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# Prototyping and Dissemination of Ecological Olive Production Systems in Co-Operation with Farmers

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## Abstract

Ecological olive production systems are a feasible first step towards a long term solution for the shortcomings of conventional olive production in the Mediterranean. Ecological olive production is particularly important in less favoured areas. Therefore, an innovative research project has been laid out, aimed at the design, development, evaluation and dissemination of ecological olive production, in co-operation with a pilot group of ecological farmers. A set of parameters has been used to quantify the objectives of the prototype systems, and six new methods are developed to achieve the system objectives. The methods are combined into prototype farming systems while avoiding any conflicts between them. Each method is evaluated and improved on the basis of a set of four criteria. The prototype systems are evaluated and improved in a methodical procedure. Prototypes are disseminated among olive growers, members of the Cretan Agri-environmental Group in Messara plain, Crete, Greece. A methodical way of dissemination across a region is prepared. In this paper the methodical procedure and the initial results of prototyping and dissemination of the ecological olive production systems in a less favoured area are presented.

## Introduction

Conventional olive production in the Mediterranean area is facing increasing agronomic, ecological and socio-economic problems (Kabourakis, 1996; Kedros, Margaris and Chodzeas, 1988) as production methods are aiming at maximum yields whilst price subsides are being increasingly abolished by the European Union (EU) and member states (Table I). These problems are more acute in less favoured areas around the Mediterranean. The major problems are related to their various causes, from the agronomic, ecological and socio-economic points of view. These problems are compared to the objectives of Ecological Olive Production Systems (EOPS). They are interrelated and one cause is often related to more than one problem (Kabourakis, 1996).

The diagnosis of problems faced on the Messara plain, Crete, stresses the need for innovation, for a long term improvement of olive production. A first step to advance olive production is to ecologize the primary production and land use and to re-establish an ecological knowledge system for the olive growers. Although traditional olive growing offered an ecologically sound and sustainable model, it is neither profitable nor attractive to the olive growers under current conditions (Kabourakis, 1996). Therefore, innovation should be targeted. The strategy for this innovation should have two stages: in the first stage the olive production is prototyped and the ecological knowledge system is introduced in the research area. During the second stage, the prototype is optimized and widely disseminated on a broader regional scale.

The methodological way of five formal steps used in prototyping arable farming systems by a European network (Vereijken, 1994; Vereijken, 1995; Vereijken, 1996; Vereijken, 1997) was used for the interactive prototyping of EOPS. These steps are:

(1) an hierarchy of general and specific objectives for the prototypes is made

(2) the major objectives are transformed into multi-objective parameters to quantify them and the multi-objective methods needed to achieve the quantified objectives are established

(3) a theoretical prototype is designed by linking parameters to farming methods and the methods are designed in this context until they are ready for initial testing

(4) the prototype is laid out and it is tested and improved in general and the methods in particular, until (after repeated laying out) the objectives as quantified in the set of parameters have been achieved

(5) the prototype is disseminated by pilot groups and through regional networks

Introducing and re-establishing an ecological knowledge system (Rolling and Jiggins, 1996), for facilitating the dissemination of prototypes in area and regional context, implies a methodical way of three steps:

(1) a pilot group is formed for the interactive prototyping and the introduction of the ecological knowledge system

(2) an agri-environmental group is formed facilitating the dissemination of the prototypes and transition to an ecological knowledge system in the area

(3) a network of satellite groups of the agri-environmental group is formed facilitating the dissemination of the prototypes and re-establishing an ecological knowledge system on a regional scale.

## Region of the Pilot Project

The innovative pilot project takes place at the western Messara plain, Crete, Greece. The area of the project is marginal; characterized as a less favoured area by the European Union. The area is typically semi-arid where olives have being cultivated for thousands of years. The climate is maritime Mediterranean.

Two agroecological zones are represented: the plain and the hilly zone. These zones posses different types of soil and microclimatic conditions, caused by topographic differences. Besides, different types of olive plantations occur in these two zones (Kabourakis, 1996).

