



IOBC
OILB

*WPRS International Organisation for Biological and Integrated Control of Noxious
Animals and Plants: West Palearctic Regional Section*

*SROP Organisation Internationale de Lutte Biologique et Intégrée contre les Animaux et les
Plantes Nuisibles: Section Régionale Ouest Paléarctique*

Commission "IP-Guidelines and Endorsement"

Integrated Production

Principles and Technical Guidelines

2nd Edition 1999

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Foreword

2nd edition

Five years ago IOBC published for the first time the conceptual frame of Integrated Production as it developed during the past 2 decades as one possible solution of a sustainable agricultural production system. This basic concept has found international interest and recognition and provided the basis for the development of technical guidelines and of the endorsement activities of the Commission.

The experience gained during the past 5 years indicate that the basic content of the concept is valid and does not necessitate modifications. However, it was evident that certain elements of the technical guidelines and of the endorsement procedure defined in 1992 had to be adapted to satisfy the present needs. Therefore, the Commission decided in agreement with IOBC/WPRS Council to publish this 2nd edition in order to provide an up-dated document for its future work.

Whereas the definition and objectives remain unaltered, we have added a short synoptic description of the general concept as used by members of the Commission addressing interested parties.

Substantial changes have been made in the Technical guideline I addressing the general IOBC requirements for organisations and their members practising Integrated Production according to IOBC standards. They concern mainly clarifications in vital points concerning the content of contracts between organisations and their members, the structure of guidelines, the organisation of the inspection system and the establishment of lists of sanctions, respectively.

Minor modifications have been made in the Technical Guideline II addressing the general agronomic aspects of Integrated Production programs. They concern mostly the elimination of unnecessary redundancies and the incorporation of a new chapter dealing with irrigation. We have added as appendix the description of the modern plant protection concept in the framework of sustainable agriculture as perceived and published by IOBC in the IOBC-WPRS Bulletin Vol. 21 (1), 1998 to emphasise the approach described in the respective chapter of Guideline II.

We would like to extend our thanks to all persons that have supported the work of the Commission in the past and provided us with important suggestions for improvement. Without that fruitful feedback the preparation of this present new edition would not have been possible.

Wädenswil, December 1, 1998

Ernst F. Boller
Chairman of the Commission

IOBC/WPRS Council

FOREWORD (First Edition 1993)

The past four decades have seen fundamental changes in European agriculture. The decline in the number of farmers demonstrates diminishing financial viability associated with serious problems for the rural society and landscape. Overproduction, endangerment of wild species and pollution of ground and surface water are now identified as major constraints of intensive farming. These and other problems became increasingly important for policy makers, farmers and society and led to a fundamental re-orientation in agriculture. Only environmentally safer, sustainable patterns of landuse can cope with the present challenge. They can be targeted by replacement of polluting agrochemicals, in particular pesticides and fertilisers, by environmentally safer and sustainable technologies.

IOBC/WPRS has always been addressing these goals. Council, Commissions, Working and Study Groups direct their activities to the development and implementation of such ecosystem based concepts in crop protection. Therefore, the present changes fit completely into the traditional strategies of IOBC. However, the identified constraints in the implementation of Integrated Pest Management on the course of IOBC/WPRS research activities had clearly shown the necessity to take all relevant farming activities into account. This has been the basis

for adopting the systems approach supported by the various research activities on **Integrated Production/ Integrated Farming**.

Taking into account these developments IOBC/WPRS Council decided to define clearly its position regarding concept and implementation of IP/IF. These efforts started at the end of the 1960s and beginning of the 1970s and led to the establishment of a Commission on "Integrated Production" in 1977 with IOBC/WPRS endorsement procedures for IP organisations in apple production. In September 1990 Council reactivated that Commission with the task of formulating a basic document which

- defines Integrated Production/Integrated Farming
- describes the underlying strategy
- establishes technical guidelines and standards for implementation.

The Commission started its activities in March 1991 and provided the first draft of this basic document 12 months later. It was reviewed by an *ad hoc* Panel of Experts representing Council and relevant horizontal Working Groups. The final version of the document was approved by IOBC/WPRS on November 1992.

Definition, principles of the endorsement procedures and Technical Guidelines I and II are officially put into effect by publication of this document. It has already been brought to the attention of all IOBC/WPRS units and will be made available to all interested parties outside IOBC/WPRS. The present document provides both the conceptual platform for IOBC/WPRS activities and the basis for IOBC endorsement procedures for farmers' organisations seeking IOBC/WPRS recognition and associated product certification. By defining the rules of Integrated Farming and by recognising the achievements of organisations and their members implementing Integrated Production/Integrated Farming as a sustainable form of agricultural production IOBC/WPRS establishes the next milestone of its own tradition.

Executive Committee and Council sincerely hope that this document might help to clarify aspects in need of clarification and to accelerate the dissemination of Integrated Farming. IOBC/WPRS invites all concerned organisations, institutions and authorities to co-operate in this common responsibility to overcome present constraints of our agriculture.

On behalf of IOBC/WPRS we extend our thanks and appreciation to the members of the Commission and to all participating colleagues for their efforts to make this document available.

Padova and Montfavet, December 21, 1992

Prof. R. Cavalloro
President

Dr. S. Poitout
Secretary General

Integrated Production

Principles and Technical Guidelines

INTRODUCTION

The development and implementation of ecosystem based technologies in plant protection have always been important objectives of the IOBC since its foundation in 1956. The leadership of the IOBC in this particular field and in the field of environmentally sound production strategies in agriculture has resulted from the pioneering activities in research and development of the various IOBC Working Groups during the last three decades.

The evolution from biological control concepts to Integrated Pest Management (IPM) and finally to a holistic systems approach was certainly not an accidental event. On the contrary, it is the logical response to progress achieved in the field of concepts and scientific standards which have been important milestones in the history of IOBC. In the wake of these developments it became necessary to define clearly the IOBC philosophy, principles and practical rules of the systems approach expressed as **Integrated Production (IP) / Integrated Farming (IF)**.

One step in this direction was the decision of IOBC/WPRS Council in 1990 to reactivate the **IOBC Commission on "IP Guidelines and Endorsement"** (thereafter called "Commission"). The Commission had the task of establishing the framework for general standards for IP complying with the official IOBC principles put down in the declarations of "Ovronnaz" (1976) and "Veldhoven" (1991). This task had to cover both philosophy and strategy as well as technical requirements for implementation, inspection and product certification.

A basic document setting out the **"Definition and Objectives of Integrated Production (Integrated Farming)"** was established by the Commission on March 6, 1992 at Wädenswil/Switzerland in close co-operation with the IOBC/WPRS Council, Executive Committee and an *ad hoc* Panel of Experts representing the horizontal IOBC Working Groups. Explanatory texts after each objective and principle identify the precise intentions of the IOBC and should provide guidance for the formulation of more specific technical documents (Guidelines) needed for practical implementation. During the preparation phase, this document has been widely analysed, discussed, improved and finally approved in the present form by all IOBC bodies involved. Hence, it is binding for IOBC Members, IOBC Working Groups and in particular for all regional IP-organisations seeking or having received endorsement by the IOBC. Furthermore, it is hoped that the document will support and accelerate the development of Integrated Farming for the benefit of producers, consumers and environment.

