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Natural Resource Management
Rural Economy
Local Governance and Civil Society

Swiss **P**roject for **H**orticultural **P**romotion in **K**osovo SPHP-K

10. December 2004

The Current Status of Vegetable Management Practices in Kosovo, with Special Emphasis on Cabbage (*Brassica oleracea var. capitata)* and Tomato (*Lycopersicon esculentum*)

Integrated Crop Management Intervention

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Executive Summary

In order to improve the production of vegetables in Kosovo, new production techniques such as Integrated Crop Management (ICM) are considered. A prerequisite for the development of an appropriate ICM strategy is to evaluate the current situation regarding crop management. Therefore, the current status of crop management practices for two selected crops, namely cabbage (*Brassica oleracea var. capitata*) and tomato (*Lycopersicon esculentum*), was determined.

Data were collected from fields belonging to small-scale farmers in three different regions of the Kosovo (Xerxe, Krusha e Madhe and Mamusha). All together, six fields were surveyed weekly during a time period of 18 weeks in order to monitor the pest and disease status. Additionally, information on cultural practices as well as on economical and ecological aspects was gathered using both semi-structured interviews and direct observation.

Soil samples from all field plots were taken in order to determine the soil type and structure. Analysis of these samples showed that in all surveyed fields the rate of loam is high. PH-value of the soil samples was neutral to slightly basic; salinity was in a normal range. The soil sample analysis demonstrated that the rate of humus, and as a consequence the soil fertility, was on a low level. This is probably due to the fact that most of the farmers never add organic matter.

Although farmers try to obtain high-quality seeds from respectable seed producers, which should show for instances in the case of tomato seeds resistance against various diseases. Nonetheless, the outcome of these seeds is low: a relatively high rate does not even germinate, or seedlings become weak and sensitive to diseases after a short time period. Based on interviews, farmers assume that the seed quality is much lower than it is supposed to be.

Sowing of cabbage seeds takes place in January and February each year. Considering the climate in the Kosovo, this is early in the year, and could be another reason for non-germinating seeds or weak seedlings. Kosovo summers are rather dry; therefore vegetables have to be irrigated regularly. Irrigation often takes place around mid-day, when temperatures and sun are high. The yield of both cabbage and tomato production is extremely high. For cabbage production, up to 110 tons/ha are harvested. For tomato production yield amounted for 95 tons/ha. A possible reason for the high yield is, among others, the high input of mineral fertilizers.

Crop rotation appears to be not a common practice in the Kosovo. Even though randomly other crops from other plant families were grown on the same plots these last years, none of the farmers did this being aware of the importance of crop rotation. Based on the farmer interviews, it can be concluded that none of them did a crop rotation planning.

The weekly monitoring of pests and diseases showed that aphids, flea beetles and bugs are amongst the most frequently occurring insect pests in cabbage. In tomato, the presence of aphids was dominating. Both cabbage and tomatoes showed symptoms of diseases. In cabbage, symptoms of *Peronospora parasitica* dominated, whereas in tomato *Phytophthora infestans* as well as *Alternaria solanii* were identified. Pesticides were used in high frequency. Preventive spraying or ‘calendar’ spraying – the practice to apply pesticides at regularly scheduled time periods – is a common practice. At the monitored field plots, farmers reported that pesticides do not always show the expected impact. They assume that, due to lack of certification, low quality chemicals are sold as high-quality pesticide products. Considering the graveling low price of chemical pesticides in this Kosovo, this assumption is most likely by all means.

Interviews with farmers revealed that an enormous input of mineral fertilizers is a common practice, particularly for cabbage production. The applied fertilizers contain N, P and K, while other important elements such as the trace element Mg are completely neglected. Organic matter is added only occasionally but mostly not at all. Covering the soil in between vegetation periods, using cover crops such as nitrogen fixing plants to improve soil fertility is not a common practice amongst the interviewed farmers.

Investment costs contain costs for seeds, fertilizer, pesticides, irrigation, soil preparation and post harvest costs. Pesticides are extremely cheap and therefore are not an important factor, whereas costs for seeds as well as fertilizers are high. Seeds and fertilizers carry most weight, but based on direct observations there is a high potential for reduction.

Due to the high input of fertilizers and pesticides an impact on natural resources, flora and fauna is expected.

Taken into consideration the above-mentioned results obtained through monitoring surveys and farmer interviews, various changes in crop management are needed in order to go towards a more sustainable ICM approach.

Monitoring surveys showed that the awareness for sustainable agriculture is currently on a low level among farmers. Farmers are solely interested in having a high yield, and if possible with less input. Though, in order to go towards a more sustainable agriculture, it is not enough to reduce the amounts of fertilizers and pesticides. Other measures such as the recommended crop rotation, proper seedbed management and other issues must be tackled.

A first step in this direction is certainly awareness creation for ICM in the Kosovo. Farmers must become aware about the agro-ecosystem in their fields. They must become aware that the use of high amounts of fertilizers and pesticides would lead to fewer yields in future, since soils would emaciate more and more and pests would become resistant against pesticides. They must also become aware that the use of high amounts of fertilizers and pesticides has a grave impact on their health but also on the health of the consumers.

Acknowledgements

I am very grateful to the ICM Focus Group: Hazer Susuri, Maxhun Shehaj, Samir Riza and Basri Pulaj as they received me cordially and supported me whenever it was necessary.

I also wish to acknowledge the staff of Intercooperation (Petrit Dujaka, Gëzim Babalia, Squipe Shala, Nora Gola, Luan Hoti, Magbule Hyseni, Faton Nagavci, and particularly Robert Berlin) for giving me this opportunity to gain experiences as a Junior Professional Officer in this project. It was both interesting and challenging to start with the ICM project in order to improve current agricultural practice and thereby potentially improve farmer's and consumer's health through reduced chemical inputs. I appreciate the willingness and contributions of farmers in Xerxe (Agim Kryeziu), Krusha e Madhe (Isa Haliti, Isa Dina), and Mamusha (Hivzi Mazrek, Esat Mazrek), which were crucial for implementing my work.

I also wish to acknowledge CABI Bioscience Switzerland Centre, and especially Dr. Ulrich Kuhlmann and Beate Kiefer, for technical support and backstopping.

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1. Introduction

In 2001, Intercooperation was mandated by the Swiss Agency for Development and Cooperation (SDC) to implement the Swiss Project for Horticultural Promotion in Kosovo (SPHP-K). The objective of this project is to support Kosovo horticultural producers to better compete in quality, price and continuity of supply with imported products. The focus is on market-oriented producers in selected areas with enabling conditions (land, water, access to the market, etc.). The horticultural producers will enhance productivity – develop new production, processing and marketing practices, and access providers for the appropriate delivery of services.

The necessity to promote a more ecological way of production has been identified from the beginning and therefore several trainings have been organized locally and abroad to promote Integrated Crop Management (ICM). An ICM Focus Group has been created within the project including one local specialist from the Ministry of Agriculture (MoA). In addition, contacts with CABI Bioscience Centre in Delémont, Switzerland, were established with the aim to develop a concept promoting and implementing ICM in the Kosovo. In order to develop and, later on, implement such an ICM concept it was necessary to evaluate the current situation regarding the occurrence of pests and diseases as well as reviewing current management practices.

Therefore, Urs Zehnder was assigned to evaluate the current crop management situation for two selected crops and to define how ICM could be introduced to these crops. Within a one-month preparatory work at CABI Bioscience Switzerland Centre information about common pest and disease problems in the Kosovo region was gathered. Within the framework of a workshop with the newly established ICM Focus Group two crops, namely cabbage and tomato, were chosen in agreement with IC representatives. During the seven months of fieldwork, a monitoring system, which allows monitoring the occurrence of pests and diseases on the nominated crops, was installed. Furthermore, current management practices in the nominated crops were documented and analyzed using a semi-structured interview concept developed for farmers. As mentioned before, surveys focused mainly on cabbage and tomato production. While monitoring of pests and diseases is very crop-specific, results of crop management practices may be applicable to other crops as well. Since cabbage and tomato played a crucial role within the monitoring survey, information about these two crops and their importance in the Kosovo, will be given in the following Para Figures.

Cabbage belongs to a large and diverse family of plants called the Brassicaceae (Cruciferae). This family contains a wide range of crops including cabbages, cauliflower, kales, Brussels sprouts and broccoli. There are two main species of cultivated cabbage: the white or head cabbage *Brassica oleracea* (variety capitata) and the Chinese cabbage *Brassica rapa* (sp. *Chinensis*), although there are currently many varieties of both species grown. The Brassicaceae family contains many wild plants of which some are important weeds while others may harbor pests, enabling them to survive from one susceptible crop to the text.

Cabbage production: Cabbages are grown all over the world, and are an important component in the diets of millions of people in Africa, Asia, United States, Europe and the former Soviet Union. In 2000, the world production was about 52.3 million tones of which over a third were produced in China. Kosovo produced 27,500 tons cabbage in the year 2003. Cabbage grows best on light to medium-heavy soils at an optimum pH of 6.0–7.5. They are grown from seeds and often raised in nurseries and transplanted out into the field when the seedlings are about 3-5 cm tall.

Crop development: Presently there is no standard terminology for the description of cabbage growth stages like there is for some other crops such as rice. Although terms such as “head formation” and “cupping” do exist, it can be confusing because this terminology is often regional and can vary among farmers and others involved in agriculture. Accurate cabbage growth stage descriptions are particularly useful in pest management since the plant susceptibility to cabbage pests varies with growth stage (seedling, vegetative, head formation and mature stage).

Pests: Pests have an important impact on cabbage production in most cropping area. The CABI Crop Protection Compendium lists 148 insects and diseases attacking cabbage. Fortunately, only a small number of these cause severe damages and is thereby of economic importance.

Tomato (*Lycopersicon esculentum* Mill.) belongs to the Solanaceae. In less than a century, tomato has become a major world food crop. The tomato, considered a vegetable but actually a fruit, is native to the South America.

Tomato production: The total area of tomato planted worldwide in 1996 was about 3.1 million ha, resulting in 84 million tons of tomatoes. Tomatoes were usually produced in the open field. Since they are not very well adapted to harsh climate and are rather susceptible to diseases when conditions are favorable, many growers in temperate climate zones, particularly in ICM and biological production, grow them in tunnels or greenhouses. The leading country in tomato production in 1996 was China with a production of 13.6 million t tomatoes. Most of the world trade tomatoes are produced in the Mediterranean region, in the USA and South and Central America. In 2003, Kosovo produced 48,050 tons of tomatoes.

Crop development: Tomatoes complete their life cycle, from seed to seed, within one season. Tomatoes are usually grown for a few months, although they can be cropped for 24 month or longer when growing conditions (water, fertilization, etc.) are optimal and diseases or insect pests do not exhaust the plants. General growth stages for tomato are as follows: 1) seedling stage: 0-45 days after sowing (DAS) (period from emerging to transplanting); 2) vegetative stage: 0-25 days after transplanting (DAT) (transplanting until first flower buds develop); 3) flowering stage: 24-45 DAT (plant with flower buds and open flowers); 4) fruiting stage: 45+ DAT (plant with small to full-sized fruits); and 5) harvesting stage: 55+ DAT (period when plant yields mature fruits).

Pests: The CABI Crop Protection Compendium lists 485 insects and diseases attacking tomato. Fortunately, only a small number of these are of economic importance. Whether the attack of insect pests or diseases will lead to economic loss partly depends on growth stage of the plant. Injury to the older leaves at a stage in crop development for example, will not influence the final yield. Tomato plants can compensate for a lot of injury by producing more leaves, new shoots or bigger size fruits.

In this report the current crop management of cabbage and tomato production in the Kosovo is presented based on a monitoring and farmer interview approach. The report is structured according to parameters (location, crop protection, crop rotation and others) which will make-up the components needed for an ICM concept such as published by the International Organization of Biological Control (IOBC). In the chapter ‘Crop Management – Current Status in Kosovo’, the results of the monitoring surveys and farmer interviews are presented. This chapter is structured in different sections following the above mentioned ICM concept components with a section named “Location” (which represents a component in the IOBC ICM concept), followed by “Seeds/ Varieties”, “Crop Husbandry”, “Crop Rotation”, “Crop Protection”, “Nutrition/ Fertilization”, “Economy”, and finalizing with a chapter entitled “Ecology”. In each section the objectives, methods used, results obtained, and the conclusions made as well as recommendations are provided. These recommendations are excerpts from the published IOBC guideline on international ICM-standards.

2. Methodology

The overall aim of this study was the evaluation of the current crop management practices used in cabbage and tomato production in Kosovo.