## Design

### Making an hierarchy of objectives

Prototyping EOPS implies a systematic methodology for establishing the objectives of production, considering biological, ecological and socio-economic circumstances and constraints of the area and the desired long term beneficial contribution of the prototypes in the agronomic, ecological and socio-economic situation.

Objectives of the ecosystem-oriented vision for agriculture, described by Vereijken (Vereijken, 1992), were used as a basis for EOPS. A hierarchy of objectives, Table II, was made following a process in which the diagnosis of current olive production was taken into consideration, relevant literature on oliviculture, agroecology, ecological agriculture and on the project area was reviewed and by discussions with growers and farm advisors in the area (Kabourakis, 1996).

### Quantifying the objectives into parameters

The hierarchy of objectives (Table II) is transformed into a suitable set of multi-objective parameters (Table IV; Table III) to quantify them. The criterion of being integrated or being indispensable for a single objective was used for the parameters‘ selection. In this way, the quantified objectives can be used as desired results, to evaluate the achieved results of the EOPS prototypes. The prototypes are tested and improved until the results achieved match the desired ones. The twelve parameters quantify and indicate the sustainability of the prototypes (Kabourakis, 1996).

### Designing a theoretical prototype and methods in its context

Following a process described by Kabourakis (1996), a theoretical prototype (See Figure 1) was designed by linking parameters to farming methods and used for designing relevant methods. The design of a theoretical prototype concerns finding appropriate farming methods which help the grower to realize desired standards, identified for all relevant parameters, described above. Those farming methods should integrate the objectives as much as possible. Six multi-objective farming methods covering the main components and process of the agroecosystem, while achieving the objectives of the prototype, were designed initially and further elaborated (See Figure 1). The theoretical prototype shows the major and minor methods required to achieve the desired results for each objective, e.g., for each parameter. Vice versa, it also shows which parameters are supported by a method and thus indicates potential impact of each method. Consequently the theoretical prototype defines the context and the order of designing the methods (Vereijken, 1997).

Because of the lack of adequate methods they were designed at first theoretically: (a) by reviewing the traditional oliviculture in the region, (b) by reviewing relevant literature on oliviculture, agroecology, soil and water conservation, entomology and phytopathology, agronomy, nature and landscape conservation and ecological agriculture, and (c) by discussion with olive growers. The annual version of each method was elaborated according to four criteria (See: 4.3 Improving the prototype). The growers, in interaction with the research team are making a specific design for their pilot grove(s) each year, taking note of each method. The design utilizes their practical experiences. Criteria for the design of the methods were to be integrated and consistent with growers‘ potential for technical improvement.

### Testing and improving the prototype variants

#### Layout of the prototype in farm specific variants

Pilot growers provided pilot groves, located at the western Messara plain and on the surrounding hills, that cover the main agroecological types of olive production for this area. For obtaining an optimal layout, the pilot groves were selected according to a set of agroecological criteria (Kabourakis, 1996). The layout of the prototype on pilot groves is presented for the three specific variants: (a) high density groves in the hilly agroecological zone, (b) low density groves in the hilly agroecological zone and (c) intensive groves in the plain agroecological zone. These variants differ in more than one of the following factors: (a) microclimate, (b) soil type, (c) water use, (d) plantation type, (e) olive tree variety.

#### Testing the prototype

Initial results of 1994 and 1995 from laying out in 17 pilot groves managed by 12 pilot growers, as well as the results of testing the prototype with 10 parameters are presented in Table V. The results are presented in the order of the 6 major methods required to achieve the objectives, as transformed and quantified in the set of the 12 multi-objective parameters (see theoretical prototype, Figure I). Table V specifies for any parameter the desired result and the main cause of a possible shortfall and in case the latter is a method, for which criterion needs to be improved (See: 4.3 Improving the prototype). The results are presented as a mean of 1994 and 1995, because of the biennial production of the olive tree and the related timing of cultural practices.

Figures in Table V show that the prototype has not been agro-ecologically optimized regarding objectives of soil, basic income and profit and local flora and landscape. But, the prototype also compared with the conventional production before introducing the prototypes shows the rapid improvements made during prototyping (Kabourakis, 1996).

