

According to the previous example, a *price* of 85 Euro can be considered, with different degrees of relevance, cheap or expansive. Hence it would "activate" differently the fuzzy rule base, through rules starting as "IF price is cheap, THEN…", and through rules starting as "IF price is expensive, THEN…". The role of the inference engine is hence to derive the final effect of a price of 85 Euro in the system. The actual mechanisms utilised are based on standard fuzzy logic. In other words, the problem of inference regarding the final output of the system becomes the problem of approximate reasoning with several conditional fuzzy propositions[4]. A numerical example of how an inference engine may operate is reported below

## Defuzzification method

The last step of fuzzy controllers procedures is to convert each conclusion (or fuzzy result) of the inference engine into a single real number. Though the final result turns out to be not arbitrary, there is not univocal defuzzification procedure. In our model the centre of area method is adopted.

The scheme of the fuzzy modelling procedure is therefore as follows:

1. external variables (inputs) enter as crisp values in the procedure;

[4] See Klir and Yuan, 1995, Canarelli, 1996 for details

2. they are fuzzified (hence are split into different fuzzy variable states);
3. fuzzified variables interact according to the fuzzy rule base;
4. system output (or system final variable states) is obtained through fuzzy inference engine;
5. finally the fuzzy final variable states are defuzzified

## An example

A graphical example will help to summarise. Suppose we want to model a system, whose behaviour can be explained by Three variables (X Y and Z). A typical scenario problem could be to simulate what will happen to variable Z when changing variables X and Y. All the variables will be standardised, hence assuming values ranging between 0 and 1.

As an example, we can analyse a very simple organic market model, where the variables are:

Variable X = food scares

Variable Y = political climate towards organic farming

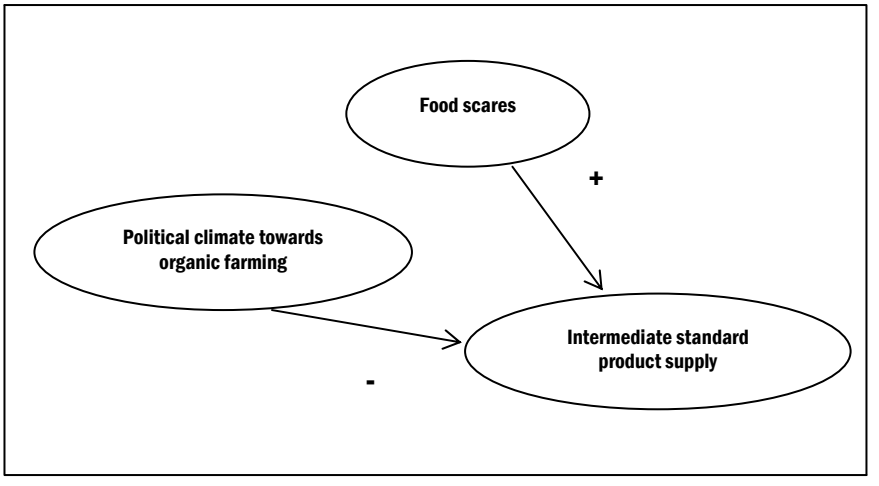
Variable Z = intermediate products supply (such as those deriving from integrated agriculture).

It is supposed that there is a positive impact of variable X on variable Z, because of a general shift of food demand towards "ecological" food in the presence of increasing food scares.

Alternatively, the relationship between Y and Z is negative, as a supporting policy in favour of organic farming should "protect" the sector from competitive productions.

A graphical scheme of the system is represented in Figure 24

***Figure 24 Example of a simple Model scheme***




*Definition of variable states*

For simplicity, variables can be defined using two states:

- Food scares (X): low – high;
- Political climate towards organic farming (Y): favourable – unfavourable;
- Intermediate standard products supply (Z): low – high.

*Fuzzification*

In Figure 25 are described the membership functions of the three variables. For variable X, given an initial value of X = 0.8 the membership to the subsets "low" and "high" are respectively 0.2 and 0.8.

For variable Y given an initial value of Y = 0.6, the resulting membership to the subsets "unfavourable" and "favourable" are respectively 0.4 and 0.6.