Field plots from small-scale farmers were chosen in the major traditional vegetable production area Dugagjini, in the southwest of Kosovo. In this area, three regions were chosen: Xerxe, Krusha e Madhe and Mamusha. In each of the three regions one cabbage as well as one tomato field plot was selected. The size of the plots varied between 1,100 and 2,200 m². Originally the idea was to have three plots (including a control) for each crop in order to compare the effect of different pest management strategies on the occurrence of major insect pests and diseases. Based on local technical considerations, all field plots were treated with pesticides, which means that results for untreated control plots are missing.

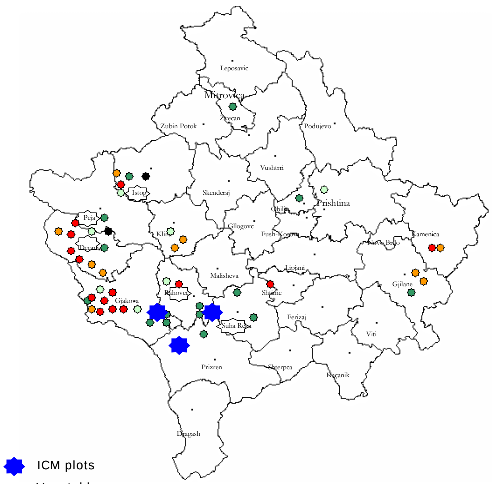


Figure 2: Locations of Inter-cooperation activities in Kosovo.

Although the scheme below shows certain components, which are determining ICM, it can also be used in order to evaluate the current status of crop management, and, consequently, what might be needed to improve agricultural practices leading towards the implementation of ICM in the Kosovo.

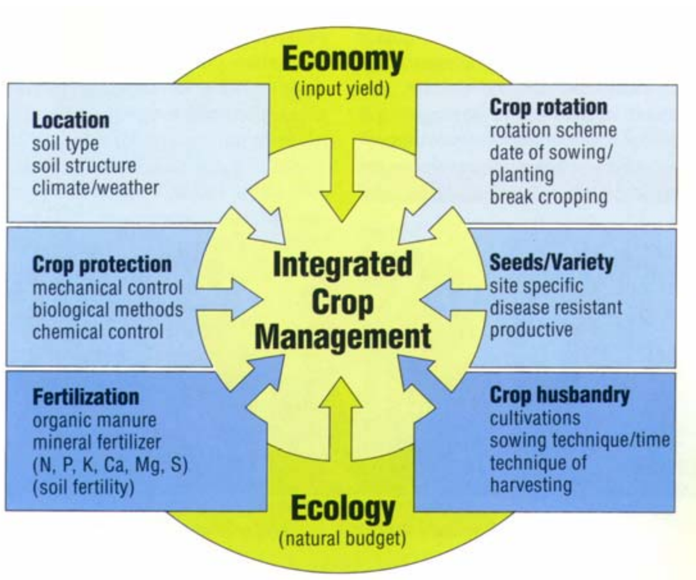


Figure 1: Components and Parameters of Integrated Crop Management (ICM) developed by the International Organisation of Biological Control (IOBC). (www.google.ch/imagesICM)

Starting with the assumption that with the components and parameters in the scheme presented, current crop management can be described, information about all these parameters had to be gathered. In addition to these management practices, a regular monitoring of insect pests and diseases was carried out. As mentioned above, this monitoring has its limitations, since it was done in treated field plots.

Different techniques were used to gather the required information:

- Monitoring of insect pests and diseases:
  Plants of all six plots were monitored in weekly intervals for 18 weeks, starting in May. Therefore 5 spots in each field were chosen along a diagonal line from one corner of the field to the opposite corner. Distances between the spots were approximately the same. At each spot, ten successive plants in that row were checked for presence of insect pests or diseases. If insect pests were present, they were identified and their numbers were noted. For each insect, an average per plant was calculated.

- Semi-structured interviews:
  In order to encourage a two-way communication, a semi-structured interview was used. This technique allowed gathering information on crop management practices such as time and amount of pesticide- and fertilizer application, crop husbandry, used varieties, investment costs etc. The farmers of all the six field plots were met at least ten times each. Using this technique, not only quantitative and qualitative information was obtained, but also a range of insights on specific issues was gained.

- Yield measurement:
  Cabbage: At harvest time, randomly ten plants per field plot were weighed in weekly intervals. Considering the planting density, the total yield per ha was determined.
  Tomato: At harvest time, each week eleven tomato plants were chosen. All crops of the chosen plants were weighed. Considering the planting density, the total yield per ha was determined.

- Soil analysis:
  In each plot, soil samples of the A-Horizon (0 to –30cm) were taken. A certified laboratory in Switzerland (Eric Schweizer Samen AG) analyzed these soil samples. For comparison of results, soil samples of one location were additionally analyzed by the Institute of Agriculture in Peja.

3. Crop Management Practices in Kosovo

In this chapter the current Crop Management Practices in Kosovo are described. This report is structured according to parameters (location, crop protection, crop rotation and others) which will make-up the components needed for an Integrated Crop Management (ICM) concept such as published by the International Organization of Biological Control (IOBC).

Based on the IOBC definition, ICM is a method of farming that balances the requirements of running a profitable business with responsibility and sensitivity to the environment. It includes practices that avoid waste, enhance energy efficiency and minimize pollution. ICM combines the best of modern technology with some basic principles of good farming practice and is a whole farm, long-term strategy.

ICM is a 'whole farm approach', which is site specific and includes:

- Careful choice of seed varieties
  The choice of the seed variety can have an important impact on the crop. Not only the productivity, taste, size and colour are determined by the choice of the seeds, but also susceptibility to insect pests and diseases depends on the choice of seeds. Seeds have to be chosen considering the local conditions.
- Appropriate cultivation techniques
  The careful preparation of the soil, proper seedbed management, transplanting technique, planting density etc all play an important role in order to grow a healthy crop.
- The use of crop rotations
  Crop rotation is probably the most efficient cultural practice to avoid diseases, and also to maintain fertile soils
- Minimum reliance on artificial inputs such as fertilizers, pesticides and fossil fuels
  Although artificial fertilizers are widely used to add nutrients to the soil, soil fertility decreases in the long run, if they are used without simultaneous provision of organic material. Both artificial fertilizers and chemical pesticides have a negative impact on the environment and human' health
- Maintenance of the landscape and the enhancement of wildlife habitats

In short, ICM balances the demands of the consumer for high quality produce with the needs of farmers to make a profit, and the desire of both to protect the environment.

This chapter is structured in different sections following the above mentioned ICM concept components, starting with a section named “Location” (which represents one of the component in the IOBC ICM concept, refer again to Figure 1), followed by “Seeds/ Varieties”, “Crop Husbandry”, “Crop Rotation”, “Crop Protection”, “Nutrition/ Fertilization”, “Economy”, and finalizing with a chapter entitled “Ecology”. In each section the objectives, methods used, results obtained, and the conclusions made as well as recommendations are provided. These recommendations are excerpts from the published IOBC guideline on international ICM-standards.

3.1. Location

The Location is an important parameter for a successful crop management. Every location is characterized by its climate conditions, its soil type and structure.

3.1.1 Objectives

The objective of this chapter is therefore to review published information about climate conditions, information on the soil, as well as their consequences on crop production.

3.1.2 Methods

Information about the climate was obtained using both literature (Graf Hoyos C. et al. 2002) and direct observations. In order to obtain information on the soil, soil samples from all six sites were taken. 10-14 samples per plot from the A-Horizon (0 to –30cm) were taken using a soil-sampling tool. These samples were analyzed by a certified laboratory in Switzerland (Eric Schweizer Samen AG, Thun). Soil samples of one location (Mamusha) were additionally analyzed by the Institute of Agriculture in Peja, Kosovo.

3.1.3 Results

Climate / Weather

Kosovo lies within the Grande Balkan high plain complex, between latitudes 42N and 43N. At these latitudes, the country experiences a western central continental climate. Agro climatic criteria would divide Kosovo into 2 major zones. The central plain is split into two major valleys: the Dugagjini to the west through which the largest river in Kosovo, the Drini, flows south to drain through Albania. In this area are all of the six field plots located (Xerxe, Krusha e Madhe and Mamusha). Winter daylight under normal cloud cover is weak and does not extend beyond an average of nine hours in length, while mid-winter light is of low intensity and general restricted to the growth of most commercial food crops. Winter night temperatures can reach lows of around –20 degrees centigrade. All these phenomena restrict growth, for a period of some 2 to 2.5 month. Low night temperatures are a total constraint to nearly all plant growth ceases at 4 degrees C.
Conversely during the summer period temperatures in excess of 34 degrees C will equally restrict growth. There are, therefore, climatic restrictions to both winter and summer plant growth. The Hydro-meteorological Institutes for Kosovo show that the country receives a very equable bi-modal rainfall regime, peaking in November/December and again in May, with the lowest precipitation received in March and August.

Average annual rainfall varies from a high of 980 mm/annum to a low of 593 mm/annum in Gjilan. The absolute Maximum and Minimum Temperatures are measured over 25 years. The absolute minimum temperature was measured in Gjilan (-32.5 degrees C) and the maximum temperatures were measured in Prizren (38.9 degrees C).

Soil type and structure

Results of the soil analysis from the cabbage plots are summarized in the Table 3.1.3a/b. A humus concentration varying between 4 to 4.5% was found by the laboratory in Switzerland. The Institute of Agriculture Peja identified the humus concentration in Mamusha by 3%. The amounts of clay and silt determine the soil types. The percentage of clay was between 21 and 26%, the percentage of silt was 31%. This results in a loamy soil type.

The soil map of Kosovo specified the soils as Loamy alluvium, Meadow loamy soil and Sand-loamy alluvium. In all locations, the pH-value was similar: neutral in Krusha e Madhe (pH 7.1) and slightly alkaline in Xerxe and Mamusha (pH 7.5 and 7.7). The salinity shows a value from 33 to 45 mg/100g.

Table 3.1.3a: Results of Soil Analyses of the cabbage plots.

Parameter	Unit	Xerxe	Krusha e Madhe	Mamusha
Humus	%	4	4.5	4.5 (3.0)
Clay	%	21	26	26
Silt	%	31	31	31
pH-value		7.7	7.1	7.5 (7.6)
Salinity	mg/100g	33	37	45
Soil Type		Loam	Loam	Loam
Soil type according to the Soil Map Kosovo		17 Loam alluvium	29 Meadow loamy soil	16 Sand-loamy alluvium

() Results of soil analysis done by the Institute of Agriculture Peja, Kosovo.

Results from soil analysis of soil from tomato plots are summarized in table 3.1.1b. The rate of humus varied between 4 and 4.5%. When the Institute of Agriculture in Peja analyzed soil samples, the humus fraction was much lower and ranged at 2.5% for Mamusha. The amount of clay and silt are indicators for the soil types. The rate of clay was between 26 and 31%, the rate of silt was constantly 31%. While in Krusha e Madhe as well as in Mamusha the soil type is loam, soil type in Xerxe is clay loam due to the higher fraction of clay. The soil map of Kosovo defines the soils as Loamy alluvium, Meadow loamy soil and Sand-loamy alluvium. Showing pH-values between 7.3 and 7.6,the soil of all three locations is slightly basic. While the salinity in the location Krusha e Madhe and in Mamusha is normal (42-45 mg/100g), salinity of the tomato plot in Xerxe is rather high (89 mg/100g).

Table 3.1.3b: Results of Soil Analyses of the tomato plots.

Parameter	Unit	Xerxe	Krusha e Madhe	Mamusha
Humus	%	4.5	4	4.5 (2.5)
Clay	%	31	26	26
Silt	%	31	31	31
pH-value		7.5	7.6	7.3 (7.8)
Salinity	mg/100g	89	45	42
Soil Type		Clay Loam	Loam	Loam
Soil Type according to the Soil Map Kosovo		17 Loamy alluvium	29 Meadow loamy soil	16 Sand-loamy alluvium

() Results of soil analysis obtained by the Institute of Agriculture Peja, Kosovo.

Results of soil analysis obtained by the laboratory in Switzerland and the Peja Institute are different. Since the laboratory in Switzerland uses Good Laboratory Practices (GLP) and updated, standardized labor techniques, their soil analysis might be more reliable.

