# CHAPTER 3 LAND EVALUATION AND EXPECTED CULTIVATION/LAND USE

## 3.1 BASIC CONCEPT OF LAND RESOURCE EVALUATION

Appropriate land evaluation is essential for realizing efficient and sustainable agriculture through introducing proper land use under every condition. Land resource evaluation in Slovakia has been carried out based on the accumulated soil database at the country level.

Existing land productivity evaluation is shown as an integrated index based on the soil database (BPEU) and the productivity is confirmed by crop yield in the field. The land characteristics are converted into the point value system taking into account the following items in the system.

- Soil conditions (soil sub-type, parent material, gravel content, soil depth, soil texture)
- Geographic condition (slope)
- Climatic condition (temperature, precipitation)

In the existing system, land productivity is assessed and classified into 15 classes in four categories through the analysis of calculated point value.

- A (1~7) : Suitable for cropping
- AG (1~3) : Suitable for rotation crop (Alternating fields)
- G (1~4) : Suitable for meadows (unsuitable for cropping)
- N : Unsuitable for agricultural use

Since the existing system mainly relies on the countrywide soil database, it is suitable for outlining the land resources in the country on a regional level. This system was built up in order to evaluate the whole country, which contains all areas from lowlands to mountains, by using the same standard. Hence, there is a possibility that not all of the characteristics and differences among the sandy soils are expressed in this broad evaluation system.

The following aspects should be considered in the evaluation system of land resources specific for Zahorska lowland.

- The evaluation system should express adequately the characteristics of sandy soils that are typical for Zahorska lowland. For this purpose, new evaluation items should be added to the existing land evaluation system in order to express the characteristics of the area.
- The evaluation system should consider the availability of existing irrigation systems, an important resource in Zahorska area, as one of the major factors of land resources.
- The evaluation system should consider restrictions on agriculture necessitated by soil conservation as well as social and economic environment.
- The evaluation system should be a comprehensive one which could reflect above points adequately.

As regards land suitability for cropping, an area of poor sandy soil might be specified as marginal for cropping because of severe restrictions caused by the natural conditions. In such areas, some of them might be judged unsuitable for cropping as far as the land potential, impact on natural resources or economic balance is concerned. In some parts, a particular cultivation method is required because of the natural conditions. The evaluation system will give priority to the identification of such areas in the Guidelines.

In the Guidelines, the marginal area is defined as:

- Land where it is impossible to continue with the present farming style in the future even if the profit is attained in the short term.
- Land where economic benefit is not expected given the present farming style.
- Land where use as meadows is more profitable than the cultivated field under disadvantageous conditions.

## 3.2 AGRICULTURAL PRODUCTIVITY

There is no significant difference between geographic and climatic conditions throughout Zahorska lowland that would strongly influence agricultural productivity. Therefore, the soil conditions represented by soil type and soil texture become a major factor of land productivity.

Soil types observed in the Zahorska lowland consist of clay soils that are expected to have a high productivity and sandy soils with expected low productivity. Most clay soils are classified from loamy-clay to sandy-loam. There is very little distribution of heavy clay soil, a type which has a negative influence on production.

Sandy soil in the Zahorska Lowland falls into a single category of light soil (sand and loamy sand) in the existing soil texture system, however, there are two groups of sandy soil in accordance with the existing land productivity evaluation. One is a group of higher productivity with $2^{nd}$~$4^{th}$ grade of suitability for arable land and another is a group of lower productivity with $6^{th}$~$7^{th}$ grade. This difference of productivity of Sandy Soils in Zahorska area is caused rather by the different soil moisture conditions than by nutrient supply capacity. The soil moisture conditions represent water content in soil layer, water retention capacity and available moisture in the soil. It is said that the clay content has a direct influence on soil moisture conditions. The Guidelines propose an evaluation system reflecting the clay contents of soils to help assess the land productivity of sandy soil in the Zahorska Lowland based on the soil conditions.

In accordance with examination of the soil database and the existing productivity evaluation in the sandy soil of the Zahorska Lowland, the distribution of sandy soil with different productivity is observed to be similar to their pedogenesis differences. More productive sandy soils are found in the area of Fluvic Gley Phaeozem and less productive sandy soils are found in the area of Eutric Regosol. It is considered that this similarity is caused by the fact that the clay contents of these soils are strongly influenced by the pedogenesis process in the area. In the Guidelines, it is proposed that sandy soil areas are divided into two groups, i.e., the group dominated by Fluvic Gley Phaeozem and the

group dominated by Eutoric Regosol, of land productivity as a first step of land evaluation. Based on this idea, the land categories shown below are proposed, comprising three categories derived from the existing soil database and land productivity evaluation. Furthermore, an attempt to divide each category into classes will be made based on the soil moisture conditions.