*Fuzzy rule base*

A simple fuzzy rule base may be as follows:

1. IF "food scares"(X) is *low*, AND if "political climate towards OF" (Y) is *favourable*, THEN "intermediate standard products supply" (Z) is *low*;
2. IF "food scares" (X) is *high*, AND if "political climate towards OF" (Y) is un*favourable*, THEN "intermediate standard products supply" (Z) is *high*.

*Inference engine*

The final effect in the system of the input values X = 0.8 and Y = 0.6 is determined as follows.

A firing strength of each rule is deduced by taking the minimum value of each couple (corresponding to X and Y) of membership degrees. Hence, the firing strength of Rule 1 is 0.2 and that of Rule 2 is 0.6 (Figure 25).

The firing strength is then multiplied by the respective membership function corresponding to the different variable states.

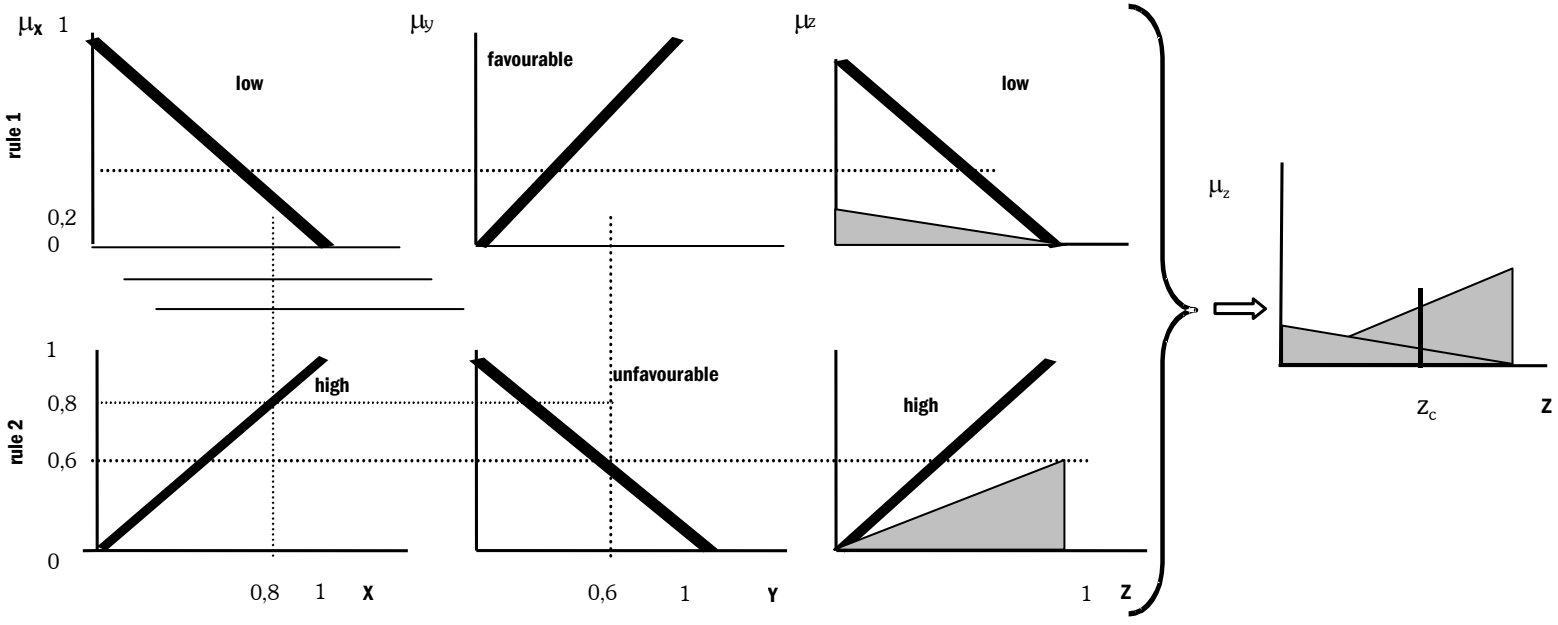
The product determines the fuzzy subset resulting for each rule's consequent subset. The final fuzzy result is defined as the sum of the two subsets (Figure 25).

*Defuzzification*

The last step of the procedure is to calculate a final crisp value from the final fuzzy result deriving from the inference engine.

