

Summer School

# BIODIVERSITY SERVING AGRICULTURE

**Katarzyna Biala, Maria Luisa Paracchini, Jean-Michel Terres,  
Philippe Pointereau, Julien Pezet**



Institute for Environment and Sustainability

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**Joint Research Centre**



## **Summer School**

# **BIODIVERSITY SERVING AGRICULTURE**

**Ranco, 3-6 July 2006**

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2006

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## **INTRODUCTION**

The Summer School 'Biodiversity Serving Agriculture' was organised with the objective of exchanging information on the latest research results and developments in the broad field of functional biodiversity in agroecosystems as well as creating a platform for discussion and further developments in selected topics. The following subjects, followed by more detailed questions were proposed to the participants for discussion:

- 'Biodiversity serving agriculture' versus 'agriculture serving biodiversity': definition of biodiversity in agroecosystem and its role in multifunctional agriculture; Biodiversity perception at different levels: farmer, environmentalist, policy-maker; Implications of management for functional biodiversity in different farming systems.
- Functional biodiversity and crop protection: state of the art; Conservation Biological Control: from research to the field application; Habitat management to enhance beneficial organisms: success stories; How to transfer the knowledge from researchers to farmers and to policy makers?
- What are the current policy tools to enhance biodiversity in agroecosystems? How to safeguard economic viability of farms applying biodiversity conservation measures? Role of indicators in biodiversity assessment and monitoring; Assessment of some Agri-Environmental Schemes (AES) implemented in Europe
- How to optimise the information exchanges via an Agroecological Network to make the link between policy makers, researchers, advisers and farmers?

To answer these questions, the Summer School was organised in five thematic sessions, including three workshop sessions, with oral presentations by invited speakers on the proposed topic and ample time opened for discussion as well as one whole-day session devoted to a technical visit to local farms. The last, fifth session was a round-table discussion, where all participants contributed to drawing final conclusions and suggested possible lines of further research and ways of transferring the research results to farmers, advisers and policy-makers. Furthermore, the idea of creating a European Agroecology Network, put forward by the JRC, was further explored by the participants.

The proceedings follow the actual progress of the Summer School, presenting the syntheses of oral presentations, the main points of the following discussion and finally conclusions of each session. The summary of the final session is enriched by closing remarks provided by each of the participants after the Summer School conclusion.

## **Summer School Programme**

**Monday 3 July 2006 (afternoon)**

### **Session 1: Concepts of functional biodiversity**

*Chairperson: **Anne Luik** (Estonia)*

*Speakers:*

**Peter Duelli** (Switzerland): Concepts of multifunctional agriculture and functional biodiversity

**Jon Marshall** (United Kingdom): Agroecosystem management and design for functional biodiversity enhancement

Discussion

**Tuesday 4 July 2006 (morning)**

### **Session 2: Functional Biodiversity and Crop Protection: from research to the field application**

**Part 1:** *Chairperson: **Ricardo Bommarco** (Sweden)*

*Speakers:*

**Ricardo Bommarco:** The role of biodiversity for Conservation Biological Control  
Case studies 1:

**Jean-Pierre Sarthou** (France): The hoverflies case: biological control of aphids by syrphids

**Paolo Bàrberi** (Italy): Functional biodiversity as related to weeds and their interactions with other agroecosystem components

**Dionyssios Perdikis** (Greece): Biodiversity and insect natural enemies: the case of generalist predators in vegetable agroecosystems

Case studies 2:

**Ferenc Samu** (Hungary): Habitat management to enhance spiders in arable crops

**Yann Clough** (Germany): Habitat management to enhance generalist predators - insights from studies in German wheat fields

Discussion

**Tuesday 4 July 2006 (afternoon)**

**Part 2:** *Chairperson: **Peter Esbjerg** (Denmark)*

*Speakers:*

**John Holland** (United Kingdom): Biodiversity conservation schemes serving Conservation Biological Control: success stories

**Ramon Albajes** (Spain): Transfer from research to the field: training and farm advisory

**Claudio de Paola** (Italy): Actions for sustainable agriculture development in Ticino Park

Discussion

**Wednesday 5 July 2006**

**Session 3: Technical visit to the "Parco del Ticino"**

*Chairperson:* **Claudio de Paola** (Italy)

*Speakers:*

**Lisa Hildebrand, Claudio de Paola** (Italy): Parco del Ticino

**Gabriele Corti** (Italy): Organic farming and agritourism – Visit to Azienda Agricola Cascina Caremma (Besate, MI)

**Aldo Paravicini** (Italy): Organic farming on large agriculturally utilised area – Visit to Azienda Agricola La Zelata (Beregardo, PV)

**Thursday 6 July 2006 (morning)**

**Session 4: Policy options for safeguarding economic viability of farms applying biodiversity conservation measures**

*Chairperson:* **Jean-Michel Terres** (JRC)

*Speakers:*

**Ariel Brunner** (BirdLife International): Policy tools to enhance biodiversity in agroecosystems

**Katarzyna Biała** (JRC): Tools for biodiversity assessment and monitoring

**Assessment of agri-environmental schemes (AES) for biodiversity in Europe**

**Henrik Vejre** (Denmark): Impact models for agri-environmental policy effects

**Felix Herzog** (Switzerland): Assessing the effect of ecological cross-compliance in Switzerland

Discussion

**Thursday 6 July 2006 (afternoon)**

**Session 5: Towards a future European Agroecology Network**

*Chairperson:* **Philippe Pointereau** (Solagro)

Topics for discussion and further development in the European Agroecology Network

Conclusions of the Summer School and proposals for further work

## **INTRODUCTORY SESSION**

After the welcome from Jean-Michel Terres (JRC-IES) a brief presentation of the organisers followed.

Jean-Michel Terres presented the structure and mission of the Joint Research Centre of the European Commission, focusing on the Agri-Environment Action of the Rural, Water and Ecosystem Resources Unit of the Institute for Environment and Sustainability. Mr Terres presented the Action's main activities developed for various customers, mainly: Directorates General of the European Commission (Agriculture, Environment, Eurostat) and the European Environment Agency. A particular link between the Agri-Environment Action activities and the Summer School topics was shown through work on the concept of High Nature Value farmland, defined as areas in Europe where agriculture maintains or contributes to a high level of biodiversity.

Furthermore, J-M. Terres provided the overview of the Summer School objectives, summarised in the following questions:

- How to transfer knowledge from research to policy?
- What are the policy options for safeguarding economic viability of farms supporting biodiversity?
- Networking: how to build (and maintain) a network on these topics – (Creating an Agroecology Network in Europe)?

adding related questions for policy instruments from Pillar 1 and 2 of the Common Agricultural Policy (CAP) and potential means of answering them, ex. through development of indicators for Rural Development Programs evaluation, research projects in Framework Programmes and a proposal for an integrator instrument: landscape management at various spatial scales.

Philippe Pointereau presented the French non-profit organisation Solagro and its objectives of sustainable management of natural resources, in the context of multifunctional agriculture.

He focused his presentation on the ambitious European agri-environmental objectives:

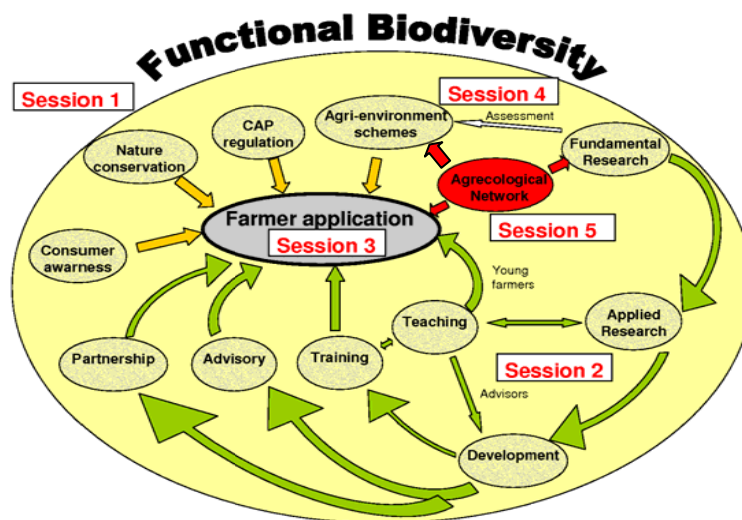
- 2008: support the HNV farmland
- 2010: stop the loss of biodiversity
- 2015: achieve good quality of water resources (Water Framework Directive)

Biodiversity maintenance and enhancement represents one of the environmental goals and is integrated in an interdependent and multiple interaction schemes, including water quality, soil fertility, waste recycling etc. Functional biodiversity and 'wildlife' biodiversity act on these interactions and are complementary, often using common habitats.

The services brought by biodiversity can be found at different levels, from the field to the landscape. Thus, biodiversity contribution is huge and difficult to assess.