The data related to parameters and methods are recorded on spreadsheets and databases with the Microsoft Excel and Access computer programmes. In accordance to the methods' research plans, a number of tables are constructed with data provided by the growers and measured by the growers and the researchers. Growers provide data related to the activities on their farms, the application of the methods to their groves and the quantification of parameters. Researchers measure data related to the quantification of the parameters. The data of the filled tables were used by the researchers to calculate the parameters achieved results for every grove, each year. Research was also shown to the growers in a practical form using Excel.

#### Improving the prototype

Improving the prototype is a matter of relating the shortfalls between achieved and desired results to the methods and improving them in a targeted way (Table V). Such under-achievements may arise from one or more of the following causes (Vereijken, 1994): the method(s) in question is not sufficiently elaborated by the researchers, or not manageable by the farmer, or not acceptable to the farmer, or not effective in the pilot groves.

The methodical procedure of the European network for prototyping arable farming systems (Vereijken, 1994) is adopted in order to improve the prototype. The first step is to establish which parameters indicate shortfalls between achieved and desired results (See Table V). The second step is to establish, using the theoretical prototype, which methods are involved (See Figure 1). The third step is to establish which criteria are not yet fulfilled by these methods

(Table V). The fourth step is to target the improvements needed to meet the criteria. The last step is the laying out and retesting of the prototype again. Following this procedure researchers and pilot growers interacted in 1994 and 1995 to improve the prototypes. Each year the results of the above procedure were presented to the members of CAG and comments were received regarding the application of methods.

Improving the prototype presupposes the improvement of knowledge, management, skills and agrotechnology related to the methods, by researchers and growers. Furthermore, it implies the improvement of interaction and understanding between them.

## Networks For Prototyping And Dissemination

Prototyping activities on a large scale requires a network to cover the different agroecological, economic and social conditions of the region. These conditions vary from region to region. Therefore, prototyping has specific characteristics regionally. So prototypes may differ from objectives to be achieved by the new system, but may also differ in parameters and farming methods.

### Agri-environmental group for conversion and dissemination

The CAG is an agri-environmental non-governmental organisation, which facilitates two aspects of the innovative pilot project. The first is conversion of farms to current ecological agriculture (EU guidelines and label). The second is dissemination of prototypes in the area of Messara plain and around Crete.

Dissemination of the prototypes takes place in several sequential stages. At first, the prototype is disseminated to neighbouring growers of a pilot grower and their groves, and also among the other farmers of the same village. The rest of the farming community pays attention and follows attempts, failures and successes of the pilot growers and of the pilot groves. Thus, the selection of the pilot growers and groves is critical (Kabourakis, 1996). Dissemination is easier and faster when an established farmer organisation exists (Kabourakis, 1996).

Later, when dissemination within close circles around the farmer is completed, the creation of satellite groups in other areas indicates the onset of a wider dissemination.

In the next stage, every satellite agri-environmental group may publicise the prototypes and offer organisational assistance to new growers for a larger scale dissemination in their area. Then the prototypes may be disseminated to the majority of the growers of the area of the group. Besides, at this stage, integration, that has been started earlier with contacts to other institutions and organisations, may be performed. This integration may lead gradually to the transition to a more ecological knowledge system in the area. Now may be the time for contacts with policy makers and formal institutions to establish a supporting policy for the prototypes.

The final stage is the dissemination of prototypes in the whole region. This requires satellite groups which have completed the first stage of prototyping and have tested the variants of the prototype for their area at least once. Of course farmers in the region may, and will, adopt the prototype methods but they will probably hardly meet the standards of production that each area specific prototype requires. If this happens, then the contribution of the prototype will be limited regarding the sustainability of the area (Kabourakis, 1996).

Within the framework of CAG all different pilot groups may introduce harmonization of standards, especially regarding social, economic aspects of conversion to EOPS and regarding marketing of products from EOPS all over Crete. This might avoid conflicts between various farmer groups. This may be easier if one of them has the role of co-ordinator for the rest of the groups, facilitating the exchange of information and agrotechnology. Besides, this core group will facilitate the interaction with networks of other regions.