3.1.4 Conclusions

- With 593-980mm / annum rainfall the water resources are limited and the crops have to be irrigated during summer period. The temperatures (<4 degrees C and >34 degrees C) restrict growth for a period of around 3 month in the Kosovo.
- The soils of all six plots show a low fraction of humus. Though, humus is extremely important to the successful growth of plants of all kinds because it tends to promote a more favorable soil structure. When a sod cover remains on the soil for two or more years, the soil is greatly improved both by the organic residue and the fibrous root system. Humus increases the water-holding capacity of the soil, lessens erosion, decreases the loss of valuable minerals by leaching, and makes the soil easier to cultivate.
  Organic matter can be added to the soil using various methods, for example: Cover crops, green manure, organic mulch or compost. Cover crops are crops (often a legume crop such as clover or soybean) planted during a fallow period in order to avoid erosion of the soil. When these cover crops are cut and ploughed into the soil to increase the organic matter and fertility of the soil, they are called green manure. Organic mulches can be any organic material placed on the soil surface to protect the soil from heavy rain, wind, and water loss. They are not only used to reduce erosion, but also to control weeds.
- Soil of all locations is loamy. While loam is known to have a medium intake rate, high water retention, moderate drainage and a low erosion rate; clay loam has got a moderately low intake rate, high water retention, average drainage and average erosion.
- Soil fertility is directly influenced by pH through the solubility of many nutrients. At a pH lower than 5.5, many nutrients become very soluble and are readily leached from the soil profile. At high pH, nutrients become insoluble and plants cannot readily extract them. Maximum soil fertility occurs in the range 6.0 to 7.5. All three locations have neutral or slightly basic pH-values and therefore are appropriate for cabbage and tomato production.
- The soil salinity is normal (33 to 45mg/100g) to low increased (89mm/100g). The salt concentrations have a big impact to the flora and fauna;

3.1.5 Recommendations

- For new cultivation sites there must be a risk assessment of documented food safety, operator health and environment that takes into account prior use of land, type of soil, erosion potential, quality and level of ground water, availability of sustainable water sources, and impact on and of adjacent area;
- When the assessment identifies a non-controllable risk that is critical to health and/or environment, the site must not be used for production. There should be a corrective action plan, setting out the measures to minimize all identified (and controllable) risks in new agricultural sites;
- Sustaining and improving soil fertility must be achieved by;
  - Definition of optimum humus level according to the characteristics of the location and its maintenance by appropriate measures;
  - Maintaining a high diversity of fauna and flora species. The use of bioindicators, (earthworms, cellulose decomposing organisms, predatory mites etc), is to be encouraged;
  - Optimizing biophysical soil properties, (e.g. aggregate size and stability, conductivity), to avoid compaction. The sequence of annual crops should be adjusted to meet these demands;
  - Maintaining the longest possible soil protection by crop or non-crop cover;
  - Arranging for the least possible soil disturbance (physical and chemical);

- Cultivation technique must be appropriate for soil type; cropping, topography, erosion risk and climate in order to sustain and improve soil fertility;
- Farm machinery should be chosen in order to reduce soil compaction and preserve organic matter, to improve the efficiency and effectiveness of mechanical weed control and agrochemical applications, and to reduce fuel consumption;
- Low intensity cultivation is preferred. In regions with leaching and **erosion** risks, an appropriate soil cover, (with adequate N-uptake capacity), must be maintained;
- In very sloping areas, soil protection can also be achieved with contour cultivation and/or terraces;
- Measures to avoid or control soil erosion should be defined for each crop based on the erosion potential specific to the region and farm;
- Where erosion damages are visible, a plan for corrective actions must be established and implemented;

3.2 Seeds / Varieties

The choice of the seed variety can have an important impact on the crop. Not only the productivity, taste, size and colour are determined by the choice of the seeds, but also susceptibility to insect pests and diseases depends on the choice of seeds. Seeds have to be chosen considering the local conditions.

3.2.1 Objectives

In this chapter, the used seed varieties and their origin will be assessed.

3.2.2 Methods

Information on varieties, producers and intermediaries was obtained using a semi-structured interview. Detailed information about these varieties, regarding the productivity plants/ha, the weight, the yield kg/ha and the resistance or tolerance, was obtained from literature (S&G and Seminis Catalog).

3.2.3 Results

Farmers buy their cabbage seeds in Agriculture Shops. Mainly hybrid seeds from well-known seed producers such as S&G and Royal Sluis are used. Cabbage producers in Krusha e Madhe and Mamusha used the variety Grenadier, while the farmer in Xerxe used a white cabbage F1 Hybrid. These two different varieties have similar characteristics. Users of both varieties are advised to plant 40-60000 plants per hectare (4-6 plants/m^2). The expected weight of a cabbage head is between 1.5 – 2.5 kg. In case the recommended planting density is respected, a yield around 42'500 kg/ha can be expected. The used cabbage seeds are not resistant or tolerant against pests or diseases in the genome.

Table 3.2.3a: Used Cabbage Seeds.

Cabbage	**Xerxe**	**Krusha e Madhe**	**Mamusha**
Company	Royal Sluis	S&G	S&G
Variety	White Cabbage F1 Hybrid	Grenadier	Grenadier
Rec. no. of pl/ha	40-60000	40-60000	40-60000
Cabbage weight in kg	1.5-2.5	1.5-2.5	1.5-2.5
Yield t/ha	∅ 42,5	∅ 42,5	∅ 42,5
Resistance	No resistance	No resistance	No resistance

Farmers buy their cabbage seeds in Agriculture Shops. All the farmers used the same hybrid: the variety Amati F1 from Royal Sluis. This variety is characterized by the following data: farmers are recommended to plant 22500 plants per hectare (2-2.5 plants/m^2).

The expected weight of a tomato fruit is about 180-220g. When recommended planting density is respected, yield should be around 65000 kg/ha. The used cabbage seeds show resistance or tolerance against six pests and diseases. This variety is resistant against the Mosaic virus, the *Verticilium* wilt, *Fusarium* wilt, *Cladiosporium fulvum*, and Nematodes.

Table 3.2.3b: Used Tomato Seeds.

Tomato	**Xerxe**	**Krusha e Madhe**	**Mamusha**
Company	Royal Sluis	Royal Sluis	Royal Sluis
Variety	Amati F1	Amati F1	Amati F1
Rec. no. of pl/ha	22500	22500	22500
Tomato weight in g	180-220	180-220	180-220
Yield t/ha	∅ 65	∅ 65	∅ 65
Resistance	Tm, V, F1, F2, C5, N	Tm, V, F1, F2, C5, N	Tm, V, F1, F2, C5, N

Tm Mosaic virus, **V** Verticilium wilt, **F1** Fusarium wilt, physio 1, **F2** Fusarium wilt, physio 2, **C5** Cladiosporium fulvum, physio 1-5, **N** Nematode

Although farmers try to obtain high-quality seed from well-known seed producers, they are doubtful that the quality of these seeds is as high as it is supposed to be. Some of the farmers stated that germination rate is low; others doubt that their plants are resistant against major diseases and pests.

3.2.4 Conclusions

- All farmers use hybrid seeds from well-known seed-producers. Since they cannot produce hybrid seeds, they are dependent on imported seeds from local Agriculture Shops. However, some of the farmers appear to be not satisfied with seed quality. It remains unclear whether the quality of the seeds is limited or for instances low germination rate is a result of not using appropriate sowing techniques.

3.2.5 Recommendations

- A national list of cultivars has to be developed;
- Cultivars should be chosen that provide a good general health and that **are resistant or** tolerant to major diseases and pests;
- The cultivars chosen should meet the specified requirements of the market, (e.g. quality standards including taste, visual appearance, shelf life, agronomic performance and minimum dependence on agrochemicals);
- The grower must inspect all propagation material to make sure that it is free of pests and diseases;
- Infested material must not be used;
- Purchased material must be accompanied by plant health certificate and kept available for subsequent inspection;
- Alternation and mixtures of cultivars are recommended, where appropriate;

- A seed record/certificate of seed quality, variety purity, variety name, batch no. and seed vendor must be kept available;
- Sowing and planting aspects:
  Timing can help to secure healthy crop development, to limit negative impact of weeds, pathogens and pests and minimize nutrient losses;
  Density: Defined average yield expectations should be obtained by lowest possible crop densities. Crop specific guidelines III (www.iobc.ch) specify circumstances in which crop density can reduce pest and disease problems.

3.3 Crop Husbandry

Crop husbandry comprises practices from sowing to harvesting. Key points are cultivation techniques such as seedling production, the timing of the crop cultivation, the soil preparation, the crop irrigation, the planting density on the open fields and the technique of harvesting. Information about the crop protection, fertilization and crop rotation is presented in separate chapters.

3.3.1 Objectives

The objective was to determine the current management practices regarding both seedling production and production in the open field.

3.3.2 Methods

Information on crop husbandry practices was mainly gathered by semi-structured interviewed with the farmers. Additionally, weekly visits of all the field plots allowed observing seedling production, plant stages, plant density, irrigation techniques, as well as techniques of soil preparation and harvesting.

In order to compare the number of invested seeds to the number of obtained plants in the open field, the weight of used seeds was measured. Using the *Handbuch Gemuese 2004*, the number of expected seedlings was calculated. The number of expected seedlings was then compared to the number of existing plants in the open field.

In order to get information about the planting density, all the field plots were measured and plants were counted.

The measurement of the yield was done in the following manner:

Cabbage: At harvest time, randomly ten plants per field plot were weighed in weekly intervals. Considering the planting density, the total yield per ha was determined.

Tomato: At harvest time, each week eleven tomato plants were chosen. All crops of the chosen plants were weighed. Considering the planting density, the total yield per ha was determined.

3.3.3 Results

Seedling production; Cabbage & Tomato

Observed practices in the seedling production:

- The cabbage and tomato seedlings are produced in seedbeds in tunnels or glasshouses
- Before sowing, the farmers add around 1 cm of organic matter, a mixture of forest soil and cow manure, to the seedbeds
- The cabbage and tomato seeds are sown directly on the prepared seedbeds
- After 8 to 11 weeks for cabbage and 5 to 6 weeks for tomato, the seedlings are collected by hand and transplanted to the open fields
- The seedlings were not treated with any pesticide during the seedling production

For the calculations of the productivity in the seedling production the following assumptions, based on the *Handbuch Gemuese 2004,* were made:

Cabbage: 200-330 seeds/g
→150 seedlings/ g seeds
Thousand-corn weight is between 3-5g

Tomato: 260-350 seeds/g
→220 seedlings/ g seeds
Thousand-corn weight is between 2.8-3.8g

A comparison of expected seedlings and actual seedlings is visualized in the Figure 3.3.3a.

The '*Handbuch Gemüse 2004'* assumes for cabbage 150 seedlings per 1g of seeds. Though, the number of seedlings, which farmers obtained, is much lower. While the cabbage farmer in Mamusha still got more than half of the expected amount, the cabbage farmer in Xerxe needs three times more seeds to reach the expected amount. In the seedling production of tomato, 220 seedlings are expected per 1g tomato seeds. The farmer in Krusha e Madhe still achieved 181 seedlings per gram, while the farmer in Xerxe got 118 and the farmer in Mamusha only got 55 seedlings out of 1g seeds.

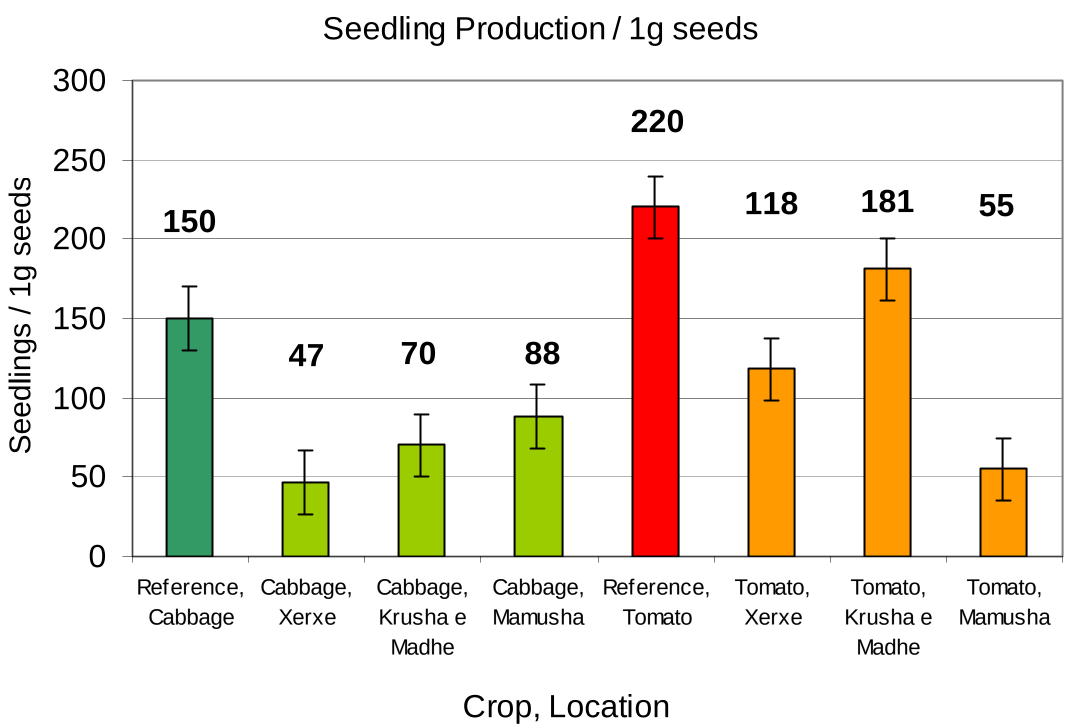


Figure 3.3.3a: Seedling production for cabbage and tomato.