In this context several questions can be asked

- How can farmers be motivated to appreciate the biodiversity services (which are difficult to evaluate because of the complexity of interactions)?
- How can farmers be made aware of and appreciate beneficial arthropods and, in general, functional biodiversity, which is very difficult to observe as beneficial arthropods are small, nocturnal and mimetic?
- How can farmers and conservationists work together for biodiversity even if their interests are different?
- How can policy tools support functional biodiversity, in particular the concept of Conservation Biological Control for Plant Protection?



The programme of the Summer School has been drawn to respond to the complexity of the interactions implicating numerous actors and domains, with different levels of development and often experiencing difficulties in communicating. The creation of a European Agroecological Network seems to be a good means to enhance information exchange and create links between the different stakeholders.

The introductory session finished by brief introductions of the participants themselves. Different skills and knowledge were brought together, to achieve the Summer School objectives (viz. the list of participants).

## **PLENARY SESSIONS**

### **Session 1 – Concepts of functional biodiversity – *Chairperson: Anne Luik (Estonia)***

The objective of this session was to discuss the concept and role of biodiversity in agriculture and ways of enhancing functional biodiversity (FB) through agroecosystem management.

#### **a. Concepts of multifunctional agriculture and functional biodiversity – *Speaker: Peter Duelli (Switzerland)***

Peter Duelli started the session introducing different concepts of biodiversity. The term 'biodiversity' has become a great success both in science and politics and started to be recognised by wider public. Like an irregularly refined diamond, it offers different aspects depending on the environmental conditions and the angle of observation. However, all the debate on biodiversity conservation is unavoidably based on the anthropocentric values system. The broadness of the term is reflected in various modes of its interpretation, depending on the conservation goals to be achieved as well as on stakeholders involved. For agricultural landscapes the main value systems concerning biodiversity are conservation (of rare and threatened species or breeds), ecological resilience (against local impacts and global change), and biological control of potential pest organisms (focus on predatory and parasitoid arthropods).

For centuries agriculture had been trying to reduce uncontrolled variability, therefore agricultural politics and practice have adopted the plea for biodiversity somewhat reluctantly. Nowadays, however, it is firmly embedded in agricultural policies and agri-environment schemes (AES) are well-established instruments aiming at the management of associated biodiversity in agricultural landscapes. The AES payments provide opportunities to invest a lot of money into biodiversity conservation and enhancement and at the same time take into account socio-economic factors, compensating farmers for loss of income or additional costs of applying alternative farming practices to maintain an ecologically sustainable agriculture in industrialized European countries.

It is necessary, however, to evaluate the AES effectiveness, as the considerable costs for taxpayers require adequate justification.

Recent EU-projects (EASY (<http://www.dow.wau.nl/natcons/NP/EASY/>) and BioAssess (<http://www.nbu.ac.uk/bioassess/>) showed that the issue of design and targeting of agri-environmental programmes is crucial as not all AES have been successful. Moreover, we realised that the choice of indicators is crucial for the evaluation of the schemes. Accordingly, the future AES have to state specific goals, and the indicators to evaluate the success or failure of an AES have to focus on these goals.

According to Peter Duelli it is therefore necessary to separate the holistic term 'biodiversity' back into its viable components and aspects. They can be based on

completely different values and motivations of the stakeholders. The main controversy on values and motivations is between ecosystem functions and species conservation. The AES to enhance ecosystem functions or, more generally, ecological resilience are completely different from the conservation efforts necessary for rare and threatened species. On the one hand, biodiversity is serving agriculture, on the other hand, agriculture is serving biodiversity.

Biodiversity aspects serving agriculture are ecological resilience and specific ecosystem functions such as pollination, biological control, erosion prevention, soil fertility, and saving non-renewable resources.

Agricultural management serving biodiversity aspects includes species, genotype (breed) and habitat conservation, cultural heritage, aesthetics, and unique landscapes.

P. Duelli concluded that the current challenge is to set regional priorities for the competing schemes: while ecosystem services can and should be enhanced everywhere, mainly at the farm level, AES serving biodiversity should consider regional preconditions and a larger spatial scale.

The presentation generated an animated discussion. According to most participants, regardless of the type of agri-environmental measures or schemes, it is indeed necessary to state their clear goals. It should be avoided to use the general, broad term 'biodiversity' as it results in the lack of identification with the goal among the stakeholders, especially farmers, who fail to see its immediate impact on their own activities.

The scale of AEM application depends on the type of area and farming system. When a farm relies heavily on subsidies for its existence, direct payments play a much more important role than AEM. On the other hand, appropriate programmes have to be drawn according to the natural, bio-physical conditions of an area. Species conservation measures, for example, might not be applicable everywhere. In general, each farm may apply some forms of Conservation Biological Control but not all farms might effectively apply conservation measures.

Highest level of biodiversity, measured as ex. species richness is not equal to the highest level of functions that biodiversity performs in agroecosystems. It is necessary to first identify the key functions. There is a complex relationship between values for biodiversity and policy priorities. The inherent biodiversity values themselves do not change, there is normally a change in their relevance to the current policy. Setting up clear goals for instruments aimed at biodiversity enhancement, and the subsequent assessment of their efficiency, might provide guidelines for their adapting / refining. This, in the long run, should allow maintaining the coherence of relevant policy tools.

The participants also raised issues related to the role of biodiversity in the social pillar of sustainable agriculture. Conserving diverse landscapes and the so-called 'flagship' species – rare species of high heritage and/or aesthetic value has a great importance for the wide society, fulfilling educational and recreational functions. The aesthetic aspect is another important factor in this context.

However, the economic requirements for maintaining farm competitiveness on the market determine other priorities for farmers – a boring unicolour landscape with temporary grasslands consisting of very low number of species might represent a higher nutritional value for livestock than spectacular multicolour alpine meadows. The main objectives of farmers are economic profits and economic returns so it is highly important to refine methodologies for valuating the non-market ecosystem services if we want to stimulate farmers to take actions for biodiversity enhancement.

### **b. Agroecosystem management and design for functional biodiversity enhancement – *Speaker: Jon Marshall (UK)***

The second presentation of the session by Jon Marshall was a comprehensive overview of implications of management for functional biodiversity in different farming systems. The term 'functional biodiversity' describes providing ecosystem functions by species richness, such as pollination or biocontrol. However, there is rather little understanding of species redundancy within agroecosystems.

Biodiversity within agroecosystems is often associated with the non-crop elements in the landscape. The UK Countryside Survey (2000), an audit of the major habitats and landscape features of the British Countryside is a valuable source of relevant data. It was shown that plant species diversity is generally declining in the landscape, most probably as a result of eutrophication. Highest floral diversity was observed in linear landscape elements. Non-crop habitats (ecological infrastructures), with an average of 10 m<sup>2</sup>, seem to be important for a wide range of plant species compared to the main plots (200 m<sup>2</sup>). A study on densities of ground beetle species (Carabidae) in crop vs. non-crop areas showed, however, the relative dependency of several species to the non crop habitat and other to the crop areas, and yet others utilised both habitats at different times of year.

Non-crop habitats (ecological infrastructure) within agricultural landscapes can be remnants of a wide range of habitats and refugia for their associated species. However, there are also many species that depend either entirely or partly on agricultural fields. Agriculture has co-evolved in Europe for 10000 years, so there are many farmland specialist species. Many of these, most notably birds, have shown dramatic declines in populations and/or ranges over the past 40 years, associated with major changes in agriculture.

Production systems have evolved, reflecting price support, technological advances and farm specialisation. The era of high input "recreational" pesticide application of the 1970's and 1980's has given way to justified inputs, using threshold decision-making in conventional farming. An appreciation of rotations, cultivations and inputs has allowed the development of more integrated arable systems, while organic production has shown marked increases across the EU. All these systems cause some non-target effects and variable uses of energy, water and other resources. Up to now, the indirect environmental costs of farming

systems have not been a part of policy development. Organic systems tend to have lower indirect costs and thus smaller overall impacts.

Considering the enhancement of biodiversity for functional benefits in European farming, there are marked climate differences and therefore differences in plant communities. Thus different approaches may be required in Mediterranean areas compared with Scandinavia. Farming landscapes cover at least 50% of the EU and over 75% of the UK. Thus species and landscape conservation often needs to take place in farmland. Current farm landscapes can be considered as a continuum between a matrix of fields with linear non-crop elements, or as mosaics of crop land with discrete non-crop patches. One might consider the spatial arrangements of farming, considering the production and biodiversity elements, as either 1) fully separated (designated sites or wilderness areas versus production), 2) fully integrated or 3) mixed. However, the appropriate spatial scale will vary with the taxa considered and the connectivity of elements will influence resilience. The inter-dependence of some farmland species on different habitats for different parts of the life cycle indicate that the best approach is to attempt the integration of biodiversity within agriculture. There are promising examples of habitat creation and management of ecological compensation areas across Europe, for example grass and flower strips in arable land. A recent study in the southern England carried out in the context of the EASY project, assessed the impacts of an agri-environment field margin prescription on farmland biodiversity. There were positive impacts on diversity or abundance for the flora, bees and grasshoppers. No effects on birds were observed or bird territories, spiders or Carabid beetles but also no negative impacts. The results confirmed that there are benefits to farmland biodiversity from introducing new grassland habitat at the edges of arable fields, though their effects vary between taxa and species and are dependent on landscape structure.