In this study, the actual relation between soil conditions and cropping will be clarified. The details of each evaluation category according to soil type, relation between the clay content and soil water condition and its evaluation method will be carried out in the next stage of the Study.

| Soil condition | Major soil type | Major soil texture | Existing land productivity category | Note |
|---|---|---|---|---|
| Good (A) | Loamy clay to sandy loam | Heavy ~ medium heavy soil (lighter) | A1~A3 | |
| Medium (B) | Loamy clay to sandy loam | Heavy soil ~ medium heavy soil (lighter) | A4~A6 | Limiting factors are perceived in cultivation condition (inundation, over-humidity, heavy-clay soil, available soil layer) and field condition (clay, gravel content) |
| | Sand and sandy loam | Light soil | A2~A4 | Fluvic Gley Phaeozem |
| Low (C) | Sand and sandy loam | Light soil | A6~A7 | Eutric Regosol |
| | All type | all | A7<br>AG<br>G | Heavy limiting factors are perceived in cultivation condition and field condition |

Category of the existing land productivity evaluation

A: Suitable for arable land ($1^{st}$~$7^{th}$ grade: $1^{st}$ grade has highest productivity)

AG: Suitable for arable land in the condition of alternative use

C: Suitable for grassland (not suitable for cultivation)

## 3.3 IRRIGATION POTENTIAL

Due to the low and unstable precipitation as well as the low water retention capacity of sandy soils, irrigation has a dominant influence on crop productivity and its stability in the Area. Thus, it is also important that irrigation availability is included in the land resource evaluation.

This area was once developed with a large number of irrigation systems. However, many of them are malfunctioning or damaged at present. The operating irrigation systems/facilities will be evaluated together with an easily and economically recoverable system. The possibility of irrigation should be considered as one of the potentials or attributes of the land.

The possibility of recovery of existing irrigation system was categorized, based on the survey, as follows:

- Category I : Operating or easily recoverable at low cost
- Category II : Possible to recover
- Category III : Possible to recover at large cost
- Category IV : Difficult to recover

Water conditions in the land resource evaluation is grouped into the following three categories that are the combination of irrigation potential and soil condition taking the soil moisture condition into account.

| Water condition | Irrigation | Soil moisture condition |
|---|---|---|
| Irrigation (1) | Available | |
| Abundant (2) | Not available | Abundant soil moisture condition |
| Poor (3) | | Relatively poor soil moisture condition |

## 3.4 OTHER RESTRICTION FACTORS

### (1) Restriction Factor Due to Necessity of Conservation Activities

Restriction of farming activity due to necessity of farmland conservation, difficult to reflect in land productivity or irrigation potential, will be taken into account as one of the major factors of the land resource evaluation in the Guidelines. The reason is that specific restrictions due to necessity of farmland conservation may determine a possible farming and cultivation type on such land. In the Guidelines, the restriction of farming activity due to the necessity of farmland conservation in Zahorska lowland is arranged as follows:

- Restriction due to wind erosion:
  Consideration of land cover is required in spring, which is a high-risk season for wind erosion.
- Restriction due to inundation:
  Proper crop selection and mitigation method to the inundation damage is required in the frequently inundated areas.
- Restriction in the area equipped with underdrains:
  Periodical maintenance of equipment/facilities is required in order to maintain functionality

Farming units suffering from the above restrictions are required to consider these measures in their farm management. They should consider land use and cropping so that farmland is maintained for sustainable use. The areas that have restrictions due to farmland conservation will be specified in the Case Study.

### (2) Restriction Factors Due to Socio-Economic Conditions

The restricting factors in land use and agriculture are not only due to farmland conservation of regulations by natural environment, but also influenced by the socio economic condition

In the Guidelines, the following restrictions due to socio-economic conditions will be considered in land resource evaluation.

- Land use regulation in natural reserve areas.
  Large-scale development such as irrigation and drainage has been restricted now in the Protected Landscape Area (PLA). Furthermore, the control or limitation of the amount of agricultural chemicals and chemical fertilizer is expected to be introduced in the near future. Zone III (Flood Plain) represents this area.