In the Table 3.3.3b, actual numbers of obtained cabbage seedlings is compared to the expected number of seedlings. The ratio shows again that only 31%, 47% and 59% from the expected number of seedlings were obtained in cabbage production.

Table 3.3.3b: Productivity in cabbage seedling production.

Cabbage	**Xerxe**	**Krusha**	**Mamusha**
Used seeds in g / plot	100	100	100
Expected Seedlings	15000	15000	15000
Produced Seedlings	4656	6994	8777
Productivity in %	**31**	**47**	**59**

The Table 3.3.3c shows again the actual productivity of cabbage seeds. The ratio indicates, that in one case, 82% of the expected amount could be reached, while in the two remaining locations, only 54% and 25% of the expected seedlings were obtained.

Table 3.3.3c: Productivity tomato seedling production.

Tomato	**Xerxe**	**Krusha**	**Mamusha**
Used seeds in g / plot	40	15	100
Expected Seedlings	8800	3300	22000
Produced Seedlings	4736	2712	5460
Productivity in %	**54**	**82**	**25**

Cabbage Production

The sowing of cabbage seeds took place between January 15 (Week 3) in Xerxe, February 2 (Week 6) in Mamusha and the February 15 (Week 7) in Krusha e Madhe. Farmers cultivated the seedlings between 8 to 11 weeks in the seedbeds. Between the weeks 14 and 16 in 2004, the farmers transplanted the cabbage seedlings to the open field plots. After 10 to 12 weeks of crop cultivation in the open fields, the farmers started harvesting. The total crops were harvested within 3 to 4 weeks. The whole crop production from sowing to harvesting took between 23 and 25 weeks.

Table 3.3.3d: Culture table of the cabbage production.

Month 2004		**January**					**February**				**March**					**April**				**May**					**June**				**July**		
Date Monday			5	12	19	26	2	9	16	23	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19
Week Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	**20**	21	22	23	24	25	26	27	28	29	30
	Ares																														
Xerxe	10																														
Krusha e Madhe	22																														
Mamusha	21																														

Legend:	
Sowing	
Seedbed	
Open field	
Harvest	

The farmers ploughed the soil before the seedlings were transplanted (week 12 to 14) and after the harvest (week 28 to 30). The harrowing was done with a little cultivator in the weeks 13-15.

In summertime (week 22 to 28), the field plots were irrigated twice a week for about two hours. Irrigation was done during the midday with flooding or sprinkling irrigation techniques. Tab water or water from the river were used for irrigation.

Planting Density in Open Field Plots

The distance between plants within a row and the distance between rows determine the planting density. The Table 3.3.3e shows that the plant density varies in the three locations. While the farmer in Krusha e Madhe only grows 3.1 crops per m^2, the farmers in Mamusha and Xerxe grow 4.2 and 4.6 crops per m^2.

Table 3.3.3e: Plant density in the open field.

Cabbage	**Xerxe**	**Krusha e Madhe**	**Mamusha**
Field size (m2)	1019	2247	2083
No. of plants	4656	6994	8777
Plant Density (Plants/ m2)	**4.6**	**3.1**	**4.2**

Tomato Production

The sowing of the tomato seeds took place at March 10 (Week 11) in Xerxe, the March 20 (Week 12) in Mamusha and the March 23 (Week 12) in Krusha e Madhe. Farmers cultivated the seedlings between 5 to 6 weeks in the seedbeds. The transplanting of the tomato seedlings took place at April 23 in Xerxe and April 24 in Krusha e Madhe and Mamusha. After 12 to 13 weeks crop cultivation on the open fields, they started harvesting. Due to hail, no yield could be obtained in Mamusha. In Krusha e Madhe tomatoes were harvested within five weeks. Krusha e Madhe suffered as well from hail, 70% of the harvest was lost. Tomatoes in Xerxe were harvested during ten weeks. The whole crop production from sowing to harvesting took between 18 to 28 weeks.

Table 3.3.3f: Culture table of the tomato production.

Month 2004		March					April				May					June				July				August					September			
Date Monday		1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30	6	13	20	27
Week Number		10	11	12	13	14	15	16	17	18	19	**20**	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	Ares																															
Xerxe	15																															
Krusha e Madhe	12																															
Mamusha	20																															

Legend:

Sowing	
Seedbed	
Open field	
Harvest	

The farmers ploughed the soil before the seedlings were transplanted (week 15 and 16) and after the harvest (week 30, 34 and 39). The harrowing was done with a little cultivator in the week 16.

In summertime (week 26 to 34), the field plots were irrigated twice a week for about two hours. Irrigation was done during the midday with flooding or sprinkling irrigation techniques. Tab water or water from the river were used for irrigation.

Planting Density on the open field plots

The distance between plants within a row and the distance between rows determine the planting density. The Table 3.3.3g shows that the plant density varies in the three locations. While the farmer in Krusha e Madhe only grows 2.4 crops per m^2, the farmer in Mamusha grows 2.8 plants per m^2 and the farmer in Xerxe grows 3.1 crops per m^2.

Table 3.3.3g: Planting density of tomato plants in the open field.

Tomato	**Xerxe**	**Krusha e Madhe**	**Mamusha**
Field size (m2)	1512	1151	1978
No. of plants	4736	2712	5460
Trail size in m	1.5	1.6	1.5
Plant Density (Plants/ m2)	**3.1**	**2.4**	**2.8**

Harvesting and Yield; Cabbage & Tomato

The harvesting of the crops is done by hand. The crops are collected and placed into wooden boxes or plastic bags.
Some farmers used empty mineral fertilizer bags for harvesting!

The '*Handbuch Gemuese 2004*' indicates a reference value (42500 kg/ha) of the expected yield in an open field integrate crop management system. This value is used to compare the obtained yield in cabbage and tomato production in Kosovo.

The Figure 3.3.3h shows the yield in t/ha obtained by surveyed farmers. The cabbage farmer had a yield of 101.6 t/ha in Xerxe, 108.9 t/ha in Krusha e Madhe and 126.7 t/ha in Mamusha.
The tomato farmer in Xerxe got 99.3t/ha. In Krusha e Madhe yield was only 36.5t/ha due to hail. In Mamusha 100% were destroyed by hail. Detailed information about the yield losses due to hail are given in the Appendix IV.

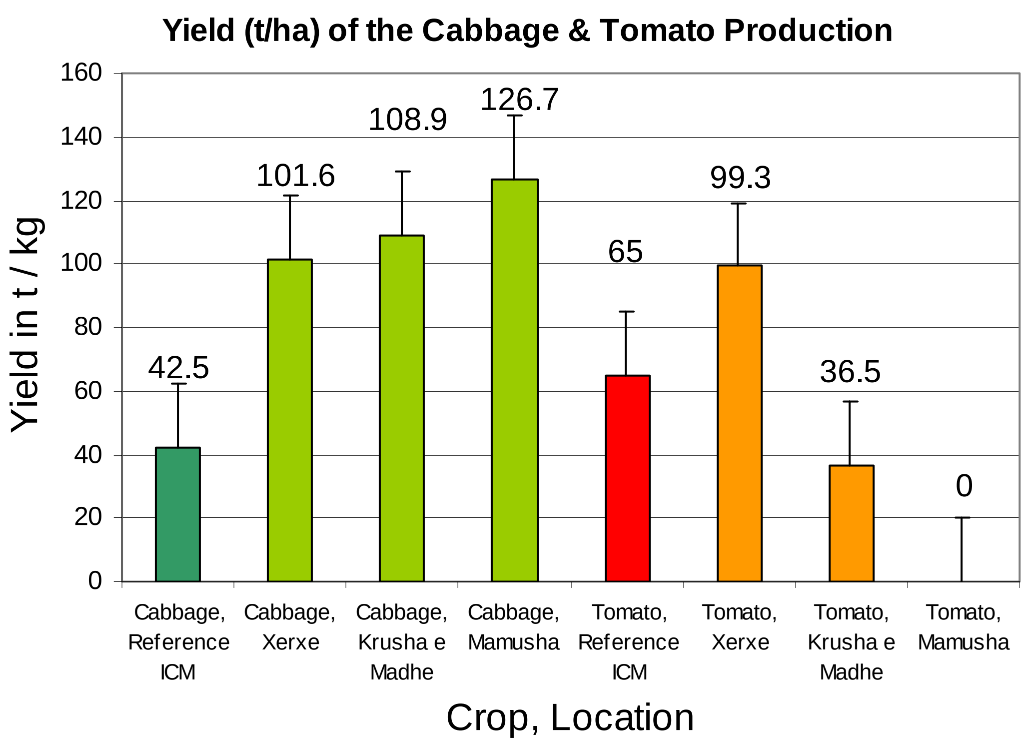


Figure 3.3.3h: Yield of the observed cabbage and tomato open field plots.

3.3.4 Conclusions

- The average of the productivity in the cabbage seedling production is 46% and in tomato seedling production 54%. Considering that high-quality seeds are very expensive, farmers have to find out the reasons for the low productivity. Several factors could be responsible for the low productivity: Sowing starts very early, temperatures in tunnels and glasshouses can be very low at that time of the year and could thereby lead to weak seedlings, which are easily attacked by pests or diseases. As already mentioned, some of the farmers believe that the quality of the seeds sometimes is not as good as it is supposed to be.
- In case there are pest problems in the seedbeds, the latter could be covered with a layer of synthetic fleece to suppress flea beetle and aphid attack and additionally two layers for protection against cold temperatures.
- The planting density in the cabbage production is 3.1 to 4.6 plants/m^2. The expected density in cabbage open field production is 6 to 8 plants / m^2. Farmers go for low densities to give plants more space for the head formation and to reach a bigger cabbage head.
  The planting density in the tomato production is 2.4-3.1 plants/m^2. The expected density in the tomato open field is 2-2.5 plants/m^2. The observed density is higher than the expected density. Planting density has an effect on crop production and susceptibility to diseases. The greater the distance between plants, the more area one plant has to grow and the more nutrients are available to the plant. Plant density also has an effect on the climate within the crop. In a close planting, wind and sunshine cannot reach to the soil level and as a result, the lower leaves of the crop stay wet longer. This increased humidity within the crop can stimulate disease and infection because many diseases thrive in moist conditions.
- The fact that farmers use bags of mineral fertilizers for harvesting their crops demonstrates that there is no awareness for health.

3.3.5 Recommendations

Seedling production
- Certificate seed with a resistance or tolerance against major pests and diseases have to be used;
- The seedling productivity can be optimized by adapted location to the crop needs: grow rooms (glasshouse, tunnel, early bed box, open land), seedling production in pressing pot (Presstoepfe), seedling plates (Anzuchtplatten), super seedlings, and seedbeds.
  Create ideal grow conditions for the crops (Temperature, Air conditioning, Irrigation)
- Mixture of the Substrate with turf, compost, clay, fertilizer, lime.

Culture management
- Planting dates can be adjusted to make sure that the period during which the crop is susceptible to pest damage does not coincide with the period of highest pest population;
- Growing certain combinations of different crops in the same field (Intercropping) may also help to reduce pest and disease problems;
- Some crops are more attractive to a particular insect pest than others. By growing, within or near the main crop, you can attract pests away from the main crop (Trap cropping);
- Growing a secondary crop under a main crop can smother out weeds, conserve natural enemies and reduce soil erosion. Often cover crops are legumes, which also add nitrogen in the soil;

Soil Preparation

- Use lightweight machines;
- Drive only over the field, when the soil is enough dried but not to dry;
- Use different machines;
- Use different deepness by soil preparation;
- Direct sowing can replace the ploughing;
- Plough until 25 cm (maximal once a year);
- Deep ploughing can bury weed seeds and fungal spores deep in the soil, which can prevent them from reaching the host or germinating. It can also bring some insect pests to the surface and expose them to predators such as birds.