The *"Definition and Objectives of Integrated Production/Integrated Farming"* are published here in full text as well as in summary form. Although it is difficult to condense all IP principles in a few lines without over-simplifying and even misinterpreting their original content, IOBC has decided to formulate such a short definition in order to facilitate the communication with the non-professional public at large. The original English text serves as reference whenever ambiguous interpretations might occur in the respective translations.

With this conceptual basis IOBC has established an **Endorsement procedure** for regional IP-organisations seeking an international recognition of their achievements.

The Commission publishes two general technical guidelines:

Technical Guideline I defines the legal status of the IP-organisations seeking IOBC endorsement and describes minimum requirements to be fulfilled by organisations and their members.

Technical Guideline II provides the general rules and minimum requirements to be met by all farmers participating in IP programs endorsed by IOBC, on all types of farms, and in all IOBC/WPRS regions. Recommendations are given, whenever needed, to point out optional solutions that go beyond the mandatory minimum.

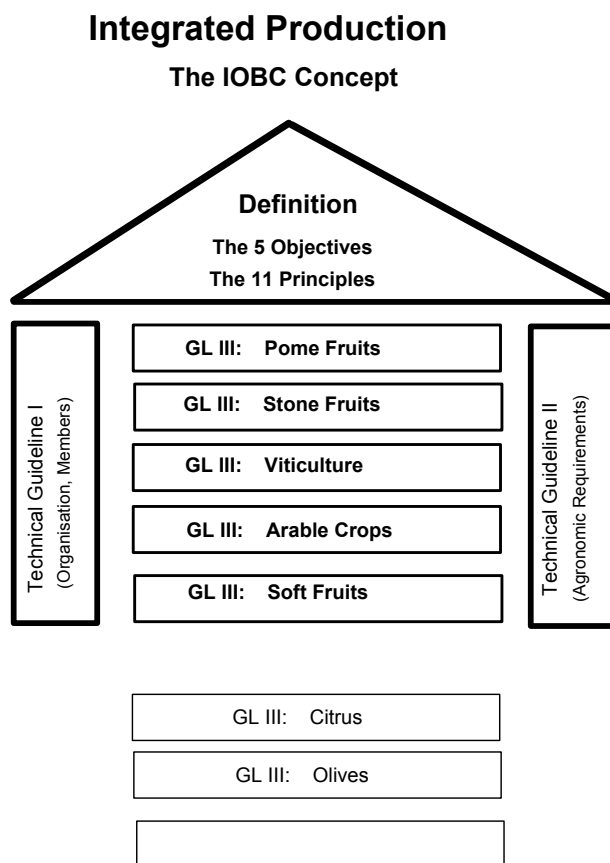
Crop Specific Technical Guidelines III, not presented here, are prepared on the basis of the two general Guidelines I and II and specify the minimum requirements and recommendations in individual crops. They are prepared and published by the Commission in close collaboration with respective crop specific IOBC Working Groups and/or *ad hoc* expert panels.

There is general agreement that Technical Guidelines should be revised at intervals of not less than 5 years in order to allow for continuity.

The Commission would like to take this opportunity to thank all members of the Executive Committee, of Council and of the *ad hoc* IOBC/WPRS Panel of Experts for their most constructive co-operation and support during the preparation and final approval of this document. Special thanks are extended to those colleagues who provided help in the translation of the individual documents that will be published separately.

The IOBC Concept of Integrated Production

The conceptual frame of Integrated Production was redefined and published in 1993 incorporating the new developments in the field of sustainable agriculture (El Titi, Boller & Gendrier 1993). The basic concept is quite simple as shown in the following figure:



Definition, objectives and principles of IP provide the conceptual roof on two pillars built by two general technical guidelines defining (I) the general standards for the organisation and its members and (II) the general agronomic requirements valid for all crops. Placed in this construction are the crop specific guidelines that define in greater detail the requirements for IP-guidelines in the respective crop. The overall aim of these documents can therefore be described as follows: They are intended as a framework for the formulation of regional or national guidelines and standards and to aid harmonisation of these concepts and guidelines throughout Europe. So far established by long international discussions among experts are the crop specific guidelines for pome fruits (2nd edition, Cross & Dickler 1994), stone fruits (Cross et al. 1997), viticulture (2nd edition, Malavolta & Boller 1999), arable crops (Boller et al. 1997) and soft fruits (Jörg & Cross 2000), in close collaboration with the respective IOBC working groups, the International Society of Horticultural Science and international *ad hoc* expert panels, respectively. Guidelines for citrus and olives are in preparation.

One of the topics and problems addressed by various organisations is the problem of national guideline structures that respect the particular situations at the regional and local level. In a recent publication (IOBC/WPRS Bull. 21 (1), 1998) the Commission presents and discusses an interesting solution that has received international attention. The rating or bonus-malus-system provides a quite flexible but still precise tool as it utilises a set of basic requirements („tronc commun“) to be observed and fulfilled at the national level that is supported by a list of additional ecological options docked onto this basic trunk. Local organisations and the individual farmer can now prepare their specific mix of options that do not only consider the local situations but also stimulate

experimentation. With this approach it is possible to transform traditionally rigid IP-guidelines with strict rules and prohibitions into a dynamic regulatory system that allows to incorporate constantly new scientific knowledge.

IOBC Definition of Integrated Production

Short Version

Integrated Production (Integrated Farming) is a farming system that produces high quality food and other products by using natural resources and regulating mechanisms to replace polluting inputs and to secure sustainable farming.

Emphasis is placed

- *on a holistic systems approach involving the entire farm as the basic unit,*
- *on the central role of agro-ecosystems,*
- *on balanced nutrient cycles, and*
- *on the welfare of all species in animal husbandry.*

The preservation and improvement of soil fertility and of a diversified environment are essential components.

Biological, technical and chemical methods are balanced carefully taking into account the protection of the environment, profitability and social requirements.

Objectives and Principles of Integrated Production

(This document is an integral part of IOBC Guidelines I, II & III)

INTEGRATED PRODUCTION IS A FARMING SYSTEM WHICH

- INTEGRATES NATURAL RESOURCES AND REGULATION MECHANISMS INTO FARMING ACTIVITIES TO ACHIEVE MAXIMUM REPLACEMENT OF OFF-FARM INPUTS

These objectives address the basic intentions of a sustainable agriculture. An intelligent management and careful utilisation of natural resources can help to substitute for farm inputs such as fertilisers, pesticides and fuel. Total or partial replacement of these materials not only reduces pollution but also production costs and improves farm economics.