Institutional and policy support will be crucial at final stage of dissemination as a large scale mobilisation of capital and human resources is required.

### Pilot group

In the pilot project for ecological olive production the entire methodical way of prototyping olive production and introducing an ecological knowledge system is done by interaction of a pilot group of twelve olive growers with researchers, in an organized way.

Potential members of the pilot group were determined using experiences and acquaintances from previous work as farm advisors in the area (Kabourakis, 1996). Ecological olive growers are suitable partners as their production should meet strict environmental and quality of production norms and is marketed under label (CEC, 1991; IFOAM, 1996). For this reason all the pilot group members have been converted to current ecological agriculture (organic farming), following the prototyping methods. Production and marketing of products with high added ecological value under label seems to be the only sustainable solution, as it implies shared responsibilities of rural and urban populations, for environment and nature.

The pilot growers address the actual shortcomings of the prototypes applying them in the realistic situation of their farms. Besides, using the prototypes they contribute with their knowledge and experience to the solution of these shortcomings, blueprinting solutions. The pilot group acts as the core of community based agri-environmental group during dissemination of the prototypes (See Figure 3). The challenge will be to link with pilot groups of the satellite groups of the CAG and to disseminate prototypes, agro-technology and management skills successfully. Pilot groups and research teams should interact also between them for improving and optimizing the prototypes of the region.

## Perspectives

The work done in the pilot project shows the lack of research on farming systems, including tree and perennial crops. Besides, it shows the need for synthetic research as well as farming systems research and design taking into consideration the regional soil, climate, nature, landscape, agronomic and management conditions, and the social and economic conditions. Our designed prototypes raise a solution to the main problems of olive production and offer a new production system for olive production. Dissemination of prototypes in a region contributes to eliminating the socio-economic problems of that region. Prototyping is particularly important in less favoured areas where little background research data exist, concerning farming systems.

Prototyping is a time consuming activity. It requires few extra resources (human, natural, technological) while it optimizes the existing ones. Consequently, it is economically profitable compared with other approaches of innovation and development. Once a production system has been prototyped successfully, then it is easier to use existing experiences and networks to prototype other production systems. The above are well suited to less favoured areas, as there are many structural problems and often scarce, unsustainable managed resources.

It is difficult to compare the results with other research results, as few other studies on prototyping are available. This was also a disadvantage for planning the research itself, as there were no other comparable research results for reference.

Considering the information and data presented above it is obvious that the innovative project is only in its first phase. Initial results are encouraging. The research must continue for another extended period to obtain a better view of the ecological methods and finally to be able to evaluate the effectiveness of EOPS prototypes. The designing methodology was shown to be a perfect way for converting olive production, in a less favoured area to an ecological one. The formation of the growers' pilot group and the role of CAG was crucial for tracing new roads. Growers laid out the EOPS, tested and disseminated the prototype at Messara plain.

## References

CEC "Official Journal of the European Communities," (L 198/1, 22.7.91, 1991).

IFOAM, "Basic standards of organic agriculture" (Tholey-Theley, Germany, 1996), 35.

Kabourakis E., Prototyping and Dissemination of Ecological Olive Production Systems. A methodology for designing and a first step towards validation and dissemination of prototype ecological olive production systems (EOPS) in Crete. (Published Ph.D. thesis, Wageningen Agricultural University, 1996). 156.

Kedros K. and Margaris N. S. and Chodzeas S. (eds.), "The olive groves of the Aegean Sea," (Proceedings of the scientific conference in Mitilini 25-27/2/1988. University of Aegean Sea, Ministry of Agriculture, District of Lesbos, Mitilini, Greece, 265, 1988). (In Greek.)

Rolling N. and Jiggins J., "The ecological knowledge system," (Paper delivered at the Second European Symposium on Rural and Farming Systems Research: Technical and Social Systems Approaches to Sustainable Rural Development, Granada, Spain, March 27-29, 1996), 5.