The crisp value for "intermediate standard products supply" (Z), deriving from the initial values X=0.8, Y=0.6, from the adopted membership functions and from the fuzzy rule base, is deduced by finding the value $Z=z_c$ which splits the area of the consequent fuzzy subset into 2 equal areas (centre of area method).

*Figure 25* *Example of fuzzy reasoning*



Annex I

## Fuzzy scenarios

The fuzzy scenario model used here was been originally developed by Canarelli (1996) and is based on a dynamic and iterative approach to fuzzy modelling.

The dynamic dimension has been introduced in the model through the attribution to the internal variables of a 'characteristic time' defined as the reaction time of a variable to stimulus coming from other variables. More specifically, the characteristic time of the variables should be understood as "…the minimum time (as imposed by their own intrinsic inertia) to move from a minimum value to a maximum one in a constraint-free context. Of course, the actual change will, in practice, require significantly more time since the factors which influence the variable considered need themselves time to evolve." (Canarelli, 1996).

The iterative nature of the model comes from the fact that each time unit (i.e. year) is split into small time-increment units, and for each period the fuzzy model is applied to the specified values of external variables and to the previous computed values of internal variables. The resulting changes in internal variables are filtered through considering the variables characteristic time, and only a fraction of the change generated through the fuzzy reasoning unit is actually inputted for the next iteration, this fraction being equal to the ratio of the time step to the variable's characteristic time.

Before applying the model, it was necessary to decide the following questions:

- the shape of the membership functions describing the states of the variables. In this model, variables assume two or three states, and membership functions have a simple triangular shape. In fact, in applications dealing with social systems, finely tuning the membership functions has proven to produce increasing computational complexity not compensated by appreciable effects on the final results detail.
- the attribution to the internal variables of a 'characteristic time' defined as the reaction time of a variable (this definition is an integral part of the model and is therefore not visible);
- identification of the initial condition of each variable, i.e. definition of the linguistic state assumed by the variable in 1999, the year in which the simulation was to begin;
- definition of a time horizon different from the one agreed for certain external variables. This decision was prompted by awareness that some of the external variables, like reform of the CAP, are functional on certain events which are predictable. In the case of the CAP, an erroneous prediction would have prejudiced the trend of certain internal variables tied to the specific external variable by a particular rule. It was therefore decided to define the CAP reform at year 2003, i.e. at the time of the mid-term review, and to define the farm-gate prices of

conventional agricultural products at year 2006, i.e. on expiry of the current planning period of EU agricultural policies.

# Annex II: Definition of the variables and respective states

*Legend:*

CP = conventional product

CF = conventional farming

OP = organic product

OF = organic farming

## INTERNAL VARIABLES

***Domestic demand for OP*** (low, intermediate, high)

Quantity of domestic (EU) organic products demanded

***Domestic supply of OP*** (low, intermediate, high)

Quantity of domestic (EU) organic products supplied. From the "market structure" point of view, we are referring only at the upper degree of vertical integration: farmers quantity production.

***Organic certification and labelling*** (not effective, effective, highly effective)

The visibility and the credibility of these services in the market. Quality assurance and certification play an important role in market transparency for the consumers: the organic label is able to assure visibility and credibility to organic products, while a good certification system is a prerequisite for market segmentation of organic products.

***Availability of OP*** (low, high)

The “product mix” (assortment, quality, etc.) as perceived by the consumers

***Consumer price of OP*** (low, intermediate, high)

Prices of organic products paid by final consumers in the market. There are two variables who are enable to explain the price mechanisms of OP: consumer price of OP and farm-gate price of OP. We distinguished these two variables in order to capture the effect of distribution costs which make the difference between consumer prices and farm-gate prices.