- SECURES SUSTAINABLE PRODUCTION OF HIGH QUALITY FOOD AND OTHER PRODUCTS THROUGH ECOLOGICALLY PREFERRED AND SAFE TECHNOLOGIES

IP aims at high quality production but mainly through ecologically sound techniques that are safe for human health. Quality evaluation of the product considers not only its specific internal and external characteristics but above all the means of production as significant criteria.

- SUSTAINS FARM INCOME
- ELIMINATES OR REDUCES SOURCES OF PRESENT ENVIRONMENTAL POLLUTION GENERATED BY AGRICULTURE

Existing pollutants of agricultural origin have to be eliminated whenever and wherever this is feasible.

- SUSTAINS THE MULTIPLE FUNCTIONS OF AGRICULTURE

Agriculture has to meet the needs of the entire society including those requirements that are not directly connected with the production of food and fibre. Diversified landscapes, wildlife conservation, decentralised colonisation and cultivation of remote areas as well as maintenance of local cultural traditions are some of the non-agricultural environmental and recreational values provided by operational farms.

THE PRINCIPLES OF INTEGRATED PRODUCTION

1) IP IS APPLIED ONLY HOLISTICALLY

IP is not a mere combination of Integrated Pest Management with additional elements such as fertilisers and agronomic measures to enhance their effectiveness. On the contrary, it relies on ecosystem regulation, on the importance of animal welfare and on the preservation of natural resources.

2) EXTERNAL COSTS AND UNDESIRABLE IMPACTS ARE MINIMISED

Detrimental side-effects of agricultural activities such as nitrate or pesticide contamination of drinking water or erosion sediments in waterways impose enormous costs to society. These external costs are normally not reflected in budgets for agricultural expenditure and must be reduced.

3) THE ENTIRE FARM IS THE UNIT OF IP IMPLEMENTATION

IP is a systems approach focusing on the entire farm as the basic unit. IP practised on isolated individual areas of the farm is not compatible with a holistic approach postulated under item 1. Important strategies such as balanced nutrient cycles and optimum allocation of farm machinery only become meaningful if considered on the entire surface of the farm.

4) THE FARMERS' KNOWLEDGE OF IP MUST BE REGULARLY UP-DATED

The farmer plays a key role in IP-systems. His insight, motivation and professional capability to fulfil the requirements of modern sustainable agriculture are intimately linked to his professional abilities acquired and updated by regular training.

5) STABLE AGROECOSYSTEMS ARE TO BE MAINTAINED AS KEY COMPONENTS OF IP

Agro-ecosystems are the basis for planning and realisation of all farm activities, particularly those with potential ecological impact. They are the visible expressions of the holistic concepts and provide both natural resources and regulation components. Stabilisation means the least possible disturbance of these resources by farm activities.

6) NUTRIENT CYCLES ARE TO BE BALANCED AND LOSSES MINIMISED

"Balanced" in this context means targeting maximum reduction of nutrient losses, a cautious replacement of those amounts leaving the farmed area through sales of commodities, and recycling of farm materials.

7) INTRINSIC SOIL FERTILITY IS TO BE PRESERVED AND IMPROVED

The intrinsic fertility of soil is the production capability of the soil without external interventions under given site conditions. Accordingly, fertility is a function of balanced physical soil characteristics, chemical performance and balanced biological activity. The soil fauna is therefore an important indicator of soil fertility.

8) IPM IS THE BASIS FOR DECISION MAKING IN CROP PROTECTION

Integrated Pest Management (IPM) applies to noxious species of phytophagous animals, pathogens and weeds. Noxious species are those causing more losses than benefits. Emphasis of plant protection in the context of sustainable agriculture is placed on preventive measures („indirect plant protection ") that must be utilised to the fullest extent before direct plant protection measures are applied (=control). „Control" means elimination of the portion of the pest population that causes economic losses. Decisions about the necessity to apply control measures must rely on the most advanced tools such as prognostic methods and scientifically verified threshold aspects. The instruments of direct plant protection are the last resort if economically unacceptable losses cannot be prevented by indirect plant protection.

9) BIOLOGICAL DIVERSITY MUST BE SUPPORTED

Biological diversity includes diversity at the genetic, species and ecosystem level. It is the backbone of ecosystem stability, natural regulation factors and landscape quality. Replacement of pesticides by natural regulation factors cannot adequately be achieved without adequate biological diversity.

10) PRODUCT QUALITY MUST BE EVALUATED BY ECOLOGICAL PARAMETERS OF THE PRODUCTION SYSTEM AS WELL AS BY THE USUAL EXTERNAL AND INTERNAL QUALITY PARAMETERS

Commodities produced under strict IP regulation do not only exhibit measurable external and intrinsic quality parameters but also meet the requirements of the ecological evaluation of the production processes. Hence a certification testifying the achievements of the producer is the prerequisite for the IP-label that defines additional requirements during storage, processing and handling of the products.

11) ANIMAL PRODUCTION

- SPECIFIC REQUIREMENTS FOR THE WELFARE OF EACH SPECIES OF FARM ANIMALS

Holding conditions of the farm animals have to respect basic behavioural needs of the species.

- ANIMAL DENSITY SHOULD BE MAINTAINED AT LEVELS CONSISTENT WITH OTHER IP PRINCIPLES

Animal density has a major impact on the nutrient balance of the farm. Purchased animal feed and animal manure have important effects on nutrient cycles, edaphon diversity and environment.

Definition, objectives and principles have been approved by a special *ad hoc* expert panel of IOBC/WPRS on March 6,1992 and have been approved and put into effect by IOBC/WPRS Executive Committee on May 16, 1992.

Technical Guideline I

General IOBC Requirements for Organisations and their Members practising Integrated Production according to IOBC Standards

The IOBC/WPRS document on "Definition, Objectives and Principles of Integrated Production" is an integral part of this document. This document will be revised at intervals not less than 5 years in order to allow for continuity. IOBC reserves the right to make modifications whenever the need arises.