Vereijken P., "A methodic way to more sustainable farming systems" Netherlands Journal of Agricultural Science 40 (1992):209-223.

Vereijken P., "Designing prototypes," (Research network for EU and associated countries on integrated and ecological arable farming systems. Progress report 1. AB-DLO Wageningen, The Netherlands, 1994), 90.

Vereijken P. Designing and testing prototypes. (Research network for EU and associated countries on integrated and ecological arable farming systems. Progress report 2. AB-DLO, Wageningen, The Netherlands, 1995), 90.

Vereijken P. Testing and improving prototypes. (Research network for EU and associated countries on integrated and ecological arable farming systems. Progress report 2. AB-DLO, Wageningen, The Netherlands, 1996), 69.
Vereijken P., "A methodic way of prototyping integrated and ecological arable farming systems (I/EAFS) in interaction with pilot farms" European Journal of Agronomy 7 (1997):235-250.

Table 1. Problems of conventional olive production

| Agronomic | Ecological | Socio-economic |
|---|---|---|
| wind and water erosion | depletion of groundwater | dependence on price subsides |
| decreasing soil fertility (biological, chemical, physical) | decreased biodiversity | low added value olive products |
| increasing pests and pathogens | levelled down landscape | decreasing incomes |
| increasing resistance of pests | contamination of air, water and soil with agrochemicals | high opportunity cost |
| increasing dependence on pesticides | environmental pollution with oil mill wastes | increasing financial problems of co-operatives |
| imbalances in beneficial entomofauna | | toxic biocide residues in products |
| shortage of water for rainfed groves | | health risks for growers and consumers |
| | | abandoned olive production in mountainous and less favoured areas |

Table 2. Hierarchy of the general and specific objectives in Ecological Olive Production Systems (EOPS)

| Hierarchy of the general and specific objectives in Ecological Olive Production Systems (EOPS) | |
|---|---|
| general | specific |
| 1. Abiotic environment | |
| | 1.1 Soil |
| | 1.2 Water |
| | 1.3 Air |
| 2. Basic income / profit | |
| | 2.1 Farm level |
| | 2.2 Regional level |
| | 2.3 National level |
| 3. Nature / landscape | |
| | 3.1 Flora |
| | 3.2 Landscape |
| | 3.3 Fauna |
| 4. Food supply | |
| | 4.1 Quality |
| | 4.2 Stability |
| | 4.3 Quantity |
| 5. Health / well-being | |
| | 5.1 Rural people |
| | 5.2 Landscape |
| | 5.3 Urban people |
| 6. Employment | |
| | 6.1 Farm level |
| | 6.2 Regional level |
| | 6.3 National level |

Table 3. Parameters quantifying the objectives of Ecological Olive Production Systems

| Parameters quantifying the objectives of Ecological Olive Production Systems |
|---|
| Soil Cover Index (SCI) |
| Soil Erosion Rates (SER) |
| Macronutrient Balances (MB) |
| Leaf Reserves (LR) |
| (Potassium (KLR), Phosphorus (PLR) and Nitrogen (NLR) Leaf Reserves |
| Organic Matter Balance (OMB) |
| Ecological Infrastructure Index (EII) |
| Target Plant Species Diversity (TPSD) |
| Quality Production Index (QPI) |
| Net Surplus (NS) |
| Energy Efficiency (EE) |
| Environmental Exposure to Biocides (EEB) |
| Irrigation Index (II) |

Table 4. Quantifying and achieving objectives in Ecological Olive Production Systems (EOPS)

