2 Vegineco, farming systems research in outdoor vegetables

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Shortcomings of outdoor vegetable production

Farmers are currently challenged by consumers and authorities to be the responsible manager of the rural area while producing high quality (even speciality) products. This affects the full depth and scale of the farm management.

Looking more specifically to vegetable farming the need for new farming systems is even more dominant. The farms that produce field grown vegetables are relatively small, mostly concentrated in certain regions (for practical market-oriented reasons) often highly specialised and characterised by the very intensive land use (all year round soil utilisation), generally a low mechanisation and high (external) labour demand per hectare. Vegetable growing is facing increasing agronomic, environmental and economical problems:

Agronomically

There is a high pressure of pest and diseases and at the same time there is a demand for a high (cosmetic) quality.

Environmentally

Emission of nutrients and pesticides to the environment are generally large.

Health and Well Being

Pesticide residues on the produce can be regularely found and working conditions for farm workers are far from optimal.

Ecologically

Nutrients and pesticides cause damage to non-target biota and fragile ecosystems. There is generally little space for nature and landscape elements.

Economically

Most farms have a low profitability and product prices are under pressure.

Consequently there is an urgent need for innovative, new farming systems that are multi-objective and integrate "new" objectives such as quality of produce and production methods, quality of the a-biotic environment, landscape and nature values and agronomic sustainability into the old objectives.

The EU Vegineco project

Vegineco: "Development of sustainable vegetable farming systems focusing on high quality production and minimum environmental impact."

The EU project Vegineco has been focussing on farming systems research to develop, test and evaluate prototypes of integrated and ecological outdoor vegetable farming systems in three important vegetable producing regions spread over Europe under different social/-economic, soil and climatic conditions. For this farming systems development a comprehensive methodology called 'prototyping', was used. This methodology is based on the work in the concerted action EU 93-96 (Vereijken). Four partners took part in this project:

- Netherlands, Applied Plant Research (PPO)
- Italy, Centre for Plant Research (CRPV)
- Spain, Institute for Agricultural Research (IVIA)
- Switzerland, Swiss Federal Research Station for Fruit-growing, Viticulture and Horticulture (FAW)

The next systems were tested (see also system description in Annex 1):

- Two integrated and one ecological experimental system of farming systems with arable and vegetable crops in the Southwest region of the Netherlands.
- One integrated system with vegetable crops for the industry, one integrated system with fresh market crops and one ecological system with fresh market crops in Emilia-Romagna in Italy.
- 5 integrated systems and one ecological system all with fresh market crops in the Valencia region in Spain.

Next to these experimental systems, in Switzerland 7 ecological and 7 integrated pilot farms have been compared and goal oriented improved.

By choosing characteristic "environments" for Europe like in this project the potential has been studied in a standardised way with a comprehensive set of parameters. Potential refers to the set of objectives and to the impediments and opportunities for the systems in the different regions.

Innovation of agriculture

Innovation of agriculture is a continuous process of creating or utilising chances and opportunities, counteracting threats and solving problems. At present a complex of problems is destabilising agriculture and threatening the sustainability. However, simultaneously opportunities are offered to revitalise agriculture by seeking links with the urban population by offering scarce products and functions as agro-tourism, recreation possibilities, diversified landscape etc. Therefore, innovation of agriculture is at the moment synonymous to finding integral, coherent solutions while integrating different objectives and functions.

Innovation can be stimulated by:

1. the total complex of policy regulatory packages,
2. technological developments or
3. more social action at the basic farming community level.

Policy packages offer an excellent opportunity to create incentives for change and to facilitate this change.

Socially based solutions refer to farming communities elaborating common objectives and plans and operating as a group in the communication with the so called

"stake-holders" in the region. This community forming and communication process can be stimulated and facilitated by social scientist and extensionists Technological developments are necessary to enable innovation. These technological solutions can be divided in three levels:

1. system innovations,
2. process integrated solutions and
3. end of pipe solutions.