Irrigation

Water requirement of the crops

- All measures must be taken to minimize water loss and optimize product quality;
- Irrigation is only justified if the available water does not satisfy the crop's requirements;
- The calculated water amount must not exceed field capacity. Irrigation scheduling systems should be used where available;
- A regional organization should provide to the farmers the specific information concerning the requirements of different crops, soil type and climatic conditions, making utmost use of available information systems;
- Irrigation should utilize, whenever possible, local data on reference evaporation rates calculated by means of local meteorological stations;
- The irrigation plan needs to be established individually for each plot. The amount of applied water has should be recorded in the farm records. The irrigated area showing a water deficit should be not less than 30% of the total surface under irrigation.

Irrigation Method

- The most efficient and commercially practical water delivery system should always be used to ensure best utilization of water resources;
- Whenever possible, a combination of irrigation with fertilization, should be considered;
- Consideration should be given to a water management plan to optimize water usage and reduce leakage, collection of rainwater from roofs, etc.;
- The cabbage plots have to be irrigated with a water sprinkle system;
- The tomato plots have to be irrigated with a trip irrigation system;

Water Quality and supply

- Irrigation water has to be of adequate quality and must not contain polluting elements, (exceeding the official tolerance levels), and pathogens relevant to the crop. The regular analysis of the water quality with respect to heavy metals, N, and Na/Cl content etc., is recommended;
- Irrigation water should be obtained from sustainable sources, (i.e. sources that supply enough water under normal conditions);
- The installation of measuring devices in every plot for requesting the amount of water applied is to be encouraged.

Harvest

- Harvest practices should fulfill the general requirements for product quality, food safety and trace ability established by international standards;
- Products should meet not only the required market standards with respect to external and internal quality parameters but also the invisible criteria of production quality, ethical quality, (especially in animal production), and social quality. Product quality must be high to demonstrate measures and visual quality traits to the consumer;

- The necessary measures to obtain optimum product quality at harvest should be defined for each crop taking into account actual international standards for external and internal quality. These parameters must be defined by regional organizations to evaluate in retrospect the proper physiological status of the particular produce;
- All staff must be aware of the need to harvest, transport, store and pack produce with the utmost care having received basic training in personal hygiene requirements for handling of fresh produce;
- A documented and up-dated risk assessment covering hygiene aspects of the harvest process and of produce handling operations must be made and hygiene procedures implemented.

Yield

The achieved yields of cabbage and tomato production in Kosovo are much higher than in ICM standards. The high yields are related to the high input of mineral fertilizer. In a sustainable farm system the yield have to be reduced through:

- Regulated mineral fertilizer application;
- Adjusting of the plant density;

The tomato plots in Krusha e Madhe and Mamusha were partly or fully destroyed by hail. These losses could be reduced by the installation of hail nets, tunnels or greenhouses.

3.4 Crop Rotation

Crop rotation is probably the most efficient cultural practice to avoid diseases, and also to maintain fertile soils.

Crop rotation involves the planting of a sequence of different crops on the same land. This sequence avoids the planting of any crop from the same botanical family in successive years throughout the sequence. Rotations of three or four years are widely applied in agriculture to maintain and improve soil fertility and to minimize the effects of soil-borne diseases. In this way, pests and diseases which are adapted to certain crops or crop families cannot accumulate in the field over time.

3.4.1 Objectives

The objective was to find out whether surveyed farmers always grow the same crops on the same fields or not. In case they rotate their crops, it is important to know what crops they planted the last years, and whether they do a planning of the rotation or they just choose any crop.

3.4.2 Methods

Information on the crops, which were planted from 2000 – 2004, was gathered using a semi-structured interview.

3.4.3 Results

The Table 3.4.3a shows the sequence of crops within the last five years. Crops which belong to the same plant family within a column are bold or italics. Even though the cabbage farmer in Xerxe planted crops of the *Solanaceae* family in 2000 and 2003, he never planted the same crop in following years. Therefore, one COULD say that he did crop rotation. However, when this farmer was asked whether he plans the sequence of the crops or whether his decision on the sequence depends on others reasons such as market prices, it became clear that no planning was done.

In Krusha e Madhe as well as in Mamusha crop rotation was not practiced. When farmers were asked which crops they had planted within the last years, some of them could hardly remember. This also shows that no planning was done.

Table 3.4.3a: Cropping since the year 2000 on the cabbage plots.

Cabbage Plots	**Xerxe**	**Krusha e Madhe**	**Mamusha**
Crop 2000	**Pepper**	"Unknown"	**Tomato**
Crop 2001	Maize	Maize	**Tomato** / Spinach
Crop 2002	Watermelon	Pepper	**Tomato** / Spinach
Crop 2003	**Tomato**	Cucumber / **Cabbage**	**Tomato**
Crop 2004	Cabbage	**Cabbage**	Cabbage
Crops rotated	**(YES)**	**NO**	**NO**

Results in tomato plots are similar: Crops of the same plant families were planted in following years. Crop rotation is not practiced.

Table 3.4.3b: Cropping since the year 2000 on the tomato plots.

Tomato Plots	**Xerxe**	**Krusha e Madhe**	**Mamusha**
Crop 2000	*Pepper*	*Tomato*	Wheat
Crop 2001	Maize	**Cucumber** / Spinach	*Cucumber*
Crop 2002	**Watermelon**	Carrots / **Cucumber**	**Tomato**
Crop 2003	**Cucumber**	**Cucumber** / Spinach	*Watermelon*
Crop 2004	*Tomato*	*Tomato*	**Tomato**
Crops rotated	**NO**	**NO**	**NO**

3.4.4 Conclusions

- None of the farmers did a 'real' crop rotation, which includes the planning of crop sequences. In one case rotation was done, but rather 'by chance'; the farmer was not really aware of the fact that he rotated his crops.
  There is no awareness about the importance of crop rotation yet. Though, by doing a proper planning of a crop rotation, and implementing crop rotation properly, farmers could benefit in many ways: they could increase the soil fertility, they could minimize the effects of soil borne diseases and pests; and even weeds are related to certain crops and can be reduced by practicing crop rotation.

3.4.5 Recommendations

Planning and Implementation of Crop Rotation
Obviously, the implementation of a four-years crop rotation, which would be ideal, is not always feasible due to the limited area of agricultural land per farm. However, even under these circumstances, it would be possible to implement at least a three-year crop rotation program on a limited area. To reach a three-year crop rotation, only a maximum proportion of 33% Brassicaceae/Solanaceae should be cultivated on the agricultural land each year. In the Table 3.4.5a some vegetables are compiled which are suggested to be used in crop rotation program with Brassicaceae/Solanaceae.

The success of crop rotation is dependent from good planning and its strict implementation. Crop rotation planning is divided in four steps:

(1) Determination of soil borne diseases;
(2) Review of crops grown at farm and grouping of these crops;

(3) Establishment of farm sectors (number of sectors equals the number of rotation years) and the fields belonging to these sectors; and
(4) Rotation of crop groups in these sectors.

In a three-year rotation at Kosovo farms, the land available for vegetable production will be determined with the aim to divide this land into three sectors. Crops considered for production will be grouped according to categories such as plant family or the susceptibility to diseases and pests as well as nematodes. These crop groups will be rotated in a three-year interval between sectors. In Table 3.4.5a, for example, Brassicaceae/Solanaceae would belong to group A, and cereals, lettuce and spinach are belonging to group B, and onions, leek, parsnip, and carrots would fit into group C. It is important for cabbage/tomato producing farms that non-Brassicaceae/non-Solanaceae crops are included in-group B and group C. In addition, it should be noted that double cropping within sectors and groups is possible. Flexibility to select crops for crop groups is possible, however, Crucifers and Solanaceae should be not considered for crop group B and C.

Table 3.4.5a: Vegetables that could be used in crop rotation programs with Brassicaceae and Solanaceae.

Plant Family	Latin Name	Common Name
ASTERACEAE	*Lactuca species* *Taraxacum officinale*	Several lettuces Dandelion
UMBELLIFERAE	*Daucas carota* *Apium graveolens* *Pastinaca sativa*	Carrots Celery Parsnip
LEGUMINOSACEAE	*Phaseolus species* *Pisum sativum*	Several beans Pea
CUCURBITACEAE	*Cucumis sativus* *Cucumis melo* *Curcubita pepo* *Curcubita maxima*	Cucumber Melon Zucchini, squash Pumpkin, water melon
SOLANACEAE	*Lycopersicon lycopersium* *Capsicum annuum* *Solanum melongena*	Tomato Pepperoni Eggplant
LILIACEAE	*Allium cepa* *Allium porrum*	Onions Leek
CHENOPODIACEAE	*Spinacia pleracea*	Spinach
POLYGONACEAE	*Rheum rhabarbarum*	Rhubarb
GRAMINACEAE	*Zea mays*	Sweet corn
BRASSICACEAE	*B. oleracea capitata alba* *B. oleracea botrytis italica* *B. oleracea botrytis botrytis* *Raphanus sativus sp*	White cabbage Broccoli Cauliflower Radies

Table 3.4.5b: Three-year crop rotation planning.

Crop Groups			**Rotation**	Sectors		
Group A[1]	Group B[2]	Group C[3]	**Year**	Sector I	Sector II	Sector III
White Cabbage	*Spinach*	*Onions*	**1**	**A**	**B**	**C**
Tomato	*Lettuces*	*Leek*				
Cauliflower	*Rhubarb*	*Carrots*	**2**	**B**	**C**	**A**
Broccoli	*Bean*	*Cereals*				
Pepperoni		*Parnsnip*	**3**	**C**	**A**	**B**

[1] and [2] = double cropping is possible within group A and B;
[3] = single or double cropping is possible in group C.

3.5 Crop Protection

In order to protect crops against insects pests, diseases or even weeds, tools of biological control (the use of beneficial organisms that suppress pest populations), cultural control (farm practices that aim to reduce pest problems, such as crop rotation and sanitation measures) and chemical control (use of pesticides and other chemicals to decrease the pest population) can be used.

3.5.1 Objectives

The objective of this chapter is to show the most important insect pests, diseases and weeds in both cabbage and tomato plots. Furthermore information on chemical control will be given.

3.5.2 Methods

Information on the occurrence of insect pests, diseases and weeds was obtained through weekly monitoring of the field plots. As mentioned before, all field plots were treated.

Plants of all six plots were monitored in weekly intervals for 18 weeks, starting in May. Five spots in each field were chosen along a diagonal line from one corner of the field to the opposite corner. Distances between the spots were approximately the same. At each spot, ten successive plants in that row were checked for presence of insect pests or diseases. If insect pests were present, they were identified and their numbers were noted. For each insect, an average per plant was calculated.

Weeds from all the six plots were collected in week 24 and identified.

Information on crop protection such as the use of chemical pesticides was gathered using semi-structured interviews.

3.5.3 Results

Insect pests on cabbage

The Table 3.5.3a shows the major insect pests on cabbage. The total numbers of the counted insects are given in parenthesis. The major insect pests on cabbage are: *Eurydema ornata, Phyllotreta cruciferae, Brevicoryne brassicae, Eurydema ventralis, and Phyllotreta nemorum.* As already mentioned, all field plots were treated. The field plot in Xerxe was only treated once with insecticides in the beginning of the vegetation period. In this field plot, the occurrence of insect pests is higher than in field plots in Mamusha and Krusha e Madhe.

Table 3.5.3a: Insect Pests on Cabbage.

Mamusha	Krusha e Madhe	Xerxe
Phyllotreta cruciferae (379)	*Brevicoryne brassicae (238)*	*Eurydema ornate (531)*
Aphis nasturi (57)	*Phyllotreta cruciferae (168)*	*Phyllotreta cruciferae (168)*
Phyllotreta nemorum (7)	*Eurydema ventralis (95)*	*Eurydema ventralis (147)*
Eurydema ventralis (7)	*Aphis nasturi (31)*	*Phyllotreta nemorum (19)*
Eurydema ornate (3)	*Phyllotreta nemorum (6)*	*Pieris rapae (13)*
Myzus persicae (2)	*Delia raudicium (5)*	*Myzus persicae (7)*
	Pieris rapae (3)	*Aphis nasturi (5)*
	Pieris brassicae (2)	*Oulema melanopa (1)*
	Muscae domestica (1)	*Ostrinia nubilalis (1)*
	Oulema melanopa (1)	*Agriotes ustulatus (1)*

Insect pests on tomato

The Table 3.5.3b shows the major insect pests on tomato. The numbers in parenthesis reflect the total number of the counted insects during the whole monitoring period. The major insect pests on tomato are: *Aphis nasturi* and *Myzus persicae*

Table 3.5.3b: Insect pests on tomato.