Organisations must have an operational history of **at least 2 years** practising IP according to IOBC principles and fulfil the following requirements before they can apply for endorsement by IOBC :

1. Requirements for Organisations

- a. Organisations must show an organisational structure recognised by the respective national civil law.
- b. The pursuit of the IP principles according to IOBC standards has to be declared clearly as objective in the statutes and/or by-laws of the organisation.
- c. The organisation realises IP by a set of appropriate rules and guidelines. Details of guideline structures are given in Appendix 1. These have to distinguish clearly between supervised mandatory requirements and recommendations. The IOBC Commission recommends to adopt a rating system (Guideline type 3) and refers to the relevant article „Guideline structures: National standards and regional characteristics“ published in IOBC/WPRS Bull. Vol.21 (1), 1998.
- d. The organisation has to organise and operate a control and evaluation system that supervises and evaluates regularly the activities and achievements of their members practising IP. The minimum requirements of the control system and the requirements for the structure of the inspection protocols (= checklists) are given in Appendix 2.
- e. The organisation has to provide at least a mandatory annual introductory course for new members starting IP activities under the responsibility of the organisation. Additional courses for the systematic education and transfer of new knowledge to their members have to be realised to the largest possible extent.
- f. The organisation has to sign a written contract with each individual member requesting to participate with the entire surface of the farm or respective farm sector in an IP-program endorsed by IOBC. The contract has to contain the points listed below.
- g. The organisation has to establish a technical committee in charge of the technical management of the IP-program, to operate an appropriate auditing committee, and to establish a legally binding procedure to resolve disputes. These procedures have to contain a list of defined sanctions for each type of transgressions committed by individual members. The requirements for the list of sanctions are outlined in Appendix 3.
- h. Organisations seeking or having received IOBC endorsement must prepare and submit to IOBC each year by the end of December an up-dated list of members that have successfully participated in the IP-program endorsed by IOBC. These members have passed through a successful transition period of 2 years. New members in transition have to be listed separately. For the prolongation of the endorsement the organisation

has also to submit the complete documents concerning the IP-program valid for the next year and indicate clearly where modifications have been made.

- i. The organisations must help in every possible way to facilitate the supervision of the endorsed organisations' activities by the authorised delegates of IOBC.

2. Requirements for the Farmer (Member)

The farmer or the responsible farm manager has to

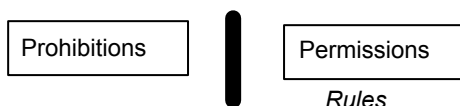
- a) be qualified professionally to manage the farm according to IP principles.
- b) declare in writing (contract) to the respective IP-Organisation (Contractor):
 - to know and accept the rules and guidelines of the organisation;
 - to apply the IP program on his free will and on his own risk;
 - to practise IP on the entire surface of the farm or of the given crop for which IOBC endorsement has been applied by the organisation;
 - to participate in mandatory introduction course and regular training;
 - to accept a successful transition period (of at least 2 years) before certification;
 - to make only true and complete farm records;
 - to refrain from unfaithful use of certificates and/or labels endorsed by IOBC;
 - to allow access to the farm and all pertinent infrastructures by authorised inspectors of the IP-organisation;
- c. Has to take farm records according to the established rules and make them available anytime to the authorised control and evaluation officers.
- d. Has to attend at least an introductory IP-course and complete successfully a preparatory transition period (2 years) before certification.
- e. Has to follow regularly the training courses offered by the IP-Organisation in order to fulfil the IOBC requirement of permanent professional training.

Appendix 1

Possible Structures of IP-Guidelines (this document is integral part of IOBC Guideline I)

There are basically 3 types of guidelines established by various organisations. All of them provide a valid basis for the implementation of IP but have certain advantages and disadvantages as follows:

1. Straight-forward system operating with strict permissions and prohibitions

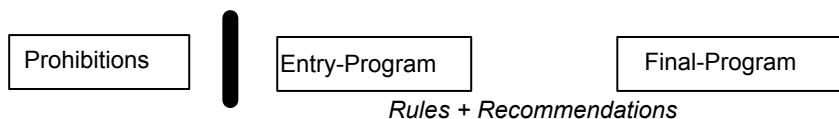


Advantages: Rules are clear cut, prohibited items can be supervised and mistakes be identified. The system works either on the basis that everything is permitted that is not prohibited (list of prohibited items) or everything is prohibited that is not permitted (list of permitted items).

Disadvantages: The guidelines are very restrictive and do not provide guidance as to the intended development. They do not stimulate the farmer to explore new possibilities and to try new alternatives on the farm.

2. Combination of prohibitions, rules and recommendations

This frequently used system sets a strict level of minimum requirements (prohibitions and obligatory rules). They often provide an entry-scenario (with lower requirements) and an end-scenario (with high requirements). The guidelines consist of a mixture of strict rules and recommendations.

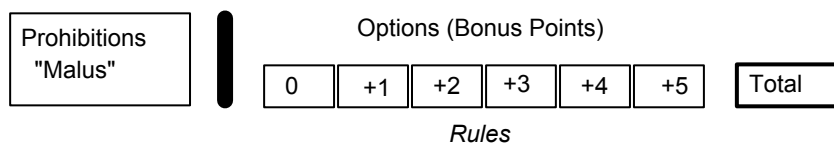


Advantages: Farms can enter an IP-program without fulfilling immediately the high standards set by national or international agencies. The transition time between entering a program through the entry-scenario and reaching the goal can be defined (e.g. 5 years) or left open.

Disadvantages: There is often a problem for the organisation to define when exactly the farmer has reached the level of receiving certificates and labels. For the public customers it is difficult to assess the quality of an IP system and of an IP product.

3. Rating systems (e.g. Bonus-Malus-System such as the Wädenswil model)

Strict prohibitions (malus points) define clearly the line between good and bad agricultural practice where farmers are either disqualified or qualified for certification. The IP-part exceeding the level of mere GAP (good agricultural practice) consists of additional bonus points or options of possibilities that are ranked according to their ecological or ethical significance (increasing bonus points given for more advanced solutions). The quality of IP programs depends on the minimum number of options or bonus points required by an IP-organisation for certification.



Advantages: The rating system allows an evaluation of the farmers achievements in essential aspects of Integrated Farming. The farmer can position his farm management according to local possibilities and constraints and can compare the results achieved with other farms operating according to the same system. The farmer is stimulated to improve continuously by trial and error, by running his own experiments and by orienting himself on the highest possible objectives.

Disadvantage: The organisation has to invest more time and care in field inspections and in the proper analysis and evaluation of the farm records.

For additional details concerning the bonus-malus-system see the following footnote*.

*Footnote

from: IOBC/WPRS Bull. 21 (1), 1998: Integrated Production in Europe

Guideline structures: National standards and regional characteristics

With the implementation of ecologically based direct payments to farmers that are opting either for IP or organic farming there is a need for the regulation and standardisation of IP guidelines by the respective governments.

National guidelines that have to cover all geographic regions of a country will contain a large number of general recommendations in order to become applicable in all situations. This situation can lead to regional differences in technical details and rules open to legal challenge.

This problem can in most cases be solved with a flexible rating or bonus-malus system that can also be used to establish regional check-lists (= inspection protocols) that consider not only basic national requirements applicable in all regions but also the specific problems of the region concerned.

Practical examples show that such a rating system contains two parts:

- The **general national requirements** as „tronc commun“ defining the basic points that must be fulfilled by every grower participating in a governmental IP-program.

The catalogue of items defines clearly what minimum requirement must be fulfilled whereby failure in one single item will lead to the disqualification of the entire farm from the financial governmental support (malus). These national requirements can cover aspects of national importance such as reduction of nitrogen and phosphorous input, reduction of soil erosion and nutrient leaching by green cover in winter time, increasing biodiversity, reduction of pesticide and herbicide input etc.