Whilst further work on the appropriate scales for species is needed, some immediate conclusions are: a) existing non-crop habitat on farms should be retained and managed (protected) appropriately, b) farmers need to be retained on the land, c) sustainable production systems that maintain in-field biodiversity should be developed, d) habitat creation and management is encouraged.

## **Discussion**

The presentation of Jon Marshall was appreciated by the participants. A lively discussion ensued, on the issues raised in both presentations of Session 1.

The discussion started with the question: 'Is it easier to 'manage' biodiversity in grasslands or in arable crops?' Although there is no clear-cut answer to this question, it highlighted the importance of grasslands to biodiversity and the need of more research on the topic. In UK 95% of species richness is lost and similar trend is observed in other European countries. Semi-natural grasslands are particularly threatened, both by the intensification of management and abandonment under more difficult environmental conditions, ex. lowland meadows in alluvial zones or grasslands in mountainous regions, where traditional extensive management does not guarantee economic returns for farmers. Valuable areas should be identified and specific conservation measures

adopted, with directly allocated financial resources to ensure the continuation of extensive management.

The participants noted that regardless of whether we consider grassland- or arable land-dominated farming systems, the question of spatial scale is crucial for appropriate agroecosystem management. The creation of an efficient ecological network must involve all farmers in the target area; otherwise the system fails to perform the expected functions. However, if the system is created on a voluntary basis, adequate incentives must be offered to farmers to encourage their participation. Territorial contracts might be effective but anyway they are still not mandatory. An operational example was provided from Switzerland, where there is a system of ecological cross-compliance with a fixed budget, in which farmers have to compete for financial resources.

The discussion then centred on the role of Ecological Infrastructures in agroecosystems. The concept is quite well known but its implementation varies widely throughout Europe. In United Kingdom, field margins are well developed and accepted by farmers, with the target of 15000 km of field margins set for 2010 already achieved. In Poland and Estonia the development is under discussion with pilot projects in the latter. In Poland, however, woody windbreaks have a long tradition. In general, farmers seem to be interested in the concept but less so in the intensive agricultural areas where they do not accept the introduction of non-crop strips. A similar situation is observed in Slovakia. In Hungary, weed invasions are currently an obstacle for the EI development. The same problem occurs in Austria where organic farming is a source of weed contamination for conventional farming systems. In Greece farmers do not want to lose land to introduce field strips and the existing linear elements have not been created through any organised scheme.

Generally, the lack of subsidies is the major obstacle. Combining ecological infrastructures and bioenergy could increase the value of non crop habitat for farmers, for example when a set-aside is used as energy crop.

Another point raised in the discussion was the relationship between productivity and biodiversity. The studies dealing with this topic are relatively rare. The way in which productivity is defined is very important for assessing whether a system is sustainable or not. If the major goal is crop yield then conventional farming is an obvious solution. Otherwise, if other environmental costs are taken into account, low input farming must be considered as a viable option. However, there is an average 20% difference in yield between conventional and organic farming, posing a research challenge to find solutions allowing to close this gap.

## **SESSION 1 – CONCLUSIONS**

The session can be summed up with the following conclusions:

- Functional biodiversity is a small part of total biodiversity.
- The AES to enhance ecosystem functions or, more generally, ecological resilience are completely different from the conservation efforts necessary for rare and threatened species.
- There is a need to define the main goals of AEM and assess their performance through appropriate indicators.
- Landscape and farm management are the 1<sup>st</sup> factor of success regardless of the agricultural system considered.
- Ecological infrastructures perform many functions and may: support functional biodiversity as well as nature conservation, serve as an additional source of income when planted with energy crops and positively impact on social and cultural functions of agriculture.

**Session 2 - Functional Biodiversity and Crop Protection: from the research to the field application – *Chairpersons: Riccardo Bommarco (Sweden) (morning) and Peter Esbjerg (Denmark) (afternoon)***

**a. Conservation Biological Control: concept and research results – *Speaker: Riccardo Bommarco (Sweden)***

Ricardo Bommarco started the session with an introduction of the Conservation Biological Control concept:

Conservation Biological Control (CBC) is the enhancement of naturally occurring indigenous pest enemies. Recent research in CBC has largely been driven by the hypothesis that diversity enhances ecosystem function, for instance, that increased predator species richness enhances biological control. Proposed mechanisms giving this effect are: 1) *The sampling effect*, i.e. that as you add species, you increase the chance of adding “better” species, for example, by adding predator with higher feeding rates. 2) *Complementarity*, that species use resources in somewhat different ways, so that resources are used more efficiently with more species present. However, increased diversity may also decrease the efficiency of an ecosystem function: 3) *Redundancy*, which occurs when a positive relation between diversity and functioning holds only for a few species, and added species do not increase function. 4) *Idiosyncrasy* can appear when there are strong interactions among species that may make diversity-function relationship variable, e.g. facilitation, no effect or intraguild predation.

There is empirical evidence that the efficiency of resource consumption increases with growing species diversity (Tilman et al 2001), but little attention has until now been given to predator communities. Studies on how increased diversity of predator affects herbivore population growth has given variable results. Herbivore suppression has been shown to strengthen (Losey and Denno 1998, Snyder and Ives 2003, Aquilino et al. 2005, Thomas et al. 2005, Snyder et al 2006), weaken (Rosenheim et al. 1993, Snyder and Wise 2001, Finke and Denno 2004), or not influence herbivore suppression (Chang 1996, Schmitz and Sokol-Hessner 2002, Thomas et al. 2005, Straub and Snyder 2006). Despite these variable results it is fruitful to ensure high predator species richness with respect to biological control in agriculture. Firstly, it is important to ensure long term resilience in the ecosystem function allowing for re-organisation after disturbances on a landscape scale (the insurance hypothesis) (Bengtsson et al 2003, Loreau et al 2003). Secondly, if there is high temporal and/or spatial variation in dominant predator species composition diversity becomes important to maintain a sufficient biological control.

A great problem is, however, that land use changes, intensified agriculture and increased pesticide use has led to that the predators, although not going extinct, reach abundances too low to ensure an ecologically viable biological control. Therefore, more information is needed on how temporal and spatial abundance variation of predators, identified as important control agents, is affected by land use and landscape structure. An important part of such research efforts will be to explore the underlying mechanisms, such as reproduction, mortality and

dispersal, which determine predator population growth, abundance and persistence. Results to date indicate that predators in agroecosystems are generally highly dependent on access to alternative food sources and refuge from disturbance, and that land use management should focus on bolstering landscape heterogeneity.

The discussion generated by Mr. Bommarco's comprehensive presentation focused on the question of species richness or diversity as an indicator of CBC efficiency. In intensive fields the abundance of predators is lower than in organic fields. An interesting example of an experiment carried out in Estonia was given, where in oilseed rape fields the dominant species abundance was higher in organic and integrated farming. It was noted, however, that organic farming cannot always be directly compared with conventional farming for CBC effectiveness assessment. Landscape heterogeneity might be an important indicator of CBC performance.

The participants agreed that there is not enough knowledge in the domain of CBC. The scale and the different type of landscape have to be included in the experiments, comparing different structures in different years and in various agricultural systems. Further discussion on these issues followed after case studies were presented, where more examples facilitated deeper exploration of crucial CBC issues included in Mr. Bommarco's presentation.

## **b. Case studies 1: habitat management to enhance hoverflies on aphids in arable crops – Weed management**

### **Hoverfly (Syrphids) case – *Speaker*: Jean-Pierre Sarthou (France)**

Jean-Pierre Sarthou started with a presentation of the syrphid studies. Syrphids (also called hoverflies in Europe or flowerflies in the USA – Diptera, Syrphidae) are more than 6000 species in the world and more than 900 in Europe where almost 1/3 of them are zoophagous at the larval stage (other species are either microphagous – feeding on micro-organisms abounding in decaying wet, dump or submerged organic matter – or phytophagous). *Episyrphus balteatus* De Geer is the most often cited species in the world literature and feeds on 234 aphid species. Apart from this species, more than thirty other aphidophagous syrphid species have been found feeding on aphids on agricultural crops as well as on aphids on numerous wild plants, allowing to postulate that it is possible to manipulate the environment of arable fields in order to favour these beneficial organisms.

In the last twenty years, syrphids have been studied through three main approaches: 1) landscape level, through description of naturally occurring processes: only four papers published; 2) field level, habitat management: 58 published research works, and 30 of them dealing with the enhancement of the efficiency of biological control (success in 75% of the cases), 3) models, "how to predict process occurring in the field?": 5 models constructed, varying according to the scale of their studied process.