Mamusha	Krusha e Madhe	Xerxe
Aphis nasturi (636)	*Aphis nasturi (477)*	*Myzus persicae (2625)*
Myzus persicae (627)	*Myzus persicae (327)*	*Aphis nasturi (517)*
Muscae domestica (1)	*Muscae domestica (14)*	*Leptinotarsa decemlineata (59)*
Trialeurodes vaporariorum (1)	*Leptinotarsa decemlineata (5)*	*Muscae domestica (11)*
	Phyllotreta cruciferae (1)	*Pieris rapae (1)*

Diseases on cabbage and tomato

In this chapter the major diseases on cabbage and tomato are presented.
The main diseases on **cabbage** are *Alternaria brassicacae* and *Peronospora parasitica* and *Xanthomonas campestris.*
The main diseases on **tomato** are *Alternaria solanii and Phytophthora infestans.*

Linda Roberge from PRISME, a Canadian organization, also carried out identification of tomato diseases. Besides *Alternaria solanii* and *Phytophthora infestans*, she identified *Pseudomonas syringae*, *Clavibacter michigarensis spp michigarensis.*

Table 3.5.3c: Diseases on cabbage and tomatoes.

CABBAGE	TOMATO
Alternaria brassicaceae	*Alternaria solanii*
Peronospora parasitica	*Clavibacter michigarensis*
Xanthomonas campestris	*Phytophtora infestans*
	Pseudomonas syringae

Weeds on the cabbage and tomato plots

In Table 3.5.3d all weeds which occurred in both cabbage and tomato field plots are listed.

Table 3.5.3d: Weeds in cabbage and tomato field plots.

CABBAGE (Cruciferae)	TOMATO (Solanaceae)
Amaranthus retroflexus	*Amaranthus spinosus*
Amaranthus spinosus	*Ambrosia artemisiifolia*
Anthemis cotula	*Anthemis cotula*
Brassica juncea	*Brassica juncea*
Brassica kaber	*Brassica kaber*
Brassica nigra	*Brassica nigra*
Cirsium arvense	*Capsella bursapastoris*
Datura stramonium	*Chenopodium album*
Galinsoga ciliata	*Convolvulus arvensis*

Matricaria matricarioides	*Convolvulus sepium*
Portulaca oleracea	*Datura stramonium*
Sonchus arvensis	*Echinochloa crus-galli*
Poaceae	*Eleusine indica*
	Euphorbia sp.
Weedy family relations	*Galinsoga ciliata*
Brassica species	*Plantago major*
Datura stramonium	*Plantago rugelli*
Solanum species	*Portulaca oleracea*
	Setaria viridis
	Sonchus arvensis
	Taraxum sp. (officinale)
	Weedy family relations
	Brassica species
	Lepidium species
	Capsella bursapastoris

Control of pests and diseases

The surveyed farmers all used pesticides to control insect pests and diseases. Both contact and systemic insecticides were used. Farmers sprayed up to four times against insect pests and up to 14 times against diseases. A list with the used pesticides and time of application is given in the Appendix III.

The control of weeds was done mechanically. Farmers harrowed up to three times during vegetation period.

3.5.4 Conclusions

- Since all field plots were treated with pesticides, it is hard to tell how serious problems due to insect pests and diseases are in reality. A survey has to be carried out in an untreated field plot in order to compare the occurring insects in treated and untreated fields. Only then information can be given on severity and conclusions can be made;
- The surveyed farmers are heavily dependant on pesticides. There is no awareness that there are other ways to combat, or, even better, prevent, pests and diseases. Farmers are not aware that the use of big amounts of pesticides is not always necessary, and that the use of chemical pesticides provokes problems such as resistant insect pests, health problems and environmental problems.

3.5.5 Recommendations

Farmers should consider other protection tools than only chemical protection. In IPM, tools of biological control (the use of beneficial organisms that suppress pest populations), cultural control (farm practices that aim to reduce pest problems) and chemical control (use of pesticides and other chemicals to decrease the pest population) are combined. Preventive (indirect) measures and observations in the field on pests, diseases and weed status are considered before an intervention with direct plant protection measures takes place.

IPM is an approach to pest management that uses a combination of several control methods that are both cheap for the farmer and sustainable. IPM systems can include the use of *pesticides, but often one of their main aims is to reduce the use of chemicals.*

The prevention and/or suppression of key pests, diseases and weeds should be achieved or supported among other options especially by the
- Choice of appropriate resistant/tolerant cultivars;
- Use of an optimum crop rotation;
- Use an adequate cultivation techniques (e.g. stale seedbeds technique, sowing dates, sowing densities, under sowing etc.);
- Use of balanced fertilization (especially nitrogen), irrigation practices;
- Protection and enhancement of important natural enemies by adequate plant protection measures;
- Utilization of ecological infrastructures inside and outside production sites to enhance a supportive conservation biological control of key pests by antagonists;
- Weed management should be achieved, as far as possible, by an appropriate crop rotation or mechanical control.

Where indirect plant protection measures are not sufficient to prevent a problem and forecasts and threshold values indicate a need to intervene with direct plant protection measures, priority must be given to those measures that have the minimum impact on human health, non-target organisms and the environment.

Risk assessment and monitoring
- Pest, diseases and weeds must be monitored with adequate methods and tools to determine whether and when to apply direct control measures;
- Scientifically sound warning-, forecasting- and early diagnosis system should be utilized. They are important for decisions about when direct control measures are necessary;
- The official forecast of pests and/or diseases risks, where available, must be taken into considerations and greatest possible use of them must made;
- Robust and scientifically sound threshold values are essential components for decision-making. For pests, diseases and weeds, officially established threshold levels defined for the region must be taken into account before treatments;
- Empirical threshold values should be replaced by more scientifically sound parameters. Differences in variety susceptibility, where known, must also to be considered.

3.6 Fertilization

Crops need nutrients (macro- and microelements) in order to grow well. In order to get healthy plants and good yield, good soil quality, containing all required elements, these elements must be available to the plant. There are different possibilities to supply the soil with nutrients. Synthetic fertilizers are widely used to add nutrients to the soil. Organic matter, which is essential for plant growth as well can be added using various methods: cover crops, green manure, organic mulch or compost.

3.6.1 Objectives

The objective was to evaluate the content of the macro-elements Mg, K, P and N in the soil at all six fields plots. An additional objective was to obtain information on fertilizers used, the time and frequency of its application.

3.6.2 Methods

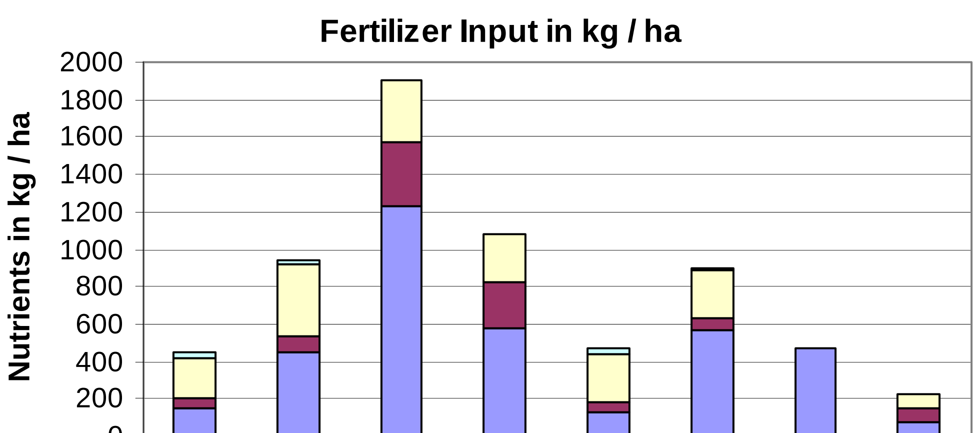
To obtain information on the content of major nutrients in the soil, soil samples of the A-Horizon (0 to –30cm) were taken. In each field plot, 10-14 samples were taken. A certified laboratory in Switzerland (Eric Schweizer Samen AG) analyzed these soil samples. For comparison of results, soil samples of Mamusha were additionally analyzed by the Institute of Agriculture in Peja.

Furthermore, semi-structured interviews were carried out with farmers to gather information on fertilizer input, the time and frequency of application.

3.6.3 Results

The Figure 3.6.1a shows a summary of the fertilizer inputs in the monitored field plots. The amount of fertilizer used by Kosovo farmers is compared with the required and recommended amount for crops needed in an ICM system. In a cabbage ICM production, 450 kg of the major nutrients are required for the whole vegetation period in one hectare. At the monitoring sites, cabbage farmers apply much more than this given value: while the farmers in Xerxe an Mamusha applied more than the double amount, the farmer in Krusha e Madhe applied four times more than recommended in an ICM production. Furthermore, farmers in Mamusha and Krusha e Madhe apply on a high level N, P and K, but neglected to apply Mg in order to grow a healthy crop.

In a tomato ICM production, the input of 470 kg of the major nutrients is required and recommended for the whole vegetation period in one hectare. The farmer in Xerxe applied the double amount. Field plots in Mamusha and Krusha e Madhe were partially or fully destroyed by hail and therefore fertilizers were only applied in the beginning of the vegetation period. Therefore the data for tomato fields in these two locations cannot be considered.



	Cabbage in ICM	Cabbage, Xerxe	Cabbage, Krusha e Madhe	Cabbage, Mamusha	Tomato in ICM	Tomato, Xerxe	Tomato, Krusha e Madhe	Tomato, Mamusha
Mg	30	24	0	0	30	16	0	0
K2O	220	382	334	252	260	257	0	76
P2O5	50	91	334	252	50	61	0	76
N	150	447	1235	576	130	569	469	76

Crop, Location

Figure 3.6.3a:Fertilizer input in kg/ha on the observed field plots.

Results of the soil analysis obtained from these two different laboratories are summarized in the Table 3.6.3b/c. In the table column for the field plots at Mamusha, the results from the Institute of Agriculture (IoA) are provided in brackets (mg/kg).

The cabbage plot in Mamusha shows an increased concentration of nitrogen, phosphor and Potassium. The other parameters are at a normal concentration level.

Table 3.6.3b: Results soil analysis cabbage field plots.

Cabbage	Xerxe	Krusha e Madhe	Mamusha
Nitrat (mg/kg)	25	28.9	21.7 (150)
Phosphor (mg/kg)	5.9	2.1	25.5 (500)
Potassium (mg/kg)	34.7	23.3	64.4 (330)
Calcium (mg/kg)	147.9	155.2	145.8 (123)
Magnesium (mg/kg)	11.9	6.5	19.7 (22)

The Table 3.6.3c reflect the measures of the laboratories. In Xerxe and Mamusha are the nutrients nitrogen, phosphor, potassium and calcium over the reference value and are colored in the table marked.

Table 3.6.3c: Results soil analysis tomato field plots.

Tomato	Xerxe	Krusha e Madhe	Mamusha
Nitrat (mg/kg)	167.8	44.4	26.8 (140)
Phosphor (mg/kg)	2.6	2.3	19.3 (550)
Potassium (mg/kg)	62.4	23.2	47.9 (760)
Calcium (mg/kg)	314.4	215.6	159.4 (178)
Magnesium (mg/kg)	18.4	8.4	21.2 (41)

3.6.4 Conclusions

- The majority of fertilizers used are mineral fertilizer such as NPK (15:15:15) and KAN (27%). Mineral fertilizer have a high leaching rate and that most probably the reason that the fertilizer input is not directly correlated to the results of the soil analysis;
- Some of the results between the two laboratories are significantly different (Nitrate, Phosphor and potassium) but the values measured for Calcium and Magnesium are more similar (exception Magnesium in tomato plots). The colored cells in the tables show a too high quantity of the available nutrients in the soil (N, P, K, and Ca) in comparison to recommendations provided by these laboratories;
- Based on the results obtained it is highly recommended that a reduction of the fertilizer inputs should be achieved, because this over use of nutrients have a negative impact to:
  - the fertility of the soil;
  - the soil fauna;
  - the vegetation constellation;
  - soil, water and air resource quality.
- The provision of organic substance is important in the vegetable production, because most vegetables require rich humus soils (Humuszehrer);
- The best condition offers a regulated crop rotation with rotational fallow and wildflower strips. Additionally the needs of organic substance can be regulated with manure and compost (at least one time in two years). To activate the flora and fauna in the soil, green manure has to be used.
- Fertilizer input on the tomato plots in Krusha e Madhe and in Mamusha is only lower, because the plots were damaged by hail. The reduction of the vegetation period is linked to the lower fertilizer application.