***Farm-gate price of OP*** (low, intermediate, high)

Prices of organic products received by farmers

***Relative profitability of OF*** (worse, similar, better)

The level of profit of organic farming relative to those available in the conventional sector

***Relative food quality of OP*** (worse, similar, better)

The average quality of organic food products relative to the average quality of conventional ones

***Media coverage & profile*** (not significant, significant)

Quality and quantity of favourable media coverage on organic market

***Promotion & advertising of OP*** (not significant, significant)

Quality and quantity of promotion & advertising in the organic sector

***Political climate towards OF*** (unfavourable, slightly favourable, highly favourable)

The variable is self-explaining: the level of the variable increase when the climate is favourable and decreases when is negative or less favourable. We consider political attitude and public opinion on OF as the main aspects to define political climate towards OF

***Technological change in OF*** (slow, similar, fast)

Process and product innovations in OF

***Intermediate standards*** products (low, intermediate, high)

Alternative & environmental friendly agricultural production systems known as Integrated Pest Management, low-input farming, etc.. More specifically, we are considering substitute products of OP

***Agro-environmental policy*** (unfavourable, slightly favourable, highly favourable)

It includes all laws, bylaws and regulations aimed at reducing the environmental impact of agriculture

***Processing & marketing capacity of OF*** (low, intermediate, high)

The development of processing and marketing capacity of the organic agro-food sector, including quality issues

***Direct producer support of OF*** (low, high)

All de-coupled income support schemes such as Reg. 2078/92

***Market development indirect support*** (low, high)

All support through market development schemes such as Reg. 951/97, etc.

***Knowledge systems in OF*** (poorly developed, well developed)

R&D, farmers education &training, information, etc. in the organic sector

## EXTERNAL VARIABLES

***Food scares*** (low, high)

The level of perception in the society as a whole of all issues concerning dangers to food safety such as BSE. salmonella, etc.

***Consumer confidence*** (low, intermediate, high)

Consumer confidence in economic prosperity. Therefore we consider both the economic situation and the consumer sociological characteristics (social status, home location, etc.), one in relation to the other

***Farmers altruistic concerns*** (low, high)

This variable measures all environmental & ethical issues as perceived by the producers. The inclusion of this variable allow to consider non neo-classical issues in both the supply and demand side of the market

***Controversial technological change in CF*** (decreasing, increasing)

Process and product innovations stemming out of agricultural and biological research which are controversial to farmers and the society as a whole. This variable includes only those highly controversial innovations such as biotech, GMOs, etc.

***Market globalisation*** (low, intermediate, high)

This variable captures all issues of market globalisation including the political ones: WTO, EMU, Extension of the EU, impact of USDA organic standards & Codex Alimentarius on EU regulations, etc.

***CAP reform*** (unfavourable, favourable)

All changes to be made to EU agricultural & food policy starting from Agenda 2000 and EU Reg. 2091/92 reform

***Consumer price of CP*** (low, intermediate high)

Prices of conventional food products paid by final consumers in the market

***Farm-gate price of CP*** (low, intermediate high)

Prices of conventional products received by farmers

Annex III

# Annex III: The fuzzy rule base

1. if consumer_price_cp is low then domestic_demand_op is low
2. if consumer_price_cp is intermediate then domestic_demand_op is intermediate
3. if consumer_price_cp is high then domestic_demand_op is high
4. if consumer_price_cp is low then intermediate_standards_products is low
5. if consumer_price_cp is intermediate then intermediate_standards_products is intermediate
6. if consumer_price_cp is high then intermediate_standards_products is high
7. if consumer_confidence is low then domestic_demand_op is low
8. if consumer_confidence is intermediate then domestic_demand_op is intermediate
9. if consumer_confidence is high then domestic_demand_op is high
10. if consumer_confidence is low then political_climate_towards_of is unfavourable
11. if consumer_confidence is intermediate then political_climate_towards_of is slightly_favourable
12. if consumer_confidence is high and food_scares is high then political_climate_towards_of is highly_favourable
13. if consumer_confidence is high and farmers_altruistic_concerns is high then political_climate_towards_of is highly_favourable
14. if consumer_confidence is low then intermediate_standards_products is low
15. if consumer_confidence is intermediate then intermediate_standards_products is intermediate
16. if consumer_confidence is high then intermediate_standards_products is high
17. if consumer_confidence is low then agro_environmental_policy is unfavourable
18. if consumer_confidence is intermediate then agro_environmental_policy is slightly_favourable
19. if consumer_confidence is high then agro_environmental_policy is highly_favourable
20. if food_scares is low and controversial_tc_in_cf is decreasing then domestic_demand_op is low
21. if food_scares is low and controversial_tc_in_cf is increasing then domestic_demand_op is intermediate
22. if food_scares is high and controversial_tc_in_cf is decreasing then domestic_demand_op is intermediate