- The **regional list of ecological options** as bonus system.

Regional organisations can select additional ecological measures (particular efforts) of specific interest for the region concerned from a national list of options.

The responsible national agency will evaluate the suitability and severity level of the selected options, make necessary corrections, define the minimum number or type of options to be fulfilled by the farmer, and finally approve the regional guidelines.

Appendix 2

Minimum Requirements for the Inspection and Evaluation of Farms operating according to IOBC IP-Standards

(this document is an integral part of IOBC Guideline I)

1. Principle

All farms certified by an IOBC endorsed organisation must be supervised and their achievements monitored, evaluated and documented according to international rules.

The broad public has the right to assume that products and services provided under IOBC endorsed labels are produced by farms bound to a strict inspection and evaluation system.

2. Organisation of the inspection and evaluation activities

2.1 Inspection systems

Each IOBC endorsed IP-organisation (thereafter referred to as "Organisation") has to operate an adequate inspection and evaluation system organised according to internationally accepted principles.

In Europe these rules are defined by European Norm Standards. We refer especially to the following EN regulations that could apply in this context:

- **EN 45004: General criteria for the operation of various types of bodies performing inspection.**

This guideline refers to the aspect of inspection of the individual members by the IP-organisation

- **EN 45011: General criteria for certification bodies operating product certification**

Refers to the action by a third party, demonstrating that adequate confidence is provided that an identified product (e.g. IP-labelled product) is in conformity with a specific standard or other normative document (e.g. IOBC endorsed IP-guidelines)

- **EN 45014: General criteria for suppliers' declaration of conformity**

Addresses the possibility of e.g. an IP-organisation to produce a statement, claiming under its sole responsibility that a product (e.g. IP-labelled product), process or service (e.g. production according to IP guideline) is in conformity with a specific standard (e.g. IOBC endorsed guideline).

Where IP-organisations seeking IOBC endorsement do not employ the service of a certified outside inspection system but operate their own „in-house“ inspection that does not fulfil the requirements of EN 45004 it is highly recommended to sign a contract with a neutral and qualified third party as supervisor of the organisation's internal inspection operation. Where such a contract with an officially certified inspection service is not possible for certain reasons, a contract for supervision should be considered with an uncertified but otherwise professionally qualified official institution (such as universities, official extension services etc.) that carry out inspections on the IP organisation's own inspection activities. These supervisors might validate with their signature a declaration of conformity established by the organisation according to EN 45014.

Inspections are normally carried out by at **least two** independent persons.

2.2 Inspection tools: The check-list and the farm inspection

The Organisation has to define clearly the points to be checked in the field and to be evaluated on the basis of the submitted farm records. The corresponding **check-list** (= inspection protocol) will provide important information for the IOBC endorsement process as it is an important indicator of the Organisation's objectives, quality and credibility. The inspection protocols must be kept for at least 3 years and must be made available to IOBC upon request.

The **check-list** is the most important document of the inspection system as it describes in detail measurable parameters and general conditions of the farm management to be evaluated during visits (announced or unannounced). Check-lists have to differentiate clearly between strict rules and prohibitions on one hand and recommendations on the other hand. Bonus-malus-systems (see appendix 1) are per se useful check lists that put different weights to recommended options according to their ecological impact. Strict rules and prohibitions must be fulfilled without exceptions and transgressions (failures) occurring in this particular compartment of the check-list will automatically trigger sanctions defined in the **list of sanctions** (see Appendix 3). The check-list has to indicate clearly, how many of the listed recommendations have to be fulfilled in order to receive the IOBC endorsed certification. These inspection protocols have to be retained on file for at least 3 years and made available to IOBC upon request.

IOBC reserves the right to propose and implement improvements whenever incomplete or vaguely described control measures of the Organisation deviate from the principles and standards set by the Technical IOBC Guidelines I, II and III.

Unsatisfactory results are discussed on site with the farmer. The inspection protocol is signed by inspectors and farmer immediately after each inspection. The signature of the farmer indicates his agreement with the assessments made by the inspectors.

Disagreement with assessments made by the inspectors (especially in cases where a certain transgression of the farmer leads to the loss of certification or more severe sanctions) should be re-examined immediately by the mandatory Auditing Committee of the Organisation. In case of disagreement the inspectors have to secure perishable material or other sensitive evidence in order to allow a second examination on site by representatives of the Auditing Committee.

2.3 Evaluation of Farm Records

Farm records cover basically activities of the farmer and elements of farm management that cannot be checked or measured directly by inspection. The completeness and truth of the statements made by the farmer in his farm records have to be ascertained in the written contract between farmer and Organisation as Contractors. Transgressions in this respect have to be followed by severe sanctions defined in a list of sanctions (see Appendix 3).

The farm records have to be submitted to the Organisation by a defined deadline and have to be evaluated by the organisation or appropriate services in at least the following essential points:

- Completeness and plausibility of records taken
- Nutrient balance (N and P)
- All inputs of agrochemicals
- All disqualification criteria.

The check-lists for the farm-inspection and for the evaluation of the farm records are often combined in one single document.

3. Types of Inspection.

3.1 Farm inspection combined with advisory services

All farms must be visited **at least once per year** (field inspection) during the **transition period**. These inspections should be combined with advisory activities (discussion of problems and their solutions). Sufficient time should be allocated for this important type of farm visit.

Farms having passed successfully the transition period have to be inspected for at least one additional year. Advisory time can be reduced and the visit restricted to actual inspection. Farm documents are analysed in detail, and the results and proposals for improvement have to be transmitted to the farmer.

3.2 Policing inspection

Certified farms that continue successfully to fulfil the IOBC requirements over a given period of time **can** be transferred to a lower category of policing inspection intensity. However, IOBC recommends in principle to continue regular inspection of all certified farms whenever feasible.

Under lower inspection intensity each certified farm has to be subjected at least **once in 5 years** to an unannounced field inspection.

4. Analysis and evaluation of farm records

Whereas the reduction in inspection intensity does only concern the physical presence of inspectors on the farm (field inspection) **all farm records must be analysed in detail and evaluated** irrespective of the intensity of field inspection. The results of the evaluation have to be transmitted to the farmer.

5. Confidentiality of observations and data collected by inspection

Inspectors and evaluation specialists are to be instructed to handle with discretion all observations made during the farm visits and all information obtained and collected. Data obtained, processed and used for information and public relation work of the Organisation and of IOBC should be **coded** with respect to the identification of the member's **name and address**. The authorised officers of IOBC are subjected to the same principles of confidentiality but must have access to the uncoded and full information in pursuit of their own supervision of the Organisation's activities.

Appendix 3

List of Sanctions

(This document is integral part of IOBC Guideline I)

Each organisation endorsed or seeking endorsement by IOBC must establish a list of sanctions for transgressions and violations of rules and prohibitions established by the Organisation.