- Competition with other sectors and restriction of enlargement of farming scale in Bratislava suburb area.
  The competition accompanies urbanization and struggle for land, water and work force between agriculture and the other sectors in Bratislava suburb. Moreover, land price is relatively high and therefore this area is not suitable for the development of farming on a scale requiring land purchase. Zone IV (Suburb of Bratislava Town) represents such an area.

These restriction factors should be considered in any comprehensive analysis of farming/land use in each zone.

**Tentative Results of Land Resources Evaluation Based on Proposed Idea**

Based on the proposed idea mentioned above, the land resources evaluation was carried out in the study area. The results are summarized below. In this evaluation, category (2) and (3), which shows difference of soil moisture conditions in the area without irrigation, has not yet been classified. This will be classified based on the results of the Case Study Stage.

Results of Land Resources Evaluation (ha, %)

| | Zone-I | | Zone-II | |
|---|---|---|---|---|
| | (1) | (2)(3) | (1) | (2)(3) |
| A | 221 (2%) | 1,021 (11%) | 554 (3%) | 1,529 (7%) |
| B | 462 (5%) | 4,716 (51%) | 3,464 (16%) | 4,803 (22%) |
| C | 41 (0%) | 2,868 (31%) | 4,372 (20%) | 6,953 (32%) |

| | Zone-III | | Zone-IV | |
|---|---|---|---|---|
| | (1) | (2)(3) | (1) | (2)(3) |
| A | 0 (0%) | 5,131 (45%) | 287 (10%) | 657 (23%) |
| B | 5 (0%) | 4,141 (37%) | 118 (4%) | 667 (23%) |
| C | 128 (1%) | 1,914 (17%) | 5 (0%) | 1,124 (39%) |

| | Total | |
|---|---|---|
| | (1) | (2)(3) |
| A | 1,062 (2%) | 8,338 (18%) |
| B | 4,048 (9%) | 14,326 (32%) |
| C | 4,546 (10%) | 12,859 (28%) |