It is obvious that end of pipe solutions are often developed on an ad hoc basis to alleviate the negative effects of farming. More sustainable farming systems have to be based on system innovation and process integrated solutions. Novel systems are based on strategic overall concepts that constitute and enhance system innovation and on integrated technology based on agro-ecological principles, agronomy and biological, physical and chemical methods. In essence these novel systems are low input-high output systems that will have to be more sustainable in ecological agronomical, economical and social terms. Such, integral new farming systems are at the moment represented by two, different, approaches namely integrated and ecological farming. Integrated production under label has been introduced in the recent past for a number of products in a number of European regions and ecological production labels are harmonised on the European level. In spite of this, the potential of these systems is much larger than the present practice. In vegetable farming a systematic and standardised evaluation of the potential of both systems is lacking as is a comparison based on a standardised set of parameters.

Innovation is always a process of design, testing and improving (see Figure 2.1) based on comprehensive objectives. This innovation process can be facilitated and stimulated by all the mentioned approaches. In many projects all over the world this is attempted in a rather top-down approach. As initial step this might be appropriate. However when insufficient attention is given to interaction with the target group and their learning process, innovations are deemed to extinguish. On the other hand when successful, the initial linear innovation model (top-down) evolves into a circular, continuous innovation model, supported by the group. Prototyping is a method that structures the process of continuous innovation towards more sustainable farming systems.

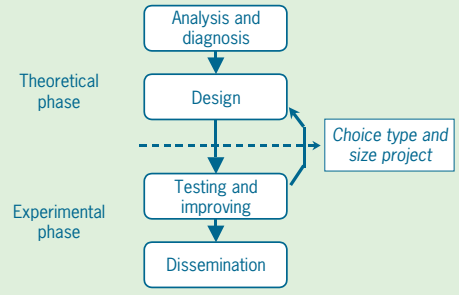

Figure 2.1 Prototyping methodology

Prototyping methodology (as used in Vegineco)

In the Vegineco project, a standardised methodology was used. This methodology is called prototyping and can be characterised as a synthetic research/development effort starting off with a profile of demands (objectives) in agronomic, environmental and economic terms for a more sustainable, future-oriented farming and ending with tested, ready for use prototypes, to be disseminated on a large scale. This methodology of analysing, designing, testing, improving and disseminating integrated and organic farming systems has been elaborated for arable farming in a four years European Union Concerted Action (Vereijken, 1994 and 1995). For vegetable farming however, this type of research is limited. It is a challenge and a necessity to transplant this methodology to vegetable production and start farming systems research to fully integrate all the different objectives and to be able to evaluate the full potential of the new systems. The methodology of prototyping is still young, dynamic and developing. However, it can be described as an innovation process in 4 steps (Figure 2.1).

Although presented as a linear top down process in figure 2.1, the different phases tend to overlap and circular processes are included (Figure 2.2 and 2.3). Especially when applying the methodology on pilot farms the dissemination phase and involvement of farmers and stakeholders already starts in the first phases.

The process of prototyping starts with a regionally based analysis and diagnosis phase of the following aspects: sectorial statistics, farm structure, agro-ecological state of the art, ecological/environmental impact, socio-economic situation, trends in structural changes and the present political conditions. Based on the analysis of the shortcomings of current farming and the perspectives in the future, a hierarchy of objectives for either an integrated (short-term alternative) or ecological (long-term alternative) farming systems has to be established. These rather abstract objectives are in the Vegineco prototyping practice