23. if food_scares is high and controversial_tc_in_cf is increasing then domestic_demand_op is high
24. if farmers_altruistic_concerns is low and cap_reform is unfavourable then domestic_supply_op is low
25. if farmers_altruistic_concerns is high and cap_reform is unfavourable then domestic_supply_op is intermediate
26. if farmers_altruistic_concerns is low and cap_reform is favourable then domestic_supply_op is intermediate
27. if farmers_altruistic_concerns is high and cap_reform is favourable then domestic_supply_op is high
28. if food_scares is low and political_climate_towards_of is unfavourable then organic_certification_labeling is not_effective
29. if food_scares is high and political_climate_towards_of is highly_favourable then organic_certification_labeling is highly_effective
30. if political_climate_towards_of is sligtly_favourable then organic_certification_labeling is effective
31. if food_scares is low then media_coverage_profile is not_significant
32. if food_scares is high then media_coverage_profile is significant
33. if farmers_altruistic_concerns is low then media_coverage_profile is not_significant
34. if farmers_altruistic_concerns is high then media_coverage_profile is significant
35. if food_scares is low and political_climate_towards_of is highly_favourable then intermediate_standards_products is low
36. if food_scares is low and political_climate_towards_of is unfavourable then intermediate_standards_products is intermediate
37. if food_scares is high and political_climate_towards_of is unfavourable then intermediate_standards_products is high
38. if farmers_altruistic_concerns is low and political_climate_towards_of is highly_favourable then intermediate_standards_products is low
39. if farmers_altruistic_concerns is low and political_climate_towards_of is unfavourable then intermediate_standards_products is intermediate
40. if farmers_altruistic_concerns is high and political_climate_towards_of is unfavourable then intermediate_standards_products is high
41. if farmers_altruistic_concerns is low and cap_reform is unfavourable and political_climate_towards_of is unfavourable then agro_environmental_policy is unfavourable
42. if farmers_altruistic_concerns is low and cap_reform is unfavourable and political_climate_towards_of is slightly_favourable then agro_environmental_policy is slightly_favourable
43. if farmers_altruistic_concerns is high and cap_reform is unfavourable and political_climate_towards_of is slightly_favourable then agro_environmental_policy is slightly_favourable

44. if farmers_altruistic_concerns is low and cap_reform is favourable and political_climate_towards_of is slightly_favourable then agro_environmental_policy is slightly_favourable
45. if farmers_altruistic_concerns is high and cap_reform is favourable and political_climate_towards_of is highly_favourable then agro_environmental_policy is highly_favourable
46. if farmers_altruistic_concerns is low then processing_marketing_capacity_of is low
47. if farmers_altruistic_concerns is high then processing_marketing_capacity_of is high
48. if farmers_altruistic_concerns is low then knowledge_system_of is poorly_developed
49. if farmers_altruistic_concerns is high then knowledge_system_of is well_developed
50. if food_scares is low and controversial_tc_in_cf is increasing then relative_profitability_op is worse
51. if food_scares is high and controversial_tc_in_cf is increasing then relative_profitability_op is similar
52. if food_scares is low and controversial_tc_in_cf is decreasing then relative_profitability_op is similar
53. if food_scares is high and controversial_tc_in_cf is decreasing then relative_profitability_op is better
54. if controversial_tc_in_cf is decreasing then media_coverage_profile is not_significant
55. if controversial_tc_in_cf is increasing then media_coverage_profile is significant
56. if market_globalisation is high then farm_gate_price_op is low
57. if market_globalisation is intermediate then farm_gate_price_op is intermediate
58. if market_globalisation is low then farm_gate_price_op is high
59. if market_globalisation is low then processing_marketing_capacity_of is low
60. if market_globalisation is intermediate then processing_marketing_capacity_of is intermediate
61. if market_globalisation is high and market_development_indirect_support_of is high then processing_marketing_capacity_of is high
62. if cap_reform is unfavourable then political_climate_towards_of is unfavourable
63. if cap_reform is favourable then political_climate_towards_of is highly _favourable
64. if cap_reform is unfavourable then direct_producer_support_of is low
65. if cap_reform is favourable then direct_producer_support_of is high