3.6.5 Recommendations

- A nutrient allocation plan for each crop on a plot level and over an entire rotation is required;
- It is recommended that soil analysis for the major elements, P, K, Mg, must be carried out at defined intervals (i.e. 3-10 years according to the crop). An adequate description of techniques applied, (i.e. interpretation criteria including the target range of desirable nutrient reserves of P, K, and Mg, sampling techniques, analytical procedures), is mandatory. Uptake and demand criteria for major nutrients must be established for the Kosovo;
- The use of nitrogen needs particular care because nitrogen leaching and evaporation have significant environmental consequences. N-requirements should be covered by Leguminosae, (biological N-fixation), to the largest possible extent while preventing any danger of leaching. N supply and timing must matched to meet crop demand. The nitrogen fertilization of the specific crops must be established in annual crops on the basis of Nmin systems and/or plant analysis;
- Excess of phosphate must be avoided, as small quantities of phosphate are sufficient to cause over-enrichment of surface waters. Phosphate from agricultural land is mostly translocated by erosion of small soil particles. Any input of P and K, (up to 10%), over the amount indicated by soil analysis must justified. The replacement of mineral P-input through enhancement of activity of pertinent soil organisms (e.g. mycorrhiza) is to be encouraged;
- Organic fertilizers and compost are preferred and can help to provide soil fertility by increasing organic matter content, improving nutrient and water retention, and reducing erosion. Organic manures must contain only lowest possible load of heavy metals and other toxicants and meet the international legal regulations. More severe limitations for heavy metal and other toxicants exceeding minimum legal requirements are to be encouraged.

3.7 Economy

The economy is an important parameter for a cost-efficient crop management. The investment costs are linked to the quantity and the prices of the seeds, fertilizers, pesticides, irrigation, post harvest and the soil preparation.

3.7.1 Objectives

The objective of this chapter is therefore to evaluate the investment cost for the cabbage and tomato production.

3.7.2 Methods

In order to obtain information on the investment costs, the investments of the farmers are recorded and a crop costing per plot was conducted for one hectare.

The tomato plots in Krusha e Madhe (70%) and Mamusha (100%) were damaged by hail on 13 July 2004. This is the reason, that costs for fertilizer, pesticide and post harvest are not included in the calculations. The excluded costs are in brackets. The irrigation and the soil preparation are fixed costs.

3.7.3 Results

The Table 3.7.3a reflect the investment costs needed for a cabbage open field production at the three observed locations in the Kosovo. The main costs in cabbage production are the fertilizer, the seed and the post harvest prices. Mean investment costs account for 2050 € / 1 ha cabbage.

Table 3.7.3a: Investment costs for cabbage open field production.

LOCATION	Xerxe	Krusha	Mamusha	**Average Plots**
Cabbage	€ / ha	€ / ha	€ / ha	**€ / ha**
Seeds	589	401	576	**522**
Fertilizer	226	1113	602	**647**
Pesticides	30	40	82	**50.7**
Irrigation	110	110	110	**110**
Post Harvest	(0)	500	500	**500**
Soil preparation	220	220	220	**220**
TOTAL COSTS	1175	2384	2090	**2050**

The Table 3.7.3b reflect the investment costs for tomato open field production at three observed locations in the Kosovo. The main costs in tomato production are the post harvest costs for wooden boxes, the seeds and the fertilizers prices. The mean investment cost was 4728 € / 1 ha cabbage.

Table 3.7.3b: Investment costs for tomato open field production.

LOCATION	Xerxe	Krusha	Mamusha	**Average Plots**
Tomato	€ / ha	€ / ha	€ / ha	**€ / ha**
Seeds	990	2262	607	**1286**
Fertilizer	184	328	(91)	**256**
Pesticides	64	(49)	(33)	**64**
Irrigation	110	110	110	**110**
Post Harvest	4390	1194	(0)	**2792**
Soil preparation	220	220	220	**220**
TOTAL COSTS	5958	4163	1061	**4728**

3.7.4 Conclusions

- In the cabbage production, fertilizers are the main investment costs, followed by seed and post harvest costs;
- The main investment costs in tomato production are the post harvest costs, followed by seed and fertilizer costs;
- The investment costs for tomato production is higher compared to cabbage production as tomatoes require wooden boxes for marketing;
- Pesticides are cheap in Kosovo, which is only a small fraction of the overall investment costs.

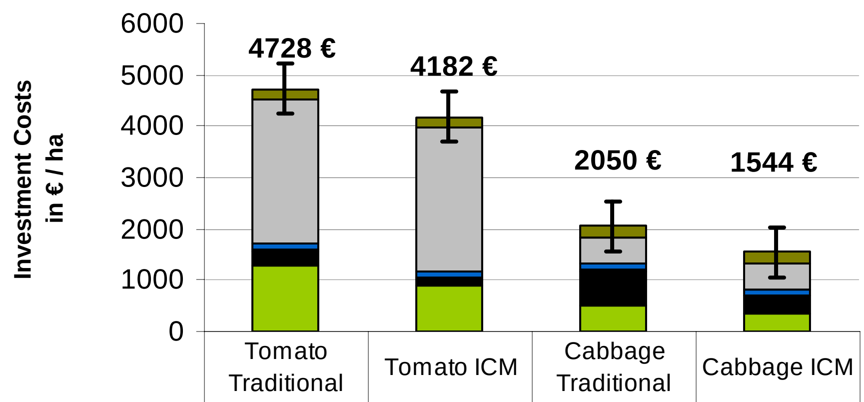
Main costs were identified with the aim to decrease the investment costs and its potential of a realistic reduction is calculated. In brackets is the maximal possible reduction shown.

- Cabbage: When the seedling production would be optimized by 30% (54%), the fertilizer input will be reduced by 50% (190%) and the pesticide application will be reduced by 50% (90%), results a decreasing of the investment costs by 24.7% this is equivalent to 506€/ha [39.9% = 752 €/ha];

- Tomato: When the tomato seedling production would be optimized by 30% (46%), the fertilizer input will be reduced by 50% (92%) and the pesticide application will be reduced by 50% (80%), results a decreasing of the investment costs by total 546€ /ha [19.5% = 727 Euro / ha).

The Figure 3.7.4a reflects the current investment costs (Crop, Traditional) and the decreasing potential in an ICM system.

Investment Costs of the current and the ICM Cabbage & Tomato Production



	Tomato Traditional	Tomato ICM	Cabbage Traditional	Cabbage ICM
Soil preparation	220	220	220	220
Post Harvest	2792	2792	500	500
Irrigation	110	110	110	110
Pesticides	64	32	51	25
Fertilizer	256	128	647	324
Seeds	1286	900	522	365

Crops, Management Practices

Figure 3.7.4a: Decreasing potential of cabbage and tomato production.

Further conclusions to improve the economy of cabbage and tomato production:
- Provide seedling production practices;
- Regular soil analysis gives the farmer to possibility to adjust the fertilizer inputs;
- Promote organic fertilizer;
- Offer plant protection advice;
- The farmers have to think about the focusing of quality and on quantity. Because the small farm surfaces, they will never be competitive to the cheap imported products from Montenegro, Macedonia, Turkey, Serbia etc;
- Make market studies about the acceptance of premium food to a higher price;

- Low (no) taxes for imports;
- No regulations of import quantities;
- Low market price for horticultural products;
- Intercooperation wants to support the farmers to achieve a better income;

3.8 Ecology

The ecology includes the following elements: the natural resources, the human, the animal and the plants and its interaction between all elements. The protection of natural resources is of high value for the farmer as it is an important sustainable component in ICM production.

3.8.1 Objectives

The objective of this chapter is to make the reader aware of the importance of a proper preserved natural environment.

3.8.2 Methods

During seven month in 2004 there are many impressions of the Kosovo during the traveling, excursions and visits collected. These results are personal observations and aren't based on scientific analysis.

3.8.3 Results

- A healthy environment helps the farmers to maintain a high biological diversity and thereby increases the impact of interactions between natural enemies and pests.
- Natural resources (soil, water and air) in Kosovo are highly polluted due the waste such as heavy metals, plastic, glass, inorganic products etc..

3.8.4 Conclusions

- Safe the environment of Kosovo and take care to the limited natural resources;
- The waste management have to be optimized;

3.8.5 Recommendations

- The biological diversity at all three levels (genetic, species, ecosystem) must be increased actively. It is one of the major natural resources of the farm to minimize pesticide input;
- Ecological infrastructures must cover at least 5-10% of the entire farm surface (excluding forest);
- Existing ecological infrastructures with low production intensity and without pesticide/fertilizer input must be preserved and increased to 10% of the farm surface;
- Headland attractants (flowering field margins) should be established as reservoirs of pests' antagonists;
- Areas of linear elements (e.g. flowering border strips, hedges, ditches, stone walls), and non-linear elements (e.g. groups of trees, ponds etc.), being present or to be planned on the farm should be combined in such a manner as obtain spatial and temporal continuity. This continuity is a prerequisite for enhancement of faunistic diversity and for the maintenance of a diverse landscape;
- Reduce deforestation;
- Protect the soil with low inputs, reduction of the erosions risk and a planned crop rotation;
- Maintenance the water quality;
- Protect the healthiness of the Kosovo population;

4. Overall Conclusions

In order to improve the production of vegetables in Kosovo, new production techniques such as Integrated Crop Management (ICM) are considered. A prerequisite for the development of an appropriate ICM strategy is to evaluate the current situation regarding crop management. Therefore, the current status of crop management practices for two selected crops, namely cabbage (*Brassica oleracea var. capitata*) and tomato (*Lycopersicon esculentum*), was determined.

Data were collected from fields belonging to small-scale farmers in three different regions of the Kosovo (Xerxe, Krusha e Madhe and Mamusha). All together, six fields were surveyed weekly during a time period of 18 weeks in order to monitor the pest and disease status. Additionally, information on cultural practices as well as on economical and ecological aspects was gathered using both semi-structured interviews and direct observation.

Soil samples from all field plots were taken in order to determine the soil type and structure. Analysis of these samples showed that in all surveyed fields the rate of loam is high. PH-value of the soil samples was neutral to slightly basic; salinity was in a normal range. The soil sample analysis demonstrated that the rate of humus, and as a consequence the soil fertility, was on a low level. This is probably due to the fact that most of the farmers never add organic matter.

Although farmers try to obtain high-quality seeds from respectable seed producers, which should show for instances in the case of tomato seeds resistance against various diseases. Nonetheless, the outcome of these seeds is low: a relatively high rate does not even germinate, or seedlings become weak and sensitive to diseases after a short time period. Based on interviews, farmers assume that the seed quality is much lower than it is supposed to be.

Sowing of cabbage seeds takes place in January and February each year. Considering the climate in the Kosovo, this is early in the year, and could be another reason for non-germinating seeds or weak seedlings. Kosovo summers are rather dry; therefore vegetables have to be irrigated regularly. Irrigation often takes place around mid-day, when temperatures and sun are high. The yield of both cabbage and tomato production is extremely high. For cabbage production, up to 110 tons/ha are harvested. For tomato production yield amounted for 95 tons/ha. A possible reason for the high yield is, among others, the high input of mineral fertilizers.

Crop rotation appears to be not a common practice in the Kosovo. Even though randomly other crops from other plant families were grown on the same plots these last years, none of the farmers did this being aware of the importance of crop rotation. Based on the farmer interviews, it can be concluded that none of them did a crop rotation planning.

The weekly monitoring of pests and diseases showed that aphids, flea beetles and bugs are amongst the most frequently occurring insect pests in cabbage. In tomato, the presence of aphids was dominating. Both cabbage and tomatoes showed symptoms of diseases. In cabbage, symptoms of *Peronospora parasitica* dominated, whereas in tomato *Phytophthora infestans* as well as *Alternaria solanii* were identified. Pesticides were used in high frequency. Preventive spraying or 'calendar' spraying – the practice to apply pesticides at regularly scheduled time periods – is a common practice. At the monitored field plots, farmers reported that pesticides do not always show the expected impact. They assume that, due to lack of certification, low quality chemicals are sold as high-quality pesticide products. Considering the graveling low price of chemical pesticides in this Kosovo, this assumption is most likely by all means.

Interviews with farmers revealed that an enormous input of mineral fertilizers is a common practice, particularly for cabbage production. The applied fertilizers contain N, P and K, while other important elements such as the trace element Mg are completely neglected. Organic matter is added only occasionally but mostly not at all. Covering the soil in between vegetation periods, using cover crops such as nitrogen fixing plants to improve soil fertility is not a common practice amongst the interviewed farmers.