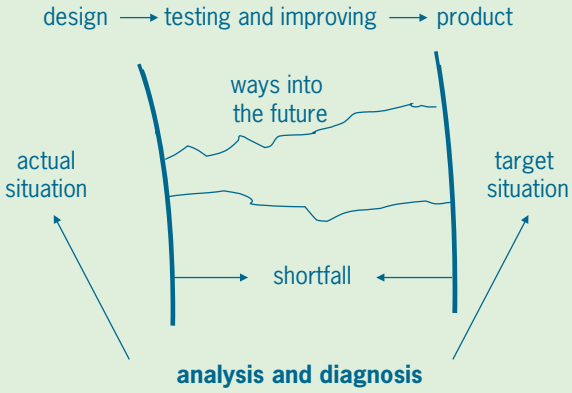

Figure 2.2 Continuous development to reach the target situation

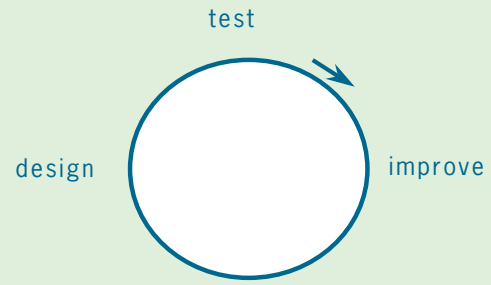

Figure 2.3 The circular process of designing testing and improving

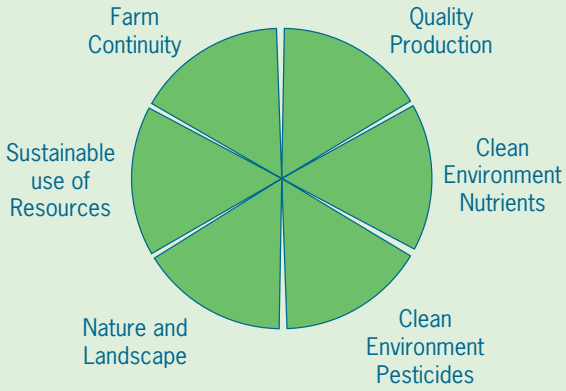

Figure 2.4 Major themes in the Vegineco project

translated in 5 directional themes: quality production, clean environment, attractive landscape and diversified nature, sustainable management of resources and farm continuity.

Each theme is concretised in a number of (farm level) parameters to be able to quantify the objectives of the theme. The main parameters used or developed in the Vegineco project can be found in Table 2.1. A brief description per parameter can be found in Annex 2. Each parameter is given a target value so that a well defined, documented and clear framework is elaborated to design, test and improve farming systems. The target levels are future oriented and are derived from legislation, scientific evidence or expert knowledge.

As next step, a suitable set of farming methods has to be designed. Methods here are defined as coherent strategies on the major aspects of farming, like crop rotation, nutrient management, crop protection and farm nature management. These methods mostly need further development in order to realise the related objectives. The results of the development of the methods in the Vegineco project are treated in depth in a correspondent method manual, which will be published as a product of the project.
The next step in the methodology is the design of a theoretical prototype in which parameters and methods are linked to each other as basis for a correct evaluation. This step is necessary to check the links between methods and parameters and as basic framework for interpretation of the results. The last part of the theoretical exercise ends with detailed cropping programmes. Adjustments

Table 2.1 Parameters used in the Vegineco project

Theme	Parameters
Quality production	Quantity of produce Quality of produce NO_3^- content (leafy vegetables)
Clean environment nutrients	Nitrogen (mineral) available reserves at the start of the leaching season Phosphorus and Potassium annual balance
Clean environment pesticides	Synthetic pesticide input (active ingredients) Pesticide input copper Potential emission to air, groundwater and soil of pesticide active ingredients
Nature and landscape	Surface ecological infrastructure Various other parameters quantifying landscape and nature (in development)
Sustainable use of resources	Phosphorus and potassium available soil reserves Organic matter annual balance Energy efficiency (in development)
Farm continuity	Net surplus or revenues per € 100 costs Hours hand weeding