Nevertheless, syrphids are often unrecognised in general beneficial surveys. This is probably due firstly to the difficulty of sampling adults as well as larvae, but

also to the difficulty of identifying species. Moreover, it is necessary to tackle several subjects concerning syrphids in order to improve CBC through their activities: 1) landscape ecology: a particular flower strip for instance, which would be set up in two different landscapes, will very probably lead to different results owing to different syrphid communities present because of the different landscapes, 2) nutritional behaviours: are visits to particular flower species due to floral and mouthpart characteristics, or are they due to daily availability of nectar and pollen sources? Why does *E. balteatus* gather nectar and pollen from various little flowers while bigger and more accessible ones are present? 3) ecological requirements: what are they throughout a year, and in particular in winter? What is the respective importance of overwintering by larvae, sedentary females and migrating females in different areas of Europe? 4) indicator species of biodiversity: what are the links between ecological integrity and CBC? How to evaluate it? What sort of efficient tool might be used for ecosystem integrity evaluation?

### **Weed case – Speaker: Paolo Bàrberi (Italy)**

Paolo Bàrberi presented results of an interdisciplinary study on field-scale interactions between weeds and *Aphis fabae* Scop. (Homoptera: Aphididae) in conventional and low-input sugar beet.

Low-input cropping systems are often related to higher weed species diversity and density. Crop pests have been reported to decrease in fields with a higher vegetational diversity due to a reduction in crop appearance and nutritional quality. For *Aphis fabae*, the decision to form a colony and the possibility for it to become large depends on the nitrate level in the plant phloem. If host nutritional quality is low, aphid fecundity is negatively affected and aphids develop more winged forms for dispersal elsewhere. It can therefore be expected that competition with weeds, by lowering the nitrate level in sugar beet sap, has a negative impact on crop 'palatability' to aphids. Furthermore, in fields with a higher weed density a higher diversity of possible alternative host plants for aphids (and possibly a higher presence of beneficial arthropods) can also be expected, which can contribute to alleviate the pest problem.

The case study was therefore designed to assess differences in *Aphis fabae*/crop/weed interactions in two cropping systems differing mainly in tillage technique, fertilisation level and weed and pest management. The experimental hypotheses were that, due to their polymorphism, aphids are able to optimise resource use through changing infestation dynamics as a response to differences in crop/weed competition in differently managed cropping systems and that in low-input cropping systems higher weed abundance could 'dilute' aphid infestation on sugar beet.

The study showed that weed density and community composition influence aphid colonization. A host plants/total plant ratio index proved to be a good means to describe the 'disturbing' effect of weeds on aphid behaviour. In the low-input system, the disturbances seemed to be higher, influencing aphid morphology (more winged forms), aphid colonisation and feeding behaviour.

In conclusion, it can be said that in this case study a higher abundance and diversity in the weed community exerted a positive function in terms of reducing aphid infestation in sugar beet. It remains to be seen if this may conflict with the negative function (reduction in crop yield) associated to the higher weed abundance level commonly found in low-input sugar beet.

### **c. Case studies 2: habitat management to enhance spiders and beetles in arable crops**

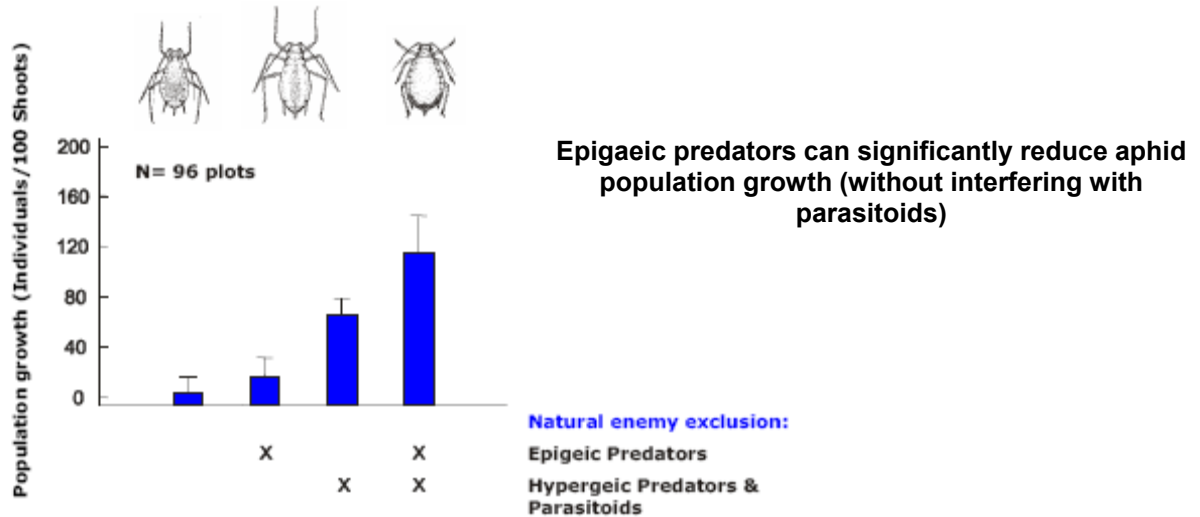
#### **Spider case – *Speaker*: Ferenc Samu (Hungary)**

The spider specialist Ferenc Samu presented results of his research on spiders in agroecosystems, dominated by *agrobiont spiders* (per definition), representing 80 % of spiders in arable fields. Due to their dominance, enhancement efforts should be targeted on those. According to recent research results, the agrobiont assemblage is remarkably invariant over moderately large geographical regions. In Hungary there was found very little variation among various arable crops, individual fields or even across smaller regions. Agrobionts not only dominate arable fields, but are specific for those, which phenomenon was proven by Indicator Species Analysis which compared arable with several non-crop habitats. The reasons why agrobionts are so successful in arable fields might be manifold, however, life history characteristics, and in particular the synchronisation of the adult / reproductive period with the most productive period of the crop was shown for *Pardosa agrestis* (main wolf spider agrobiont in Central Europe) and a similar phenomenon is observed, in fact, in many spider families. The main findings of Hungarian research, namely that the arable spider communities are rather invariable (e.g. independent of neighbouring habitats) largely determines the possible strategies for enhancement. Extensive data collection in Hungary revealed that non-crop habitats: field margins, disturbed grasslands and to some extent 'generic' grasslands are suitable habitats for agrobionts, thus spider exchange is possible. If we consider a scale smaller than neighbouring habitats, literature data show that among various field manipulations most successful were those which enriched ground-zone structure (ex. mulching, partial weeding). Moreover, management practices more interspersed within the crop (e.g. undersowing vs. intercropping in strips) could enhance spiders to a larger extent. A case study carried out in Hungary in alfalfa revealed a similar trend. Unmown strips themselves contained significantly more spiders, but their effect on neighbouring 'normal' alfalfa was moderate.

It can be concluded that at least for Central European arable systems there is a need to further examine the main limitations that are likely to be encountered if we want to enhance spiders, but also to determine the main directions in which management practices should evolve, if we want to overcome the limitations. Moreover, a lot remains to be done in understanding: a) larger scale (landscape level) processes better; b) differences in the requirements of various agrobiont groups; c) interactions between natural enemy groups. Finally the whole process should be directed at working out concrete, feasible recommendations for farmers.

## Generalist case – *Speaker*: Yann Clough (Germany)

Yann Clough presented a talk on habitat management to enhance generalist predators with insights from studies at different spatial scales in German wheat fields. In the first part of his talk, Y. Clough showed the effect of generalist predators on cereal aphid population growth.



Schmidt et al. 2004 *Ent. Exp. Et applic*

Habitat management can provide resources for generalists (ex. food, shelter, overwintering sites) and can be implemented at different scales: from the field/boundary scale through reducing land use intensity and creating specific habitats (ex. edge management, beetle banks, soil surface heterogeneity) to the landscape scale through promoting perennial habitats and maintaining small scale mosaics. Different effects on predators are observed, mostly positive or neutral, depending on the species, crops, years, habitat management measures and landscape scale context. Results of recent studies presented by Y. Clough showed that for spiders the amount of perennial habitat in the landscape determines the size of the species pool whereas local factors, especially the proximity of the perennial field boundary, the activity-density in the field. Two other groups of predators, rove and ground beetles showed different trends: rove beetles were more diverse and caught in higher numbers near field edges, but this could not be found for ground beetles. In this study the landscape composition was of minor importance for these two groups. Thus, the context of the studies, especially the influence of time and spatial variability, makes difficult the understanding of the mechanisms between predators and perennial crops. Moreover, landscape scale studies are relatively scarce, and always cover a small part of Europe. To allow the transfer between research and application by farmers, more studies assessing landscape-level diversification with respect to the effects on pest and yield are necessary to quantify landscape level ecosystem services.