Severe sanctions (e.g. permanent or temporary loss of membership with immediate exclusion from certification) have to be established for violations of rules covered by the contract between Organisation and its individual members. Especially severe sanctions have to be applied for each type of fraud and violation of mutual trust.

Temporary sanctions (exclusion from certification for the current growth season):

Strict rules and prohibitions defined by IOBC guidelines and incorporated in the inspection protocols must be fulfilled by each member in order to receive an IOBC endorsed certification. The division into minor or major transgressions concerning strict rules and prohibitions is not permitted. In case these rules and/or prohibitions are violated the entire farm sector involved has to be eliminated from certification during the current growth season.

Accidents and unforeseen problems

Facing an unexpected severe problem at the farm level (e.g. special climatic conditions, specific pest or disease problem, specific physiological disorder of the crop) a farmer can **apply for the permission** of an intervention not included in the IP-program. The Technical Committee of the Organisation can refuse or grant this permission after careful analysis of the situation. In the case of a granted permission the entire plot of the crop concerned has to be eliminated from certification and labelling. **The same farmer can not apply for another exception for at least 3 years.**

Unique and obviously involuntary accidents (e.g. use of wrong fertiliser or herbicide) reported by a farmer successfully certified for at least 5 years can be examined and decided upon by the Technical Committee. In the case of acceptance the entire plot of the crop concerned has to be eliminated from certification and labelling.

Pesticides used with restrictions

The proper use of pesticides of the yellow list is not considered a case of transgression subjected to sanctions. However, it is requested to limit the use of these products strictly to situations where no valid and safer alternative is available.

Technical Guideline II

General IOBC Guidelines valid for all farms participating in IOBC endorsed IP-programs

This guideline defines the general requirements to be fulfilled at the farm level and to be considered in the definition of more specific guidelines III addressing the individual farm sectors. The document on "Definition and Objectives of Integrated Farming" as defined by IOBC/WPRS on March 6, 1992 is integral part of this document.

Revision of this basic document will be made in intervals not shorter than 5 years in order to allow for continuity. IOBC reserves the right to make important **additions** in shorter intervals should need arise.

Topic	Strict Rules or Prohibitions	Recommendations
<p>General Agronomic Aspects</p> <p>Annual crops</p>	<p>Timing and intensity of field operations have to minimise possible polluting effects. Low intensity of tillage/cultivation.</p> <p>Crop rotation is mandatory for both arable and mixed farming systems. A rotation has to include at least 4 different crops. An individual crop considered as part of the rotation has to cover at least 10% of the arable land.</p> <p>Guidelines III have to specify the maximum portion of individual crops in the rotation.</p> <p>- Sowing/planting aspects:</p> <p>Cultivars: resistant/tolerant against at least one of the major diseases. Timing: secure healthy crop development; limitation of weeds, pathogens and pests; minimising nutrient losses. Density: specify where crop density can reduce pest and disease problems</p>	<p>Several crops of minor importance can be added-up to obtain a total of 10%. In mountain regions and in areas with special conditions exceptions to the rule of 4 crops can be tolerated based on specific official regulations</p> <p>Alternation and mixtures of varieties. Existing official national lists of varieties are to be considered. Secure defined average yields at lowest possible crop density</p>
<p>Perennial crops</p>	<p>Cultivars and rootstock adapted to local conditions</p> <p>The system of cultivation including training and pruning has to respect the optimum physiological status of the crop plant.</p>	<p>Disease resistant or tolerant varieties</p>
<p>Unsustainable systems</p>	<p>Non-soil cultures and heated protected crops are not compatible with the principles of a sustainable production system as defined by the IOBC definition</p>	
<p>GMOs (genetically modified organisms)</p>	<p>Their use has to be defined and explicitly be permitted on a case by case basis.</p>	

Topic	Strict Rules or Prohibitions	Recommendations
Soil Fertility	<p>Sustaining and improvement of soil fertility to be achieved by:</p> <ul style="list-style-type: none"> a) definition of optimum humus level according to the characteristics of the location and its maintenance by appropriate measures b) maintaining high species diversity (fauna, flora) c) optimising bio-physical soil properties to avoid compaction (e.g. aggregate size and stability, conductivity) d) maintaining the longest possible soil protection by crop or non-crop cover e) the lowest possible soil disturbance (physical and chemical) 	<p>Bioindicators (earthworms, cellulose decomposition, predatory mites etc.)</p> <p>Adjust the sequence of annual crops to meet these demands</p>
Erosion Control	<p>Measures to avoid or to control soil erosion have to be defined for each crop based on the specific erosion potential of the region and farm.</p>	

Topic	Strict Rules or Prohibitions	Recommendations
Irrigation	<p>All measures have to be taken to minimise water loss and to optimise product quality.</p> <p>Irrigation is only justified if the available water does not satisfy the requirements of the crops concerned.</p> <p>The organisation has to provide to the farmers the specific information concerning the different crops, soil types and climatic conditions.</p> <p>The amount of applied water has to be recorded in the farm records.</p> <p>The irrigation plan has to be established individually for each plot.</p> <p>Irrigation water has to show an adequate quality and must not contain polluting elements exceeding the official tolerance levels.</p>	<p>Irrigation should utilise whenever possible local data on reference evaporation rates calculated by means of local meteo stations.</p> <p>Installation of measuring devices in every plot for the registration of the amount of water applied. The humidified area should be not less than 30% of the total surface under irrigation.</p> <p>Whenever possible combine irrigation with fertilisation (fertigation).</p> <p>Regular analysis of the water quality with respect to heavy metals, N, and Na/Cl content etc.</p>

Topic	Strict Rules or Prohibitions	Recommendations
<p>Biological Diversity and Landscape</p> <p>Ecological compensation areas</p> <p>Actions to increase biological diversity</p> <p>Field size</p>	<p>The biological diversity at all 3 levels (genetic, species, ecosystem) has to be increased actively. It is one of the major natural resources of the farm to minimise pesticide input.</p> <p>Areas for ecological compensation to cover at least 5 % of <u>entire farm surface</u> (excluding forest). They include areas with no input of fertilisers and pesticides managed ecologically (e.g. alternate cuts and provision of flowering plants, hedges, natural biotops, field boundaries, brooks and ditches, and extensified agricultural surfaces). In the case of small farms unable to fulfil this requirement it has to be shown that sufficient ecological compensation areas are present and well distributed in time and space in the municipal area thus providing a guaranteed continuity.</p> <p>The IP-guidelines III have to provide a list of at least 5 ecological options for the active enhancement of biological diversity. At least 2 appropriate options have to be selected as "must" by the farmer.</p>	<p>The surface of land with extensified production and without pesticide/fertiliser input should eventually increase to 10%</p> <p>Creation of special habitats for endangered species.</p> <p>More comprehensive lists of actions increasing biological diversity stimulate the farmer to develop the farm management to a higher degree of diversity and ecological stability.</p> <p>The lateral dimension of an individual field in annual crops should not exceed 100m. Otherwise fields should be separated or divided by annual or permanent vegetation barriers of at least 1 m width to provide adequate ecological reservoirs/buffer zones.</p>