| Top 10 objectives ranked | top 10 objectives quantified in multi-objective parameters | top 10 objectives realised by multi-objective farming methods |
|---|---|---|
| 1. Abiotic environment - soil | 1.1 *SER<1 t ha$^{-1}$ year$^{-1}$ | 1.1-1.3 EMCW [1] |
| | 1.2 OMB$\geq$1, <1 | |
| | 1.3 MB$\geq$1, <1 | 1.3-1.4 ENM |
| | 1.4 1.6%<NLR<1.8% | |
| | 0.09%<PLR< 0.11% | |
| | 0.7%<KLR<0.9% | |
| | 1.5 EEB=0 | 1.5 EMIP |
| 2. Basic income and profit- at farm level | 2. NS>0 | 2. FSO |
| 3. Abiotic environment - water | 3.1 SCI=0.5 | 3.1 EMCW |
| | 3.2 II$\leq$1 | 3.2 EWM |
| | see 1.3, 1.4, 1.5 | see 1 |
| 4. Nature and landscape - flora | 4.1 EII=1 | see 1 and 3 |
| | 4.2 TPSD (a)TII=1, | |
| | (b)TSI=1 | |
| | see 3.1 | |
| 5. Basic income and profit - at regional level | see 2 | see 2 |
| 6. Food supply - quality | 6.1 0<QPI<1 | see 1 and 3 |
| | see 1.5 | |
| 7. Nature and landscape – landscape | see 1.1, 4.1, 4.2 | see 1 and 2 |
| 8. Health and well-being - of rural people | see 1.1, 1.2, 1.5, 2, 3.1, 4.2, and 6.1 | see 1, 2, 3 |
| 9. Food supply - stability | 9.1 EE> 10 | see 1 and 2 |
| | see 1.3 | |
| 10. Abiotic environment - air | see 1.4 and 1.5 | see 1 |

* Full names of abbreviations are presented in Table III and Figure 1.

[1] Full names of abbreviations are presented in Figure 1 and Table V.