## **Conservation Biological Control in vegetable agroecosystems – *Speaker: Dionyssios Perdikis (Greece)***

Dionyssios Perdikis focused his talk on the importance of non-crop habitat in Mediterranean vegetable crops to enhance *Macrolophus* species, important polyphagous predators. The two non-crop plants studied (*Dittrichia viscosa* and *Solanum nigrum*) showed a real importance to attract and maintain *Macrolophus caliginosus* and *M. pygmaeus*, providing food source and overwintering site. This knowledge can be used in developing appropriate strategies for the use of these plants in biological control in vegetable crops in the open field or in the glasshouses.

### **Discussion**

The discussion combined the issues raised in the introductory presentation by Riccardo Bommarco and in the 5 case studies. Studies on CBC effectiveness are relatively numerous, but, due to the heterogeneity of studied communities, applied methods and study sites, it is difficult to compare research results. Spatial and temporal scales seem to be crucial factors influencing the numerous interactions between various communities. A suggestion put forward by the participants was to standardise the methods, and test them in different landscapes of various bioclimatic regions. Moreover, this kind of a European-scale experiment would necessarily involve an active participation of farmers.

Another important point raised during the discussion regarded the promotion of CBC among farmers. Application of CBC measures may have an immediate negative impact on crop yields, so any CBC guidelines or prescriptions given to farmers must be based on sound scientific research.

### **d. Biodiversity conservation schemes serving Conservation Biological Control: Success stories – *Speaker: John Holland (UK)***

In his talk, John Holland reviewed the development of agri-environment measures in UK and, in particular, the beetle banks scheme.

Conservation biocontrol has focussed predominantly on non-crop habitats that aim to increase the numbers and/or the diversity of beneficial insects within the adjacent crop. Such habitats are developed either through a targeted research programme, as is the case for beetle banks, or through a 'hope and see' approach where it is assumed that the presence of an invertebrate rich habitat will be sufficient to improve biocontrol. The value of beetle banks as overwintering habitat was found (Thomas et al., 1991), however their value for pest control was only later demonstrated (Collins et al., 2002); an impact being detected at up to 58 m from the beetle bank. The wider benefits of beetle banks to farmland wildlife were shown (Thomas et al., 2000) and that their value as overwintering habitat persisted even 13 years after establishment (Thomas et al., 2002). Despite being widely publicised, their uptake was low even when

funding was made available in the UK; by 2004 they only covered only 89 ha compared to 24,091 ha of 6m wide grass margins. When surveyed, farmers rarely reported establishing beetle banks for their biocontrol potential instead they were used to divide fields and create habitat for game and wildlife. Those agri-environment schemes that are simple to establish and maintain were most readily adopted, even though they may provide fewer environmental benefits. Options involving manipulation of the crop had poor uptake. On-farm advice is needed to support agri-environment schemes if a diverse, multifunctional range of habitats are to be established taking into account local objectives.

The value of hedgerows for biodiversity and biocontrol has been poorly researched, although their removal has now been halted in Western Europe. Hedgerows have a multifunctional role in the landscape as they harbour beneficial invertebrates throughout the year, provide a source of alternative prey including pollen and nectar, facilitate dispersal, act as mating sites, prevent soil erosion and provide a refuge from farming operations. Disadvantages include inhibition of pest dispersal, harbouring of noxious species, acting as a barrier to dispersal of beneficial species and increasing the deposition of aerial pests. There is, however, evidence that more complex landscapes with more non-crop habitats and smaller fields suffer fewer pest levels than simpler landscapes with larger fields.

A number of studies have demonstrated that flying beneficial insects contribute more to the control of cereal aphids than ground-active invertebrates. In addition, although beetle banks and field margins enhance overwintering densities of ground-active invertebrates their overall contribution to mid-field densities is small compared to the number overwintering within fields and techniques to enhance their numbers are needed.

In conclusion, there is clear evidence that habitat manipulations increase beneficial invertebrates within adjacent crops and the mechanisms are sometimes understood, however, there is less conclusive evidence that they enhance pest control (Gurr, 2000). Economic evaluations are rare and uptake of agri-environment schemes is driven by the levels of financial support and ease of use.

**e. Transfer from research to field application: training and farm advisory – *Speakers: Ramon Albajes (Spain) and Claudio de Paola (Italy)***

In the **first** presentation Ramon Albajes talked about the transfer of research results to the field, with a focus on training and farm advisory. There is an increasing demand from European consumers for sustainable and environmentally friendly techniques to produce food. On the other hand, growers feel that some biodiversity in the crop and surrounding habitats may favour agricultural productivity and product quality. From their side, entomologists and other scientists have shown that biodiversity management permits to enhance natural pest control and have contributed to develop conservation biological control. In response to this situation, European Union devotes a significant part of its budget to agri-environmental measures (AEM) that should lead to implementing programmes for biodiversity enhancement. Technology and knowledge transfer is a decisive element in the network involving growers,

growers' advisers and researchers for biodiversity enhancement and agriculture. R. Albajes' presentation aimed to respond to three main questions: 'why to transfer', 'what to transfer' and 'how to transfer'.

'Why to transfer?' If we pursue to have a new technology applied by growers we must know first their interests as we do not operate in a 'religious' activity. Among stimuli that may push growers to adopt a new technique we can find yield increase and more efficient pest control (sometimes the only way to reduce pest damage), a healthier atmosphere in the farm, an increased aesthetic value for visitors and guests (rural tourism) among others. Public and private labels or certifications, as well as AEMs, have tried to reflect the increasing social demand for biodiversity enhancing techniques in agriculture and to translate it into grower's revenue.

'What to transfer?' Researchers have frequently shown the relationship between biodiversity enhancement in agricultural and non-agricultural habitats and improved pest control, but less frequently have identified the elements, causalities, and mechanisms responsible of improved control. Without this knowledge it is extremely difficult to show growers how to proceed in biodiversity enhancement. Some examples from Mr. Albajes' research centre in Catalonia, North East Spain can exemplify the importance of identifying key elements and mechanisms of biodiversity role in conservation biological control. A successful management programme of crop and crop-surrounding habitats for taking benefit from natural colonisation of tomato greenhouses and fields by predatory bugs that has been implemented by entomologists at IRTA Centre in Cabrils in cooperation with growers' advisers and growers themselves, illustrates the feasibility of biodiversity enhancement for improved agriculture in highly intensive crops.

'How to transfer?' To involve growers and farm advisers in the last steps of development of a research project may help to make benefits from biodiversity visible. This can be achieved by means of demonstration trials. It should be aimed to make visible the actors responsible for improved control. Insect traps, popular bioindicators, and other simple means may help to show to growers the benefits of biodiversity enhancement. A common constraint in demonstration activities is the availability of true control plots. A base line of control efficiency in farms may complement imperfect control plots. Selection of opinion leaders (prescriptors) among growers to carry out transfer activities is another key aspect. Mr. Albajes was of the opinion that the most decisive actor in changing technology for biodiversity improvement is the farm adviser. Academic background of farm advisers must focus on both agricultural and biological disciplines. To train farm advisers who make decisions concerning crop management in the farm for improving their ecology, entomology, etc. background is a good way to incorporate environmental components in production techniques at farm level.

The **second** presentation was given by Claudio de Paola from the Italian Regional Ticino Park in Lombardy. The Ticino Park case is a good example of building farmer awareness of the biodiversity concept and knowledge transfer between environmentalists and farmers applying intensive farming practices. Ticino Park has a particularity of having a high urban (20% of its area) and agricultural (50%

of its area) pressure on its territory. In the 1980s, relationships between environmentalist from the park and farmers were tense, caused by opposite objectives. Nowadays, the Park is devoting a large part of its activities to agriculture, promoting multifunctional agriculture, landscape and biodiversity management benefits. Technical assistance and field experiments ensure a constant dialogue with farmers, enhancing exchanges between farmers, technicians, agri-environmental associations and the regional authority. Handbooks, simple technical cards or leaflets are regularly published, dealing with non-crop habitat management (tree lines, hedges, wetlands, grasslands) or best practices. Low input agriculture and agri-environmental measures application are the main goals of Ticino Park, where intensive agriculture is still prevalent. Biodiversity is also an important issue for the Park, especially with regard to crop diversity, ex. conserving local varieties of rice or bean, such as the "Borlotto of Gambolo" varieties. Starting with 4 farms involved in the scheme, today more than 400 farms (1/3 of farmers) are implementing one or more agri-environmental measures.

## **Discussion**

The session was closed by a general discussion led by Peter Esbjerg. The Ticino Park example was a source of several questions and comments. The close cooperation between environmentalists and farmers was found particularly interesting. This kind of agreement does not exist in many countries and Ticino Park might serve as a reference case. Nevertheless, coexistence between intensive farming and natural protected areas is difficult to manage and it is a long battle to convert all farmers into accepting low input farming system.

The communication system for transfer research has to be efficient and the regional authority financially involved. Apart from information materials distributed among farmers, demonstration farms can be a powerful tool for knowledge exchange and conveying to farmers the benefits of new practices. An important message emerged from the discussion: motivation and awareness are crucial factors of success. They can be supported with subsidies but also with training / educational activities to increase farmer awareness. In some countries, like UK, awareness building is rather difficult due to the low level of farmer involvement. This is often the case with part-time farmers or the older generation of farmers, less open to new approaches than the young ones. For other countries, the difficulties are to attract the farmer attention in the first place and, particularly demanding, to maintain their motivation. In Spain, motivation exists mainly in the advisory domain and farmers seem to be satisfied in their 'routine' activities, according to Ramon Albajes.