Topic	Strict Rules or Prohibitions	Recommendations
<p>Nutrient Management and Fertilisers</p>	<p>Plant nutrients have to be provided basically via the soil. A plant nutrient allocation plan for each crop on a plot level* and over an entire rotation is required Off-farm fertiliser input has to compensate the real exportation and technical losses and aim a) in annual crops at rotational balance b) in perennial crops at annual balances.</p> <p>Major nutrient analysis of soil (every 3-10 years depending on crop) is the basis of assessing nutrient needs (except N).</p> <p>Hidden nutrient sources such as importation through polluted air (N), animal feed and mine-ralisation potential of organic soil components have to be taken into account.</p> <p>Organic materials can only have the technically lowest possible load of heavy metals and other toxicants and have to meet at least the legal regulations</p> <p>Measures to reduce nutrient losses by leaching, erosion and evaporation (e.g. ground cover, timing of soil cultivation) to be indicated.</p>	<p>Organic fertilisers are preferred</p> <p>No soil analysis = no fertiliser input. Foliar analysis as complementary test method.</p> <p>More severe limitations for heavy metal and other toxicants exceeding minimum legal requirements</p>
Nitrogen	<p>Maximum nitrogen input (expressed in kg N/ha/year) and period of application has to be defined for each crop and to be adjusted according to the soil type. The same rule applies to other nutrients with high polluting potential. Mere references to official recommendations are not acceptable.</p>	<p>N - requirements to be covered by leguminosae (biological N-fixation) to the largest possible extent while preventing any danger of leaching.</p> <p>Nmin- tests and adequate methods to measure N in the plant.</p>
Other nutrients	<p>Other nutrients have to be allocated according to actual requirements of the crop.</p> <p>Definition of application in time and location to satisfy peak demands and to improve effectiveness of fertilisation.</p>	<p>Replacement of mineral P-input through enhancement of the activity of pertinent soil organisms (e.g. Mycorrhiza).</p> <p>"Fertiliser windows" for other nutrients.</p>

*) Plot: several individual lots with the same crop can be grouped to a larger plot

Topic	Strict Rules or Prohibitions	Recommendations
Plant Protection General principles	Integrated Pest Management (IPM) is the basic strategy of crop protection. Problems must be prevented by natural regulation mechanisms and appropriate agronomic measures (= indirect plant protection). (see Appendix 4)	
Indirect measures: (Prevention)	Pest resistant or tolerant varieties or compatible mixtures of varieties to be selected to the largest possible extent.	
Antagonists	At least 2 of the main antagonist of regional importance in each crop have to be specified and their protection and augmentation be declared important.	A ranking of antagonists according to their regional importance stimulates their promotion and facilitates the choice of selective pest control measures
Risk assessment	Scientifically sound warning, forecasting and early diagnosis systems have to be utilised. They are important for the decision when direct control measures are necessary. Robust but scientifically sound threshold values are essential components for decision making.	Empirical threshold values to be replaced by scientifically sounder parameters.
Direct control measures:	Direct control measures are only applied against pest organisms above the appropriate critical threshold levels (region, farm, plot). Ecologically safer control methods such as biological, biotechnical, physical and agronomic methods are preferred to chemical biocides.	Lists with selective control techniques and products are recommended
Pesticides	Only officially registered pesticides are permitted and their intended use has to be respected. Unselective pesticides with long persistence, high volatility, leachable or with other major detrimental characteristics (e.g. stimulation of non-target pest organisms) are prohibited. For pesticides with high risk of resistance development an adequate anti-resistance management scheme has to be established. The safety regulations for pesticides are to be stressed.	Reduction of treated area. Reduction of herbicide dosage. Small untreated areas (zero treatment or "spray windows") are maintained in each crop and in each major plot/field except for arthropod pests, diseases and weeds declared as "highly dangerous/ contagious" by national authorities.
Spraying equipment	The regular calibration of the equipment by the farmer is a basic requirement. Regular and thorough service of the equipment (especially manometers and nozzles) by an authorised service station at least every 4 years	Annual field calibration of equipment as part of IP training programs. The use of spraying equipment producing the least drift and pesticide loss should be encouraged.

Topic	Strict Rules or Prohibitions	Recommendations
<p>Product Quality</p> <p>Pre-harvest</p> <p>Post-harvest</p>	<p>IP products - especially those sold under IP label have to meet required market standards.</p> <p>The necessary measures to obtain optimum product quality at harvest have to be defined for each crop taking into account actual national and international standards for external and internal quality</p> <ul style="list-style-type: none"> - to evaluate in retrospect the proper physiological status of the respective crop and the result of the IP-operation. - to demonstrate quality standards to consumers <p>Post-harvest treatments have to be specified for each crop and those eliminated that are in contradiction to the requirements of human health and request for natural products.</p>	<p>Intrinsic quality parameters should receive at least the same attention of IP producers than external quality.</p>
<p>Animal Production</p> <p>Livestock density</p> <p>Holding and care</p> <p>Nutrition</p>	<p>The welfare of the farm animals is part of the declared IP principles Procedures of animal production have to include ethical considerations.</p> <p>Maximum livestock density of 2.0 Livestock Units (LU) /ha in order to avoid excessive amounts of manure that offsets balanced nutrient cycles.</p> <p>A maximum density of 2.5 LU/ha can be tolerated if the farmer can prove that the N and P supply is balanced and that the excessive manure can be exported on a contract basis to another farm with less than 2.0 LU/ha.</p> <p>Minimum storage capacity for manure has to be defined in accordance to the regional climatic and crop requirements to allow a justified nutrient supply.</p> <p>Holding conditions for farm animals have to satisfy at least national legal regulation.</p> <p>All veterinary treatments have to be recorded.</p> <p>The nutrient content of animal feeds has to consider the actual requirements of the animals especially with respect to phosphorous and trace elements.</p> <p>Antibiotic additives (nutritional) and hormonal growth enhancers are not allowed.</p>	<p>IOBC reserves the right to add major items on short notice should need arise.</p> <p>IP-guidelines should list recommended procedures of animal husbandry that go beyond the minimum legal requirements</p>

Appendix 4

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Integrated plant protection in the context of a sustainable agriculture

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Integrated Plant Protection looks back to a longer history. In Europe IOBC played a major role in its development and implementation. A closer examination of the relevant literature does, however, reveal that the concept was not always straightforward and open to a considerable array of interpretations.