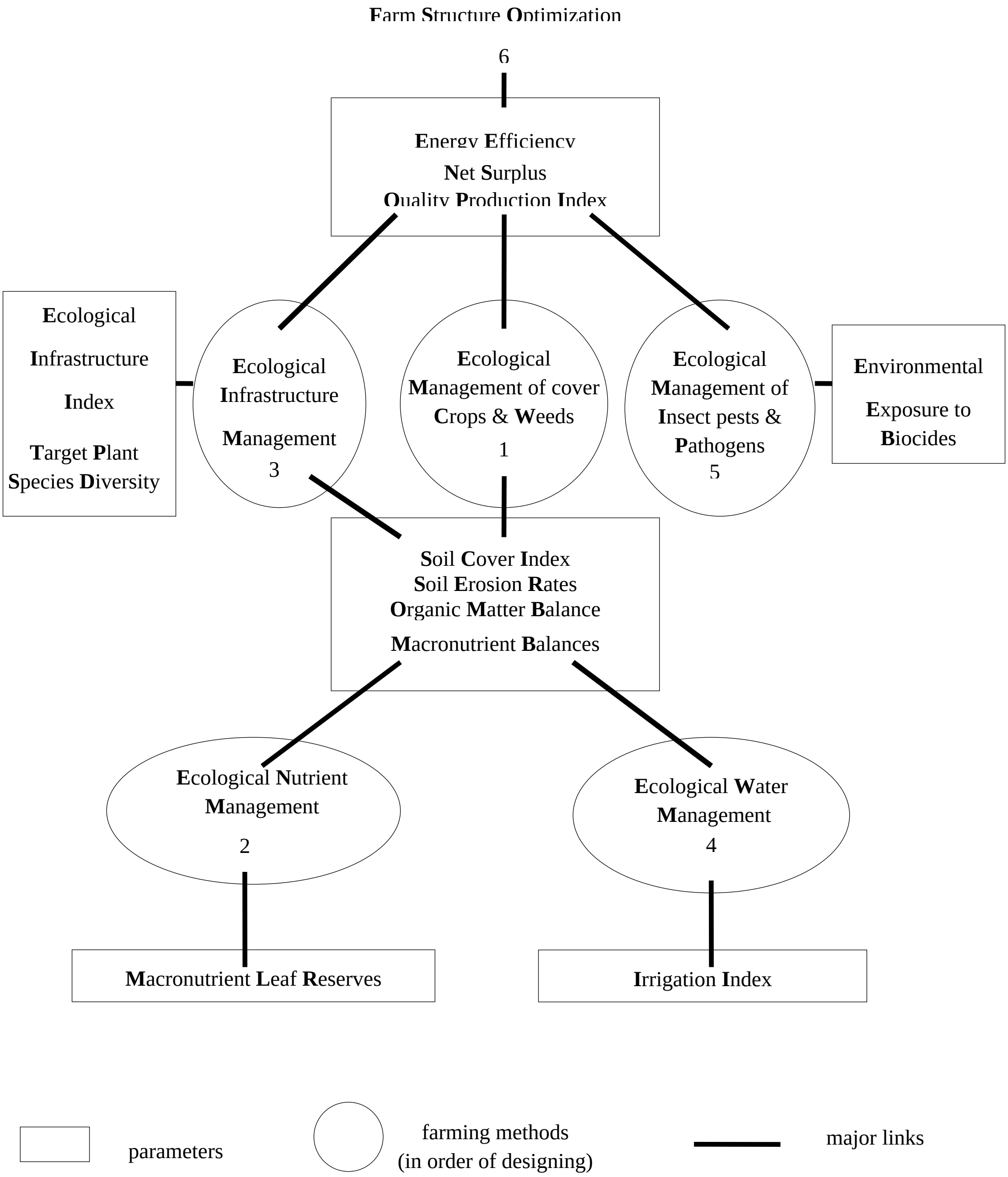


Figure 1. Theoretical prototype of an Ecological Olive Production System (EOPS)

Table 5. Initial testing results of Ecological Olive Production Systems (EOPS) over the pilot group, in 1994-1995

| multi-objective parameter | unit of parameter measurement | desired result | achieved result | main cause of shortfalls | method to be improved regarding readiness of use | effectiveness | manageability | acceptability |
|---|---|---|---|---|---|---|---|---|
| SER* | t/ha, year | <1 | not measured | - | - | - | - | - |
| OMB | Output/input | 1 | not calculated | - | - | - | - | - |
| MB | Output/input | >1 | | ENM** | | X | | |
| KB | | 1.4-1.7 | 2.4 | | | | | |
| PB | | 1.4-1.7 | 0.62 | | | | | |
| NB | | 1.4-1.71 | 1.43 | | | | | |
| LR | % | | | ENM | | X | | |
| KLR | | 0.7-0.9 | 1.01 | | | | | |
| PLR | | 0.09- 0.11 | 0.14 | | | | | |
| NLR | | 1.6-1.8 | 1.99 | | | | | |
| EEB | /ha | | | EMIP | X | | | |
| EEB air | | 0 | $1,19^{-19}$ | | | | | |
| EEB soil | | 0 | 0,139 | | | | | |
| EEB groundwater | | 0 | $3.319^{-15}$ | | | | | |
| NS | GRD/ha | >0 | -151646 | FSO | X | | | |
| SCI | soil cover/year | 0.5 | 0.35 | EMCW | | | X | |
| II | Used/desired | ≤1 | 1.31 | EWM | X | | | |

| multi-objective parameter | unit of parameter measurement | desired result | achieved result | main cause of shortfalls | method to be improved regarding readiness of use effectiveness | manageability | acceptability |
|---|---|---|---|---|---|---|---|
| EII | Share of area/desired | 1 | 0,735 | EIM | | X | |
| TPSD | Number of target plant species per 100 m / desired number | | | EIM | | | X |
| TI | | 1 | 0.45 | | | | |
| TS | | 1 | 0.42 | | | | |
| QPI | | >0.95 | 0.77 | FSO | X | | |
| QI | Achieved / top quality price | >0.95 | 0.82 | | | | |
| | | | | EMIP | X | | |
| PI | Marketed / on-field yield | >0.95 | 0.932 | | | | |
| | | | | EWM | X | | |
| EE | Output/input | ≥10 | 2.85 | FSO | X | | |

* Explanation of the parameter's symbols in Table II
** ENM: Ecological Nutrient Management, EMIP: Ecological Management of Insect pests and Pathogens, FSO: Farm Structure Optimisation, EMCW: Ecological Management of Cover crops and Weeds,
EWM: Ecological Water Management, EIM: Ecological Infrastructure Management