Building the farmer motivation requires adopting adequate strategies, taking into account particular farming conditions of the area – environmental, economic and social. In UK, a new project, presented to the audience by John Holland, has been launched, called 'Promoting Adoption of Alternative Pest Management Strategies in Field Crop Systems'. The study aims to understand the key environmental, economic and social issues of adoption of alternative strategies. Interviews with growers combined with field experiments are used to carry out the project.

It cannot be forgotten, however, that policy makers also need to be aware of the environmental issues, including landscape management and biodiversity enhancement.

The last part of the discussion centred on the successful examples of training and farm advisory in the participants' countries. Agri-Environmental Schemes could be seen as a communication tool. Indeed, in Ireland, training sessions on basic measures applied in AEM are compulsory not only for advisers but also for farmers.

In UK the Countryside Advisory Group is strongly involved in bringing to farmers knowledge of new techniques developed in research projects and giving advice on simple methods of their application.

In Portugal, the success of communication in agriculture and particularly with regard to integrated pest management is based on cooperation between the scientists and farmers perceived as leaders of their communities. Their farms are used by scientist to promote the good practices and thus influence other farmers.

In France there is a network of demonstration farms on different topics, such as ex. renewable energy. Moreover, these farms can receive European subsidies.

## **SESSION 2 – CONCLUSIONS**

The discussion of Session 2 might be summed up as follows:

Research:

- CBC is generally approved as an effective means of pest control.
- Diversity and abundance of natural enemies are key factors.
- Weeds can be regarded as an element of pest control attracting natural enemies and decreasing the nutritional value of a field for the pest.
- Standardization of the methodology protocols in Europe would enable valid comparisons of research results.
- Landscape studies are necessary but adapted to the species studied.
- There is a need to associate bottom-up and top-down strategies in the studies.
- Economic research on cost/benefits of CBC is lacking and there is an urgent need of its development.

Transfer:

- It is necessary to involve policy makers in the knowledge transfer process.
- Training and advisory activities should be targeted to the needs of local farmers, using simple, transparent tools.
- Various organizations should be involved, ex. hunting, nature conservation. Wildlife conservation could be a good way to enhance functional biodiversity.

### **Session 3 – Technical visit to “Parco del Ticino” – Italian Regional Ticino Park – *Chairperson: Claudio de Paola (Italy)***

This part of the Summer School aimed at presenting biodiversity and agriculture in a territorial context of a protected area of the first regional park in Italy, Parco del Ticino. In the presentation of the Park activities Lisa Hildebrand and Claudio de Paola emphasised the environmental goals ranging from issues related to the water shortage in the region, the urban pressure and intensive agriculture, to the ecological infrastructures restoration. Then two farms, located within the Park area, were visited to illustrate practically the topics discussed in the plenary sessions.

The first one, Azienda Agricola Cascina Caremma located in Besate (MI) was presented by its owner Mr. Gabriele Corti. Orientated towards agritourism and managed in line with organic farming rules, the farm was an excellent example of multifunctional agriculture. It has a restaurant, relaxation centre / beauty farm as well as accommodation facilities. Animal and plant production of the farm is designed for self-sufficiency and forms the core source of supply for the restaurant, which serves ca. 5000 clients a year. The farm breeds poultry, pigs, dairy cows, as well as fish. Crops are also diversified and give good yields, with rice yields exceeding those normally obtained in the surrounding area under conventional farming.

The second farm visited, Azienda Agricola La Zelata in Bereguardo (PV) was a dairy production biodynamic farm, covering an area of 270 ha. A guided tour of the farm and the shop located on the premises was given to the participants by the owner, Mr. Aldo Paravicini. The farm is highly independent of external inputs and with two crops a year produces adequate forage amounts to satisfy the feeding requirements of the farm livestock. The pest outbursts are prevented through cultural practices. Moreover, a direct sales system has been developed, offering rice, honey, pastas and cheese obtained after milk transformation.



Photograph: Åse Eliasson

## **Session 4 – Policy options for safeguarding economic viability of farms – *Chairperson: Jean-Michel Terres (JRC)***

Session 4 was the last with oral presentations, which aimed to answer the following questions:

- What are the existing policy tools to enhance biodiversity in agroecosystems? Are they efficient and sufficient? How to improve them?
- What are the existing tools to assess and monitor biodiversity?
- How to evaluate the effectiveness of Agri-Environmental Schemes in Europe?

### **a. Policy tools to enhance biodiversity in agroecosystems – *Speaker: Ariel Brunner (BirdLife International)***

The first presentation by Ariel Brunner (BirdLife International) was an in-depth analysis of the status and future challenges of integrating biodiversity protection and enhancement in the Common Agricultural Policy (CAP). CAP was initially designed to provide food security of Europe and support farmers as food producers. Major changes in farming practices included increased mechanization, increased intensity, polarisation of arable land and pasture, increased use of chemicals, increased farm size and abandonment of marginal areas. These changes impacted heavily on biotic components of agroecosystems causing loss of mixed farming, loss of habitat diversity, decline of birds, loss of landscape heterogeneity, and a general loss of biodiversity. They also had socio-economic impacts, through loss of employment in rural areas

Finally the general public, policy makers and farmers themselves became aware that increasing food overproduction and negative impacts of intensive farming practices on the environment required serious changes in policy. After a gradual introduction of various environmentally-friendly tools, in 2003 CAP underwent a major reform, perceived as an important step forward, in particular on account of high importance given to decoupling, cross-compliance and Agri-Environmental measures. However, several concerns have been raised with regard to those instruments. Cross-compliance might be a rather shaky baseline for improvements as its implementation depends on Member States, and is extremely variable and, additionally, there are various derogations and loopholes available. Grasslands are protected more in quantity but not in quality. Moreover, cross-compliance only covers farmers receiving direct payments. Similar concerns are evoked about rural development measures, where Axis I is often used to finance irrigation, drainage or intensification. On the other hand, Axis II includes afforestation measures which are usually highly destructive to farmland biodiversity. Recent evaluations of applied AES gave dubious results with regard to biodiversity enhancement. Interestingly enough, the set-aside regulations proved to be highly valuable for biodiversity, although this was not their intended aim.

In conclusion, policy tools of the reformed CAP play a crucial role in biodiversity conservation and enhancement in agroecosystem. The awareness of potentially weak elements can only lead to the improvement of the whole system.

The presentation generated many comments from the participants, expressing similar concerns about current policy measures. Another important issue raised was the pressure of WTO on the European agrarian policy, which might result in allocation of a higher percentage of funds towards environmental schemes. The current expenditure is only 10% of the total CAP budget. The lack of widely available information about the current situation was also emphasised by some participants. Communication with the consumers, farmers and advisory services does not seem sufficient at the moment.

**b. Tools for biodiversity assessment and monitoring – *Speaker:*  
Katarzyna Biała (JRC)**

After an overview of the policy tools, Katarzyna Biała focused her oral presentation on the need to find good indicators to assess and monitor biodiversity. Farmland birds and High Nature Value Farmland areas are two indicators proposed in the Common Monitoring and Evaluation Framework of the Rural Development Programme for the years 2007-2013 to assess the biodiversity status. HNV farmland is defined as *'those areas in Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports, or is associated with, either a high species and habitat diversity or the presence of species of European conservation concern, or both'* (Andersen et al. 2003). JRC, together with the European Environment Agency in Copenhagen is currently carrying out research on HNV farmland identification.

Farmland birds are a particularly interesting group, as they are responsive and sensitive to environmental change and are affected by both the availability of food and the structural diversity in farmed areas. For many species good data on distribution and population trends exist, with ongoing monitoring schemes providing the continuity for establishing time series. Moreover, birds have resonance and symbolic value with many different audiences and they are popular with the public.

Other biotic indicators have been suggested by various authors. According to Duelli and Obrist (1998) top indicator groups are Heteroptera, flowering plants, Symphyta and Hymenoptera – Aculeata. However, as emphasised by Duelli, there is no single, all-purpose biodiversity indicator and the choice of indicators depends on the motivation for a particular evaluation. Each aspect of biodiversity (and also each goal for using indicators) needs its own indicator with very specific and well defined features and agreements on the mode of application.

Finally areas of further development of indicators were suggested, including research possibilities and modes of a standardisation of the survey methods and rules for validation and scientific evidence of indicators. In creating an indicator system it is recommended to choose those organisms which allow minimising time and labour-input to achieve a statistically sufficient sample size. However, if the monitoring schemes aim to be scientifically valid, it is necessary to establish from the beginning the frequency in time, extent and intensity at which surveys should be repeated

A discussion followed this talk with the main idea to develop as a priority a sound indicator system for the assessment of Agri-Environmental Schemes. As far as the value of various groups as optimum biodiversity indicators was concerned, the priority was given to vascular plants, followed by arthropods and birds.