What is Integrated Plant Protection? How is it defined? These questions are frequently asked by politicians and farmers that are directly affected by the Common Agriculture Policy of the European Union, for example by the directive no. 2078/92 providing financial support for farmers participating in a program for sustainable agriculture. It is not surprising that the pioneering work of IOBC published already in 1977 has almost been forgotten. However, it merits to be re-examined to-day as it might help to clarify a certain confusion that can often be observed in political and professional circles that have not participated in the international collaboration provided by IOBC over many decades.

The basic IOBC document on „Integrated Production - Principles and Technical Guidelines“ published in 1993 addresses the aspect of crop protection as part of the technical guideline I that outlines the general technical approach without giving the background information on the rationale of the modern strategy that puts high priority on indirect preventive measures followed by direct control measures. This contribution tries to close this important gap and describes the development from early definitions of Integrated Plant Protection to the present situation.

Integrated Plant Protection: The road is not the final destination

The starting point of our review is table 1 on the evolution of plant protection methods that has been established in 1977 but still retains its basic validity.

Some 20 years ago scientists have described 4 steps in the development of plant protection with the conclusion that integrated plant protection is the most advanced step that can be reached. They separated step 4 from step 5 (Integrated Production) by a solid line indicating a sort of final destination. However, a major improvement has been made in recent years as there is common agreement that plant protection has to be removed from this isolation and put into the context of all farm operations (Boller *et al.* 1988, 1995; IOBC 1993). Therefore, we have replaced the solid line in the table by a broken one to emphasise that Integrated Plant Protection is and has to become an integral part of Integrated Production.

Tab.1.
The Evolution of Plant Protection Methods (IOBC 1977, modified)

<p>1. Blind chemical control (Lutte chimique aveugle)</p>	<p>General, schematic and routine applications of the most potent pesticides; Advice from industry</p>
<p>2. Chemical control based on advice (Lutte chimique conseillée)</p>	<p>Application of usually broad spectrum pesticides after consultation with an official advisory service</p>
<p>3. Specific control (Lutte dirigée) <i>Transitory phase</i></p>	<p>Introduction of the concept of the "economic threshold levels"; Application of pesticides with no negative side-effects; Protection of beneficial organisms</p>
<p>4. Integrated plant protection* (Protection intégrée) <i>Dynamic phase</i></p>	<p>Like specific control, in addition Integration of biological and biotechnical methods and methods of good agricultural practice; Chemical control strongly regulated</p>
<p>5. Integrated agricultural production* (Production agricole intégrée) <i>Open dynamic phase, further development possible in the whole world</i></p>	<p>Like integrated plant protection, in addition Observance, integration and exploitation of all positive factors in the agro-ecosystem according to ecological principles</p>

**) In the original table step 4 was separated clearly from step 5 by a solid line. We have replaced it by a broken line to indicate that in the modern concept integrated plant protection is removed from its isolation and put into the context of all farm operations.*

Having reviewed this evolution of methods we now can proceed to the point of our interest, namely Integrated Plant Protection in the context of Integrated Production. In this target area we can observe a high degree of vagueness and a multitude of opinions that have their roots in the definition of FAO (1967) and its later adaptation by IOBC that reads as follows:

Definition of Integrated Plant Protection
(FAO definition modified by IOBC 1977)

All economically, ecologically and toxicologically defensible methods will be applied to keep damaging organisms below economic damage levels whilst conscious exploitation of natural control factors is emphasized.

This definition leaves open space for a broad spectrum of interpretations. Many illustrations in textbooks show Integrated Plant Protection as a large range of plant protection measures arranged around the crop (e.g. Franz & Krieg, 1976). This suggests that we can make any given combination (= integration) of control methods according to our personal taste and declare it an integrated protection program. An extreme case found in the literature declares that "the principle (of integrated plant protection) consists of a combination of biological *and* chemical control methods" (Börner, 1981). Obviously, this view does no longer reflect a modern concept of plant protection in the context of a sustainable agriculture.

The modern concept that evolved in the 1980s puts emphasis on the agro-ecosystem as one of the key elements of Integrated and Organic Farming.

A clear hierarchy of priorities replaces the free combination of control methods

It cannot be the main task of plant protection to repair damages caused by inadequate farming practices. Based on these considerations IOBC has adopted a clear concept of priorities for plant protection in the context of a sustainable agriculture (IOBC 1993). The basic elements of this priority list are presented schematically in table 2.

The holistic systems approach gives highest priority to *preventive measures* that can be summarised as *indirect plant protection*. This first element includes (1) the optimal use of natural resources already in the planning stage of a new crop, (2) the elimination of all farm operations with negative impact on the agro-ecosystem (i.e. causing or enhancing plant protection problems), and (3) the protection and augmentation of natural antagonists.

Monitoring and forecasting systems as important second element provide the necessary instruments for the decision if and when the third element, namely

Direct plant protection (= control measures) has to be applied. Hence the use of pesticides is not *per se* an integral part of integrated plant protection but the last option when prevention alone does not produce acceptable results.

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Tab. 2: Plant protection in the context of sustainable agriculture
(integrated & organic farming)

<p>Indirect Plant Protection (= Prevention)</p>	<p>1. Optimal use of natural resources <i>e.g. crop adapted to local conditions; appropriate yield expectations; resistant varieties and clones; weed management with adequate intensity of competition to crop; mixtures of varieties and crops; optimal timing of sowing; optimal training systems; ecological compensation areas (= system parameters)</i></p> <p>2. Farming practices without negative impact on the agro-ecosystems <i>e.g. no surplus input of nutrients (especially N); optimal density of crop and foliage (ventilation); low intensity of tillage/cultivation and production methods protecting soil fertility; weed management (erosion control); habitat-management (green cover) to enhance biodiversity.</i></p> <p>3. Protection and augmentation of antagonists (beneficial arthropods, fungi, plants) <i>e.g. Assessing importance of individual antagonist species; inoculative releases; suppressive soils; habitat-management.</i></p>
<p>Decision to apply direct control measures:</p> <p>Monitoring & Forecasting Systems <i>Epidemiology & prognostic models (time of occurrence & risk)</i> <i>Economic thresholds and tolerance levels</i></p>	
<p>Direct Plant Protection (= Control)</p>	<p>4. Use of control measures acting exclusively upon target organisms (pests, diseases, weeds) <i>e.g. <u>Biological and biotechnical</u>: Sterile-Insect Technique; repetitive release of selective parasitoids, predators, entomopathogens (e.g. viruses) and fungal antagonists induced resistance; competitive plants, mycoherbicides and selective herbivores in weed control; <u>Selective chemicals</u>: Pheromones (e.g. mating disruption, oviposition deterrents)</i></p> <p>5. Application of less selective measures, where previous steps do not prevent economically unacceptable damage: <i><u>Semi-selective pesticides</u>: e.g. Bacillus thuringiensis, insect growth regulators (IGR), sterol synthesis inhibiting fungicides;</i> <i><u>Unselective pesticides</u>: short persistence</i></p>