might be necessary depending on actual crop, weather and soil conditions.
The next phase is testing and improving the designed farming system. Basis for a successful test-phase is the design of the farming system in time and space. This concerns not only the choice of a multi-functional crop rotation but also the agro-ecological identity of the farm. Testing implies that the shortfall between target and actual results will be analysed in terms of the methods linked to the parameters in question. The agronomic database and the qualitative observations during the growing season are indispensable for the analysis of the shortfall between actual and target results. In this phase, detailed knowledge is generated about the different production techniques, their compatibility with other farming methods, their effectivity in relation to the objectives and the (potential) conflicts with other methods and objectives. This information is directly used to improve the prototype. It increases the general knowledge of in- and output relations and enables to exchange production techniques in model studies when different balances of objectives are to be reached.
Testing on pilot farms also implies testing of the degree of manageability and acceptability of the newly developed methods.
The prototype will be improved by improving the set of methods in a targeted way, which implies to elaborate safe, efficient, acceptable and manageable integrated farming methods that can realise the target result. The prototypes will be improved from year to year. Any adjustment in the cropping programmes should avoid new conflicts between the objectives and needs therefore careful considerations.
The testing and improving continues until the objectives as quantified in a target level of the relevant parameters are reached. Primarily, agro-ecological objectives have to be realised. Economic objectives can be studied and optimised by model studies, involving different scales of farms. By these studies, it can become explicit what the consequences are for the needed farm structure when the agronomic and ecological objectives are fulfilled. This is a very important point of view for policy makers.
The required time to reach the objectives is dependent on the objectives, the specific character of the parameters (variability and response-time), the specific situation of the prototype and the extend to which production methods are already developed.
When the prototype shows stable results at the level of the targets set in the parameters, dissemination is the natural following step. The perspectives of new prototypes can only be evaluated in practice. Management is the key-factor for the success and feasibility of these new approaches. Therefore a first test of, the on experimental farms developed, region-specific prototype on a small number of pilot farms is considered to be an indispensable step before introducing new prototypes on a large scale into practice.

Vegineco results

The results of the Vegineco project provide a quantified level of the potential sustainability of the tested systems and indicate to what extent the described goals for sustainable production can be reached. Moreover the project provides the tested and improved instruments (farming methods) to realise these quantified levels of sustainability. The results and products of Vegineco can be summarised as:

- Tested and improved multi-objective farming methods concerning the key farm practices crop rotation, fertilisation and crop protection that enable integration of potentially conflicting objectives like economy and ecology. Next to these “old” practices new methods have been developed in the field of nature and landscape management (integrated in the farm practices).
- Novel approaches to pesticide use evaluation and pesticide selection, quality production of crops and energy input.
- Integration of the existing and partly newly developed international expertise elaborated it comprehensive, coherent farming methods manuals to be used by the farming industry, research, extension and education.
- A comprehensive and standardised comparison of ecological and integrated vegetable farming systems.

The next presentations will be focussed on the performance of the tested vegetable farming systems in different European regions. The methods and novel approaches used to realise this performance will not be mentioned in detail. The resulting methods are published in a final project report and a series of four method manuals on the key farm methods: crop rotation, nutrient management, crop protection and ecological infrastructure management.
The performance is presented in terms of the realised level of the parameters. This realisation is compared with the desired (target) levels of these parameters (Figure 2.5) and the remaining shortfall is commented. If possible, an additional comparison is made with the performance of the standard practice.

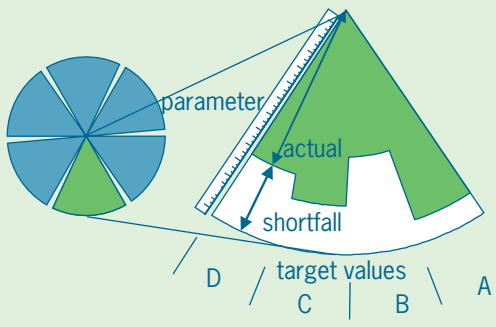

Figure 2.5 Schematic representation of realisation target and shortfall