66. if cap_reform is unfavourable then market_development_indirect_support_of is low
67. if cap_reform is favourable then market_development_indirect_support_of is high
68. if cap_reform is unfavourable then knowledge_system_of is poorly_developed
69. if cap_reform is favourable then knowledge_system_of is well_developed
70. if farm_gate_price_cp is high and farm_gate_price_op is intermediate then relative_profitability_op is worse
71. if farm_gate_price_cp is intermediate and farm_gate_price_op is low then relative_profitability_op is worse
72. if farm_gate_price_cp is high and farm_gate_price_op is low then relative_profitability_op is worse
73. if farm_gate_price_cp is intermediate and farm_gate_price_op is intermediate then relative_profitability_op is similar
74. if farm_gate_price_cp is low and farm_gate_price_op is low then relative_profitability_op is similar
75. if farm_gate_price_cp is high and farm_gate_price_op is high then relative_profitability_op is similar
76. if farm_gate_price_cp is intermediate and farm_gate_price_op is high then relative_profitability_op is better
77. if farm_gate_price_cp is low and farm_gate_price_op is high then relative_profitability_op is better
78. if farm_gate_price_cp is low and farm_gate_price_op is intermediate then relative_profitability_op is better
79. if domestic_demand_op is low then farm_gate_price_op is low
80. if domestic_demand_op is intermediate then farm_gate_price_op is intermediate
81. if domestic_demand_op is high then farm_gate_price_op is high
82. if domestic_demand_op is low then media_coverage_profile is not_significant
83. if domestic_demand_op is high and agro_environmental_policy is highly_favourable then media_coverage_profile is significant
84. if domestic_demand_op is low and food_scares is low then political_climate_towards_of is unfavourable
85. if domestic_demand_op is low and farmers_altruistic_concerns is low then political_climate_towards_of is unfavourable
86. if domestic_demand_op is intermediate then political_climate_towards_of is slightly_favourable
87. if domestic_demand_op is high and food_scares is high then political_climate_towards_of is highly_favourable
88. if domestic_demand_op is high and farmers_altruistic_concerns is high then political_climate_towards_of is highly_favourable

89. if domestic_supply_op is low and market_globalisation is low then availability_op is low
90. if domestic_supply_op is intermediate and market_globalisation is low then availability_op is low
91. if domestic_supply_op is low and market_globalisation is intermediate then availability_op is low
92. if domestic_supply_op is intermediate and market_globalisation is intermediate then availability_op is high
93. if domestic_supply_op is intermediate and market_globalisation is high then availability_op is high
94. if domestic_supply_op is high and market_globalisation is intermediate then availability_op is high
95. if domestic_supply_op is high and market_globalisation is high then availability_op is high
96. if domestic_supply_op is low then organic_certification_labeling is not_effective
97. if domestic_supply_op is intermediate then organic_certification_labeling is effective
98. if domestic_supply_op is high then organic_certification_labeling is highly_effective
99. if domestic_supply_op is low and media_coverage_profile is not_significant then political_climate_towards_of is unfavourable
100. if domestic_supply_op is low and relative_food_quality is worse then political_climate_towards_of is unfavourable
101. if media_coverage_profile is not_significant and relative_food_quality is worse then political_climate_towards_of is unfavourable
102. if domestic_supply_op is intermediate and media_coverage_profile is significant and relative_food_quality is better then political_climate_towards_of is highly_favourable
103. if domestic_supply_op is intermediate then political_climate_towards_of is slightly_favourable
104. if domestic_supply_op is high and media_coverage_profile is significant and relative_food_quality is better then political_climate_towards_of is highly_favourable
105. if relative_food_quality is similar then political_climate_towards_of is slightly_favourable
106. if domestic_supply_op is low then intermediate_standards_products is high
107. if domestic_supply_op is intermediate then intermediate_standards_products is intermediate
108. if domestic_supply_op is high then intermediate_standards_products is low
109. if domestic_supply_op is low then processing_marketing_capacity_of is low