**c. Assessment of AES for biodiversity in Europe – Speakers: Henrik Vejre (Denmark), Felix Herzog (Switzerland)**

In the **first** presentation Henrik Vejre presented preliminary results of the research carried out in the frame of the 6th Framework Programme project 'The Agri-Environmental Footprint'.

It has been noted that agricultural landscapes undergoing transformation often lose biodiversity. First generations of CAP supported transformation of agriculture and led to environmental degradation. Since 1992 the CAP has aimed at preventing degradation of natural resources, biodiversity and landscape values. The crucial questions in this context are:

- How do we incorporate biodiversity in policies?
- Do we get value for money invested in various schemes?
- How much biodiversity do we get from CAP – Agri-Environmental Schemes?

Agri-environmental policies are designed to influence farmers' decisions and behaviour. These decisions in turn are expected to affect the environment. The causal relationships between environmental objectives defined in agri-environmental policies, farmer's decisions (agricultural practices) and environmental outcomes are depicted by policy impact models (IM). According to Rossi and Freeman's definition (1993) "An impact model takes the form of a statement about the expected relationships between a programme and its goal ... It must contain a **causal hypothesis**, an **intervention hypothesis**, and an **action hypothesis**."

If agri-environmental policies do not result in the anticipated environmental outcomes, it may be due to an inappropriate policy-design (including inappropriate assumptions of the causal relationships – missing or inadequate impact model) or an inappropriate implementation (including non-compliance with the required behaviour) or both.

Impacts on natural resources might be more foreseeable than impacts on biodiversity. The problems with biodiversity in evaluation and policy can be summed up as follows:

- Long reaction time;
- Unclear impact models;
- Landscapes and ecosystems are complex and diverse;
- Policy effects are neither instantaneous nor causal.

Explicit IMs are crucial for evaluations of policy effects and for improving policy design. Policies are often based on insufficient IMs because scientific models of the causal relationships do not exist - or they are not applicable in a policy

context. Schemes are often constructed in a context set by the agricultural sector, and dominated by engineers rather than biologists, basing judgments on documented relationships, rather than complex modelling. The focus on compensation has emphasised performance effects (land use, management practice), rather than outcomes as the design has been influenced by agriculture sector, that has to perform to get subsidies.

Other problems are connected with evaluation techniques. Normally the comparison is carried out between agreement and non-agreement areas. However, there is a fundamental question: are they really comparable? If the agreement area has a higher biodiversity, can we be sure that it is the result of the agreement? In order to answer this question, we need to establish whether the two categories start at the same level of biodiversity, with the same dynamics.

Moreover, the focus in policy design has been so far on the compensation principle and therefore on performance effects (land use, management practice) rather than on environmental outcomes. In conclusion, agri-environmental measures in relation to biodiversity should be long-termed, so improvement is not as necessary as maintenance. Outcome and performance should be equally important. AES is not a sustainable solution – a new functionality should preserve biodiversity in agroecosystems.

In the **second** presentation Felix Herzog provided results of the assessment of the effects of ecological cross-compliance in Switzerland. The Swiss Federal Government introduced environmental direct payments in 1993. Since 1999 direct payments have been conditional on farms producing a 'Proof of Ecological Performance' (PEP). Linking the PEP to direct payments makes it comparable to the single-farm payments presently introduced in the European Union, where area payments depend on farmers complying with cross compliance regulations.

Today 97% of the utilised agricultural area is managed according to PEP rules. The most important PEP measures affecting nitrogen and phosphorous flows are overall farm nutrient budgets, which have to be balanced, and the implementation of suitable measures for soil conservation. For the preservation and promotion of biodiversity, at least 7% of a farm area has to be managed as ecological compensation areas (ECA, e.g. extensively managed grassland, hedgerows, traditional orchards). Further PEP requirements are diverse crop rotation, selective pesticide use, welfare-promoting livestock husbandry. When PEP was introduced, environmental objectives were formulated by the government. A 10-year research project evaluated if the objectives with respect to nitrogen and phosphorous losses and to the promotion of biodiversity were reached.

The methods of the interdisciplinary project comprised (i) monitoring of ground- and surface water quality; (ii) long-term monitoring of agricultural practices and of their effects on nitrate leaching, erosion and phosphorous run-off from grassland; (iii) scenario studies using nitrogen and phosphorous simulation models; and (iv) large scale surveys of vascular plants, arthropods and birds on ecological compensation areas. The research period covered 1995–2005.

Nitrogen and phosphorous emissions and immissions were both substantially reduced in comparison to the reference period 1990-92. However, not all objectives were reached and there is still a considerable amount of excess nitrogen and phosphorous leading to pollution problems. Biodiversity was increased on ECA as compared to intensively managed fields but the ecological quality of two thirds of the ECA in the lowlands was judged unsatisfactory. Endangered species were hardly promoted by ECA.

Because the PEP is linked to direct payments through a cross compliance mechanism, the acceptance by farmers is very high. The main difficulty in evaluating the environmental effects of the PEP regulations was that many factors (climate, technical progress, socio-economic conditions of farmers) act both on farming practices and on the environmental parameters under investigation. Only long-term observations in conjunction with the application of scenario studies by means of simulation models can single out the effect of policy measures.

The PEP rules contributed to reduce nitrate leaching and phosphorous losses, although some goals were not fully reached. The reduction of ammonia emissions was mostly due to a decline in the number of farm animals – which in turn can partly be attributed to PEP rules – and in the reduction of mineral fertiliser application.

ECA with high biodiversity levels were mostly located at sites which had traditionally been extensively managed. In the lowlands, PEP rules protect these sites from intensification whilst in mountain areas, they protect them from abandonment. ECA thus promote traditional agro-biodiversity. They largely fail, however, to promote endangered species.

The high acceptance of regulations promoted through Cross Compliance (CC) makes CC a potentially strong instrument for improving the environmental performance of agriculture. The PEP rules were found to be effective to some extent in Switzerland, although not all goals were reached. The effectiveness of the rules can be increased by better adapting them to local natural conditions and to specific local environmental problems. However, this requires intensified extension activities and higher administrative costs.

## 5. Final conclusions

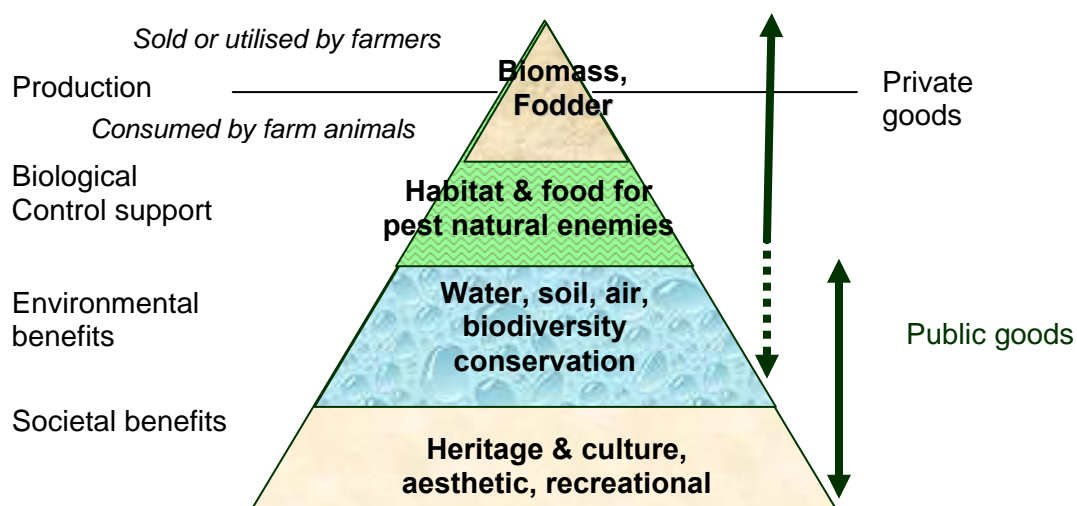
The following synthesis and conclusions were drawn thanks to the contribution of all Summer School participants.

The concept of “biodiversity serving agriculture” versus “agriculture serving biodiversity” is a simple but very important message, and can be used to highlight the crucial links between an often production-orientated agriculture and maintaining or increasing biodiversity. The meaning of biodiversity therefore is something that needs careful defining if the discipline of agroecology is to move forward in a common direction and progress with a common focus. Biodiversity is concerned with the functional attributes of ecosystems, e.g., decomposition and nutrient cycling, in addition to numbers of species of all the biota present. This differs from the concept of species diversity, which is concerned with the identity and distribution of species in a given habitat or region.