Investment costs contain costs for seeds, fertilizer, pesticides, irrigation, soil preparation and post harvest costs. Pesticides are extremely cheap and therefore are not an important factor, whereas costs for seeds as well as fertilizers are high. Seeds and fertilizers carry most weight, but based on direct observations there is a high potential for reduction.

Due to the high input of fertilizers and pesticides an impact on natural resources, flora and fauna is expected.

Taken into consideration the above-mentioned results obtained through monitoring surveys and farmer interviews, various changes in crop management are needed in order to go towards a more sustainable ICM approach.

Monitoring surveys showed that the awareness for sustainable agriculture is currently on a low level among farmers. Farmers are solely interested in having a high yield, and if possible with less input. Though, in order to go towards a more sustainable agriculture, it is not enough to reduce the amounts of fertilizers and pesticides. Other measures such as the recommended crop rotation, proper seedbed management and other issues must be tackled.

A first step in this direction is certainly awareness creation for ICM in the Kosovo. Farmers must become aware about the agro-ecosystem in their fields. They must become aware that the use of high amounts of fertilizers and pesticides would lead to fewer yields in future, since soils would emaciate more and more and pests would become resistant against pesticides. They must also become aware that the use of high amounts of fertilizers and pesticides has a grave impact on their health but also on the health of the consumers

5. Guidelines of Integrated Crop Management

The development and implementation of ecosystem-based technologies in plant protection have been important objectives since the 1960s. The evolution from biological control concepts to Integrated Pest Management (IPM) and finally to a holistic system approach was a logical response to progress developing concepts and scientific standards. Following these developments, it became necessary to define the principles and practical rules of the system approach, called ICM or IP. A basic document setting out the definition and objectives of ICM or IP was established by the Commission of the International Organization of Biological Control (IOBC) in March 1992 at Waedenswil, Switzerland. The definition of IP is as follows:

Definition Integrated Crop Management (here Integrated Production based on IOBC)

Integrated Production 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 system 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, of a diversified environment and the observation of ethical and social criteria are essential components.
Biological, technical and chemical methods are balanced carefully taking into account the protection of the environment, profitability and social requirements.

The following five general **Objectives** have been established for ICM that is a farming system which:

1. Integrates natural resources and regulation mechanisms into farming activities to achieve maximum replacement of off-farm inputs;

An intelligent management and careful utilization of natural resources can help to substitute for farm inputs such as fertilizers, pesticides, and fuel. Total or partial replacement of the materials not only reduces pollution but also production costs and thereby improves farm economics.

2. Secures sustainable production of high quality food and other products through ecologically preferable and safe technologies;

ICM aims at high quality agricultural products mainly through ecologically sound techniques that are safe for human health. Total quality evaluation of the agricultural products considers not only production quality but also all sustainable methods of crop production (=ecological quality), adequate standards in animal production (=ethical quality), and adequate working conditions of the farm workers (=social quality).

3. Sustains farm income;

Farm products produced with a high level of ecologically safe, ethically sound and socially acceptable quality must generate justified “added values”. Sustainable agriculture and marketing have to apply the principle of fair trade to the largest possible extent.

4. Eliminates or reduces sources of present environmental pollution generated by agriculture;

Pollution of agricultural origin has to be reduced or eliminated whenever and wherever this is feasible.

5. Sustains the multiple functions of agriculture (multi-functionality).

Agriculture has to meet the needs of the entire society, including those requirements that are not directly connected with production of food (local cultural traditions, cultivation of remote areas, wildlife conservation etc.).

The Principles of ICM

1. **ICM is applied only holistically;**

   ICM is not merely a combination of Integrated Pest Management and additional elements such as fertilizers and agronomic measures to enhance their effectiveness. Instead, 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 minimized;**

   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 the ICM implementation;**

   When practiced on isolated individual areas of the farm ICM is not compatible with a holistic approach postulated above. Important strategies, such as balanced nutrient cycles, crop rotations and ecological infrastructures, become meaningful only if considered over the entire farm.

4. **The farmers' knowledge of ICM must be regularly up-dated;**

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

5. **Stable agro-ecosystems must be maintained as key components;**

   Agro-ecosystems are the basis for planning and realization of all farm activities, particularly those with potential ecological impact. Stabilization means the least possible disturbance of these resources by farm activities.

6. **Nutrient cycles must be balanced and losses minimized;**

   "Balanced" in this context means targeting maximum reduction of nutrient losses (e.g. leaching), a recycling of farm materials.

7. **Intrinsic soil fertility must 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.

8. **IPM is the basis decision making in crop protection;**

   IPM applies to noxious species of phytophagous animals, pathogens, and weeds. Noxious species are those causing more losses than benefits. In the context of sustainable agriculture emphasis within plant protection is placed on preventive measures, that must be utilized to the fullest extent before direct measures (=control) are applied. "Control" measures means management of the pest population to maintain it below that level that causes economic losses. Decisions about the necessity to apply control measures must rely on the most advanced tools available, such as prognostic methods and scientifically verified thresholds. The instruments of direct plant protection are the last choice if economically unacceptable losses cannot be prevented by indirect means.

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 factors of natural regulation cannot sufficiently be achieved without adequate functional biological diversity.

10. Total product quality is an important characteristic of sustainable product quality;

Quality must not only be defined by the conventional external and internal product quality parameters but also by those production, handling and social criteria not visible to the consumers.

11. Animal production on mixed farms

Animal density must be maintained at levels consistent with other principles. The welfare of all species of farm animals must be taken into consideration.

The Conceptual Framework of ICM and Endorsement Procedure

The definition, objectives and principles of ICM provide the conceptual roof resting on two technical pillars, namely the two general technical guidelines defining (I) the general standards for the organization and its members, and (II) the general agronomic requirements valid for all crops. Within this construction are the crop specific guideline (III) that define in greater detail the requirements in each crop. *The overall aim of the documents is to provide a framework for the formulation of regional or national guidelines and standards and to aid harmonization of these concepts and guidelines at an international level.*
Within this conceptual basis, IOBC has established an Endorsement Procedure for regional ICM/IP – Organizations practicing a sustainable production system according to IOBC standards and seeking an international recognition of their achievements.
For that reason the IOBC Commission has published in 2004 the aforementioned general guidelines (I and II) but has also developed Crop Specific Technical Guidelines (III):

Technical Guideline I defines the legal status of the ICM/IP – Organizations seeking IOBC endorsement and describes minimum requirements to be fulfilled by organizations and their members.
Technical Guideline II provides the general agronomic rules and minimum requirements, clearly defined as mandatory rules/prohibitions (or “must” items), to be met by all farmers participating in ICM programs endorsed by IOBC, on all types of farms and in all geoFigureic regions. Recommendations (or “should” and “could” items) are given, whenever needed, to point out optional solutions that go beyond the mandatory minimum and to indicate desirable directions of improvements.
Crop Specific Technical Guidelines III are prepared on the basis of Guideline I and II and specify the minimum requirements and recommendations in individual crops. Their objective is to provide guidance to regional ICM/IP – Organizations or farmer associations wishing to establish their own guidelines and ICM programs according to IOBC standards. So far the following crop specific guidelines are established and available: Pome Fruits (3rd edition 2002), Stone Fruits (2nd edition 2003), Grapes (2nd edition 1999), Arable Crops (1st edition 1997), Soft Fruits (1st edition 2000), Olives (1st edition 2002), Citrus (1st edition 2004), and Field Grown Vegetables (1st edition to be published in 2005).

The basic requirements for ICM/IP – Organizations seeking IOBC endorsement are summarized under the webpage www.iobc.ch. Before organizations can apply for endorsement by IOBC they must have an operational track history of at least 2 years practicing ICM/IP according to IOBC principles and standards. In addition, 13 other requirements have to be fulfilled.

Relevant Books and Documents

Organized Documents

- Blum, A. et al. (2003): ***Datenblaetter Ackerbau***, Landwirtschaftliche Beratungszentrale Lindau (LBL), CH-8315 Lindau
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- Lind, K. et al. (2003): *Organic Fruit Growing,* CABI Publishing, UK
- Schwarz, A. et al. (1990): ***Pflanzenschutz im Integrierten Gemuesebau,*** 1. Auflage, Verlag Landwirtschaftliche Lehrmittelzentrale, CH-3052 Zollikofen
- Speiser, B. et al. (2004): ***Hilfsstoffliste,*** Forschungsanstalt fuer biologischen Landbau (FIBL), CH-5070 Frick
- Vanneste, J.L. (2000): ***Fire Blight***, CABI Publishing, UK
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- Zehnder, U. (2004): ***Literature Review***, Occurrence of Insect Pests in the Balkans, Intercooperation
- Zehnder, U., Kuhlmann U. (2004): ***New Integrated Crop Management Strategy for cabbage production in the Kosovo,*** Intercooperation

Relevant Books & Documents for the library to organize

- Anonym (1996): ***Gemuesearten***, 2. Auflage, FAW, CH-8820 Waedenswil
- Bergmann, W. (1983): ***Ernaehrungsstoerungen bei Kulturpflanzen***, Gustav Fischer Verlag, Stuttgart
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- Boller, E.F. et al. (2004a): ***Ecological Infrastructures,*** Ideabook on Functional Biodiversity at the Farm Level, LBL, CH-8315 Lindau
- Boerner, H. (1981): ***Pflanzenkrankheiten und Pflanzenschutz***, Ulmer Verlag, Stuttgart
- Franz, J.M. &. Krieg, A. (1976): ***Biologische Schaedlingsbekaempfung***, Paul Parey Verlag, Hamburg/Berlin
- Freuler, J., Fischer S. et al. (2000): ***Kontrollmethoden und Anwendung von Schadschwellen fuer die Schaedlinge im Freilandgemuesebau***, FAW, CH-8820 Waedenswil
- IOBC/WPRS (1977): ***Vers la production agricole integree par la lutte integree***, IOBC, CH-8820 Waedenswil
- IOBC/WPRS [Boller, E.F. et al]. (2004): ***Integrated Production***, Principles and Technical Guidelines, 3rd Edition, IOBC, CH-8820 Waedenswil
- Lichtenhahn, M. et al. (1999): ***Krankheits- und Schaedlingsregulierung im Biogemuesebau***, Merkblatt, Forschungsanstalt fuer biologischen Landbau (FIBL), CH-5070 Frick
- Lichtenhahn, M. et al. (1996): ***Anzucht von Jungpflanzen,*** Merkblatt, Forschungsanstalt fuer biologischen Landbau (FIBL), CH-5070 Frick

Useful Internet Links:

Agriculture Organizations

Food and Agriculture Organization	www.fao.org
FAO Community IPM	www.communityIPM.org
International Organization for biological Control IOBC	www.iobc.ch
Landwirtschaftliche Beratungszentrale CH-Lindau	www.lbl.ch
Agroweb	www.agrowebcee.net
Germany	www.bba.de
France	www.inra.fr

Ministry of Agriculture

Albania	www.mbu.gov.al
Croatia	www.mps.hr
Serbia	www.minpolj.sr.gov.yu/index.php
Switzerland	www.blw.admin.ch, www.faw.ch

Research & Development

Research Institute for Organic Farming	www.fibl.org
CABI Bioscience	www.cabi-bioscience.org
	www.cabicompendium.org
	www.cabi.org
The Plant Pathalogy Internet Guide Book	www.ifgb.uni-hannover.de
Hortikultur, Hochschule Waedenswil	www.hsw.ch
Versuchsanstalt Weihenstephan	www.fh-weihenstephan.de
Cornell University	www.ipm.ucdavis.edu
Midwest Biological Control News	www.entomology.wisc.edu
International Society for Horticultural Science	www.ishs.org
American Association for Advancement of Science	www.sciencemag.org

International Organizations

United Nations	www.un.org
United Nations Educational, Scientific and Cultural Organisation (UNESCO)	www.unesco.org
United Environmental Programme (UNEP)	www.unep.org
International Union for the Protection of New Varieties of Plants	www.upov.int
International Labour Organisation	www.ilo.org

Conventions

RIO (1992) Biological Diversity	www.biodiv.org
Conservation of Migratory Species of Wild Animals	www.wcmc.org.uk/cms
Wetlands of International Importance especially as Waterfowl Habitat	www.ramsar.org
International Trade in Endangered Species of Wild Fauna and Flora	www.cites.org
Environmental Impact Assessment in a Transboundry Context (Espoo, 1991)	www.unece.org

Literatur

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Literature: Source

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- Robert P. Rice (2001):***Nursery and Landscape Weed Control Manual****,* Revised and expanded 2001 Edition, Thomson Publication, US
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- Zehnder U., Kuhlmann U. (2004): ***New Integrated Crop Management Strategy for cabbage production in the Kosovo***, Intercooperation

APPENDIX