110. if domestic_supply_op is intermediate then processing_marketing_capacity_of is intermediate
111. if domestic_supply_op is high then processing_marketing_capacity_of is high
112. if domestic_supply_op is low then market_development_indirect_support_of is low
113. if domestic_supply_op is high then market_development_indirect_support_of is high
114. if political_climate_towards_of is unfavourable then market_development_indirect_support_of is low
115. if political_climate_towards_of is highly_favourable then market_development_indirect_support_of is high
116. if domestic_supply_op is low and political_climate_towards_of is unfavourable then knowledge_system_of is poorly_developed
117. if domestic_supply_op is high and political_climate_towards_of is highly_favourable then knowledge_system_of is well_developed
118. if organic_certification_labeling is not_effective then domestic_demand_op is low
119. if organic_certification_labeling is effective then domestic_demand_op is intermediate
120. if organic_certification_labeling is highly_effective then domestic_demand_op is high
121. if organic_certification_labeling is not_effective then promotion_advertising_op is not_significant
122. if organic_certification_labeling is highly_effective and processing_marketing_capacity_of is high then promotion_advertising_op is significant
123. if organic_certification_labeling is highly_effective and processing_marketing_capacity_of is intermediate then promotion_advertising_op is significant
124. if organic_certification_labeling is not_effective then knowledge_system_of is poorly_developed
125. if organic_certification_labeling is highly_effective then knowledge_system_of is well_developed
126. “if availability_op is low then domestic_demand_op is low
127. if availability_op is high then domestic_demand_op is intermediate
128. if availability_op is low then media_coverage_profile is not_significant
129. if availability_op is high then media_coverage_profile is significant
130. if consumer_price_op is low then domestic_demand_op is high
131. if consumer_price_op is intermediate then domestic_demand_op is intermediate
132. if consumer_price_op is high then domestic_demand_op is low
133. if consumer_price_op is low then intermediate_standards_products is low

134. if consumer_price_op is intermediate then intermediate_standards_products is intermediate
135. if consumer_price_op is high then intermediate_standards_products is high
136. if farm_gate_price_op is low then consumer_price_op is low
137. if farm_gate_price_op is intermediate then consumer_price_op is intermediate
138. if farm_gate_price_op is high then consumer_price_op is high
139. if relative_profitability_op is worse then domestic_supply_op is low
140. if relative_profitability_op is similar then domestic_supply_op is intermediate
141. if relative_profitability_op is better then domestic_supply_op is high
142. if relative_profitability_op is worse then media_coverage_profile is not_significant
143. if relative_profitability_op is similar then media_coverage_profile is not_significant
144. if relative_profitability_op is better and relative_food_quality is better then media_coverage_profile is significant
145. if relative_profitability_op is worse then intermediate_standards_products is high
146. if relative_profitability_op is similar then intermediate_standards_products is intermediate
147. if relative_profitability_op is better then intermediate_standards_products is low
148. if relative_profitability_op is worse and agro_environmental_policy is unfavourable then knowledge_system_of is poorly_developed
149. if relative_profitability_op is worse and agro_environmental_policy is slightly_favourable then knowledge_system_of is poorly_developed
150. if relative_profitability_op is similar and agro_environmental_policy is unfavourable then knowledge_system_of is poorly_developed
151. if relative_profitability_op is similar and agro_environmental_policy is slightly_favourable then knowledge_system_of is poorly_developed
152. if relative_profitability_op is similar and agro_environmental_policy is highly_favourable then knowledge_system_of is well_developed
153. if relative_profitability_op is better and agro_environmental_policy is slightly_favourable then knowledge_system_of is well_developed
154. if relative_profitability_op is better and agro_environmental_policy is highly_favourable then knowledge_system_of is well_developed
155. if relative_food_quality is worse and domestic_demand_op is low then availability_op is low
156. if relative_food_quality is similar and domestic_demand_op is low then availability_op is low
157. if relative_food_quality is worse and domestic_demand_op is intermediate then availability_op is low