The biodiversity value systems put forward by Peter Duelli at the Summer School are very important for wider biodiversity and how it might be useful to agriculture, not just agriculture helping to conserve biodiversity. Assigning particular values of importance to the biodiversity on farmland of different baseline biodiversity wealth may be important in not just focusing all of our efforts on designated lands of high conservation value for rare or threatened species. ‘Ordinary’ farmland may be assigned biodiversity values more related to what biodiversity can do for productive agriculture (e.g. biological control, nutrient cycling, protection and enrichment of soils, retention of water, purification of water and air, pollination), while helping to maintain or improve overall biodiversity.

Our current state of knowledge allows us to propose that we should achieve extended Environmental Infrastructures in **intensively managed open landscapes** using flower strips, hedgerows, extended biotopes and other similar approaches. This will enhance local biodiversity of common species, conservation biocontrol and stability/sustainability landscapes – biodiversity in support of agriculture.

### The multiple benefits of Ecological Infrastructures



In **intermediate landscapes**, where agriculture has also been intensified, there are also large opportunities to re-create habitat mosaics and reinforce biodiversity. Suitable management of the fields, e.g. arable reversion to grassland, woodland management, and enhancement of the Ecological Infrastructure will enhance biodiversity, but particularly rarer species in the landscape - agriculture in support of biodiversity.

There remains an important role for farming systems development alongside for landscape management. At the landscape scale, there are requirements for species that disperse over large distances, e.g. birds and many insects. Reliance on field- or farm-scale prescriptions may not be sufficient – solutions might be provided by enhanced land-use management strategies.

A reconstruction of the heterogeneous agricultural landscape is feasible through the implementation of Ecological Compensation Areas (ECAs), well distributed to ensure their connectivity. The ECAs are quite well developed and accepted by farmers in countries like Switzerland or UK, financially supported via Agri-Environmental Schemes (AES). In other countries where subsidies are less available, as in Estonia, Hungary or Poland, the establishment of ECAs is more difficult.

Conservation Biological Control (CBC) research should focus on predator and parasitoid population abundance dynamics in relation to land use management and landscape structure and on temporal and spatial variability in abundance and species composition of predator identified as efficient control agents.

It is of great importance to improve the knowledge of ecological requirements and biological traits and range of each species of any taxa which is intended to be an indicator species. These data have to integrate the effects of landscape structure (as far as we know them...) and those of managements by farmers. They absolutely have also to be put into a computerised database, since it is the only way to succeed in choosing convenient and reliable taxa, and to make an impact model of farm management on biodiversity indicator species.

The choice of these indicators has also to be linked to functional traits of ecological processes in agroecosystems:

- what does the presence of a particular species indicate?
- does it indicate the presence of other specific species and/or the presence of particular habitats and microhabitats? (and thus the potential presence of other taxa)
- which is the spatial scale of the given information?

The taxa which would be adopted, should preferentially match the scale which corresponds to the easiest one to be handled in the field:

- either the farm level, since farms are the unit of management through farmer's practices
- or the landscape since (i) fields of a farm may be spread all over a landscape, and (ii) some species can use different habitats of a landscape belonging to several owners.

Given our current knowledge about what determines predator dynamics and the efficiency of biological control, we should focus our policy efforts in two fields:

- increase landscape heterogeneity in highly intensified agricultural landscapes which today provide little refuge and alternative food sources for the inhabitant predators
- maintain heterogeneity in less intensively cultivated and heterogeneous areas. In these landscapes, homogenisation due to abandonment is often a problem.

Knowledge transfer between researchers and other stakeholders is of crucial importance. The means developed to favour exchanges between researchers, farm advisers, trainers, policy makers and consumers are in need of further development. Various ways of knowledge transfer presented during the Summer School might serve as stepping stones to the achievement of fully efficient communication. They include research projects with a participatory character, involving active participation of all stakeholders including in particular policy makers and farmers, demonstration farms and trials and dissemination materials.

Indeed, basic information on the current applications of research results in the domains of agriculture, environment and ecology would be useful for policy makers to direct the decisions taken when building measures integrated in the CAP and especially in the Cross Compliance or other 2<sup>nd</sup> pillar schemes. The existing measures do not always produce expected results, and represent only 10% of CAP expenditure compared to the total budget. However, examples of success exist and were presented in throughout the Summer School sessions.

Assessment of AES implementation so far is the object of some European projects such as the EASY or the "Agri-Environmental Footprint" projects. As their results do not present clear-cut benefits for biodiversity, the issue of design and targeting of agri-environmental programmes is now prominent – horizontal application of these measures may not benefit specific needs of particular areas, specific packages aimed at grasslands as well as measures concerning landscape elements may need modifications. There is also a need to develop a scientifically sound methodology for the evaluation of the effectiveness of these measures, including the development of appropriate indicators as assessment tools. Although the issue of assessing the effectiveness of agri-environmental measures is policy-driven it has definitely long-term implications for environmental impacts. Moreover, it calls for the strong incorporation of socio-economic factors which will enable the evaluation of trade-offs between natural resources conservation, especially with regard to biodiversity and landscape and economic viability of farming systems.

## 6. Proposals for future activities

First of all, as mentioned in the previous discussion, JRC's role is to support sound conception / development of EU policies and as such is a privileged interlocutor for EC policy makers.

The beginning of the last session started with the presentation of the following potential activities which could be developed in the future, put forward for discussion by Jean-Michel Terres (JRC):

- To develop a forum for information exchange on agri-environmental issues, with links to relevant research projects, workshops, pilot studies via JRC web site;
- To play a role in the establishment of the Rural Development evaluators network (for the environmental component);
- To facilitate / foster FP7 research proposals on agriculture and biodiversity;
- On the thematic side:
  - Feasibility study to develop a biodiversity indicator based on plant species (probably at the Member States level, not EU?);
  - Environmental effects of label products.

The participants supported the suggestions with the following more detailed proposals:

### **a. Research on functional biodiversity and CBC**

- Ecosystem functioning: there is a need to find and show more functionality of biodiversity (identification of key elements and key processes);
- CBC research should focus on predator population abundance dynamics in relation to land use management and landscape structure and on temporal and spatial variability in abundance and species composition of predators identified as efficient control agents;
- Standardization of methodology at European scale, particularly developing common documentation and operational tools for monitoring biodiversity state and trends;
- Economic approach to external services costs (water quality, human health, tourism ...);
- More effort devoted to prove the usefulness of CBC performance:
  - Refining relationships between farming system, landscape, species richness and resilience (especially challenging to document);
  - Effects of global change;

- Refinement of sustainable farming production systems;
- Developing more research programmes on Low Input Systems;
- Developing a new approach concerning weeds (positive effects of weeds for CBC and as wildlife habitat);
- Effectiveness of Biological Control and CBC in greenhouses and outdoors;
- More research on Agri-Environmental Schemes (AES) assessment, with AES themselves regarded as large scale experiments;
- European network: exchanging information on research via the JRC web site.

### **b. Indicators**

- Standardisation of survey methods;
- Validation and scientific evidence of indicators (gaps, possible solutions);
- Optimising time and labour-input to achieve a statistically sufficient sample size;
- Frequency in time, extent and intensity at which surveys should be repeated;
- Improving the knowledge of ecological requirements and biological traits and range of each species of any taxa which is intended to be an indicator species;
- Integrating landscape structure and farmland management.

### **c. Transfer**

- Promoting case studies on efficiency of CBC in the context of a cultivation system;
- Building up education and training programmes with regular update for policy makers, advisers and single farms towards better ways of agriculture achieving sustainability and biodiversity enhancement;
- Increasing public awareness of needs and benefits resulting from and obstacles for 'family' type environmentally friendly agricultural production of regional / typical food;
- Favouring demonstration trials, participation of farmers in research projects;

- Incorporating into research programmes ideas coming from farmers.

#### **d. Policy**

##### **Cross Compliance**

- Reduction of pesticide and nitrogen use (including pesticide guidelines in GAEC);
- Low Input System (with good indicators and defined levels) can be the minimum request, favouring practices respecting field dependent species;
- Pilot projects for demonstrating conservation interest of Ecological Compensation Areas (grass strips – hedges as corridors);
- Minimum Ecological Infrastructure (EI) (adapted per country), particularly in intensively managed open landscapes;
- Minimum Set-aside.

##### **Agri-Environmental Schemes**

- Reestablishment of connectivity in the landscape;
- Adapting measures to farm system, landscape type and ecological goals (regional zonation);
- Developing EI in intensively managed open landscape
- Set-aside for energy crop versus set-aside for biodiversity (conservation and/or functional biodiversity support);
- Supporting mechanisms for recreation and maintenance of High Nature Value areas;
- Adopting targeted AES which directly support the land users / owners of land of High Nature Value in order to prevent land abandonment and biodiversity depletion.

#### **e. Consumer**

- Easily-accessible and transparent information on the topic of sustainable land use should assist gaining consumer support for the sustainability concept;
- Reliable information about agricultural products should be provided (new labels?).

#### **f. Farming System**

- Need to evaluate the complete management system (tools?).

# Summer School "Biodiversity serving Agriculture"

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