158. if relative_food_quality is similar and domestic_demand_op is intermediate then availability_op is low
159. if relative_food_quality is better and domestic_demand_op is intermediate then availability_op is high
160. if relative_food_quality is similar and domestic_demand_op is high then availability_op is high
161. if relative_food_quality is better and domestic_demand_op is high then availability_op is high
162. if relative_food_quality is worse then media_coverage_profile is not_significant
163. if relative_food_quality is similar then media_coverage_profile is not_significant
164. if media_coverage_profile is not_significant and promotion_advertising_op is not_significant then domestic_demand_op is low
165. if media_coverage_profile is significant and promotion_advertising_op is not_significant then domestic_demand_op is intermediate
166. if media_coverage_profile is not_significant and promotion_advertising_op is significant then domestic_demand_op is intermediate
167. if media_coverage_profile is significant and promotion_advertising_op is significant then domestic_demand_op is high
168. if media_coverage_profile is not_significant then domestic_supply_op is low
169. if media_coverage_profile is significant and market_development_indirect_support_of is low then domestic_supply_op is intermediate
170. if media_coverage_profile is significant and market_development_indirect_support_of is high then domestic_supply_op is high
171. if promotion_advertising_op is not_significant then media_coverage_profile is not_significant
172. if promotion_advertising_op is significant then media_coverage_profile is significant
173. if political_climate_towards_of is unfavourable then media_coverage_profile is not_significant
174. if political_climate_towards_of is highly_favourable then media_coverage_profile is significant
175. if political_climate_towards_of is unfavourable then direct_producer_support_of is low
176. if political_climate_towards_of is highly_favourable then direct_producer_support_of is high
177. if technological_change_of is slow then domestic_supply_op is low
178. if technological_change_of is similar then domestic_supply_op is intermediate

179. if technological_change_of is fast then domestic_supply_op is high
180. if technological_change_of is slow and media_coverage_profile is not_significant then availability_op is low
181. if technological_change_of is fast and media_coverage_profile is significant then availability_op is high
182. if technological_change_of is slow then relative_profitability_op is worse
183. if technological_change_of is similar then relative_profitability_op is similar
184. if technological_change_of is fast then relative_profitability_op is better
185. if technological_change_of is slow then relative_food_quality is worse
186. if technological_change_of is similar then relative_food_quality is similar
187. if technological_change_of is fast then relative_food_quality is better
188. if intermediate_standards_products is low then domestic_demand_op is high
189. if intermediate_standards_products is intermediate then domestic_demand_op is intermediate
190. if intermediate_standards_products is high then domestic_demand_op is low
191. if intermediate_standards_products is low knowledge_system_of is poorly_developed
192. if intermediate_standards_products is high knowledge_system_of is well_developed
193. if agro_environmental_policy is unfavourable then relative_profitability_op is worse
194. if agro_environmental_policy is slightly_favourable then relative_profitability_op is similar
195. if agro_environmental_policy is highly_favourable then relative_profitability_op is better
196. if agro_environmental_policy is unfavourable then media_coverage_profile is not_significant
197. if agro_environmental_policy is unfavourable then technological_change_of is slow
198. if agro_environmental_policy is slightly_favourable then technological_change_of is similar
199. if agro_environmental_policy is highly_favourable then technological_change_of is fast
200. if agro_environmental_policy is unfavourable then intermediate_standards_products is low
201. if agro_environmental_policy is slightly_favourable then intermediate_standards_products is intermediate
202. if agro_environmental_policy is highly_favourable then intermediate_standards_products is high

203. if processing_marketing_capacity_of is low then consumer_price_op is high
204. if processing_marketing_capacity_of is intermediate then consumer_price_op is intermediate
205. if processing_marketing_capacity_of is high then consumer_price_op is low
206. if processing_marketing_capacity_of is low then promotion_advertising_op is not_significant
207. if processing_marketing_capacity_of is low then availability_op is low
208. if processing_marketing_capacity_of is high then availability_op is high
209. if direct_producer_support_of is low then relative_profitability_op is worse
210. if direct_producer_support_of is high then relative_profitability_op is better
211. if market_development_indirect_support_of is low then processing_marketing_capacity_of is low
212. if knowledge_system_of is poorly_developed then organic_certification_labeling is not_effective
213. if knowledge_system_of is well_developed then organic_certification_labeling is highly_effective
214. if knowledge_system_of is poorly_developed then relative_food_quality is worse
215. if knowledge_system_of is well_developed then relative_food_quality is better
216. if knowledge_system_of is poorly_developed then technological_change_of is slow
217. if knowledge_system_of is well_developed then technological_change_of is fast
218. if knowledge_system_of is poorly_developed then political_climate_towards_of is unfavourable
219. if knowledge_system_of is well_developed then political_climate_towards_of is highly_favourable