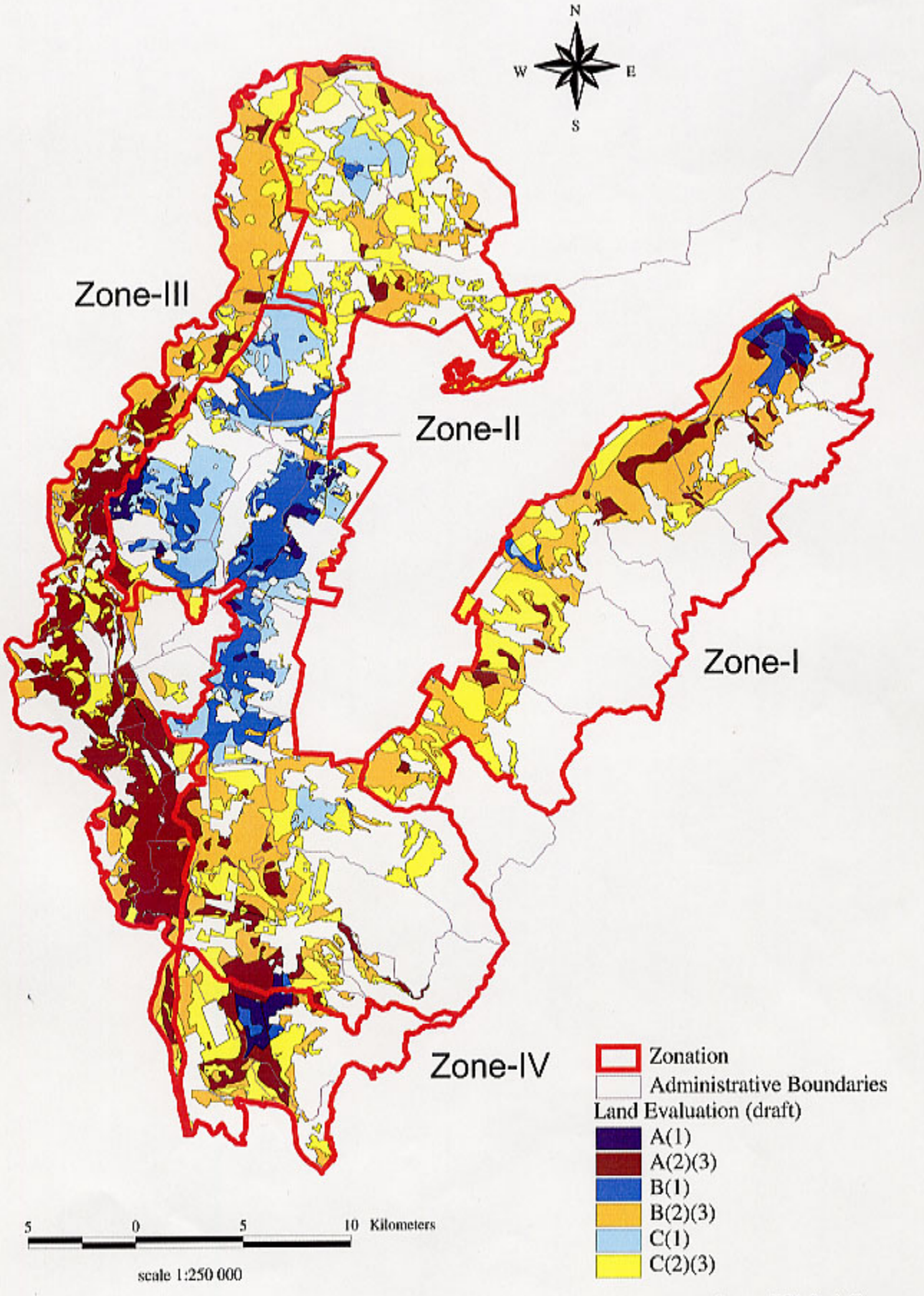



Figure 2.4 Land Resources Evaluation (Draft)

## 3.5 OVERALL EVALUATION OF EXPECTED CULTIVATION/LAND USE

The expected cultivation and land use were classified according to the soil fertility and water availability in each zone along with the consideration of the current farming situation and social conditions. The areas with land conservation restrictions are scattered so that the issues for consideration regarding the land conservation in given areas could be listed by zone.

The selection of expected cultivation type/land use described in the Guidelines shows the concept of cultivation and land use which is most suitable and rational for each land condition, without considering the current farming activity or business policy of each farming unit. Farming units are required to decide the cultivation type and land use by themselves based on the necessity of producing their own feed for livestock farming, the market conditions or contracts with food processing company, business policy, etc. referring to the concept described in the Guidelines. Especially when deciding the planting crop or producing volume in the farming plan, farming units must prioritize the feed demand of animals in their farm management plan, only after that can they decide whether to plant other crops such as cash crops. Farming units are required to seek optimal combinations and proportions taking into account their management type, scale, available farmland, available resources, etc.

# ZONE I. Fan of the Male Karpaty

## Characteristics of the zone.

The majority of the farmland in the Zone I is occupied by a single agricultural enterprise. Farming type usually found is dairy farming, which is highly dependent on self-supplied feeds. At the same time, diversification of farming is developed through the introduction of highly profitable crops cultivated in relatively fertile areas as well as other crops in the marginal areas although the areas for these crops are limited. The crop diversification will also be important in the future.

## Expected cultivation type

| Water conditions / Soil conditions | Irrigation available (1) | Irrigation not available | |
|---|---|---|---|
| | | Abundant soil moisture (2) | Poor soil moisture (3) |
| Good (A) | Cultivation of highly profitable crops using irrigation.<br>Possible combination of highly profitable crops.<br>Sunflower + Spring barley /food wheat | Cultivation of highly profitable crops (without irrigation).<br>Possible combination of highly profitable crops.<br>Rape seeds + s. barley /food wheat + maize | |
| Medium (B) | Cultivation of highly profitable crops using irrigation.<br>Possible combination of highly profitable crops and soil resting crops.<br>Sunflower, s. barley / Food wheat + soybeans. | Cultivation of crops considering maintenance of soil fertility.<br>Possible combination of feed crops and soil resting crops.<br>Feed wheat / maize + alfalfa. | Cultivation of crops considering maintenance of soil fertility.<br>Possible combination of winter feed crops.<br>Rye, w. wheat, triticale. |
| Low (C) | Cultivation of highly profitable crops using irrigation.<br>Possible combination of highly profitable crops and soil resting crops.<br>S. barley / grain maize + alfalfa. | Cultivation of crops considering maintenance of soil fertility.<br>Possible combination of feed crops and soil resting crops.<br>Feed wheat / maize + alfalfa. | Marginal areas for cropping.<br>Grasslands, meadows, ranch |

## Constraints in farmland protection.

| Cultivation type | Soil conditions | Matters to be considered or possible measures |
|---|---|---|
| Cultivation of crops considering land conservation | Susceptible to wind erosion. | Secure ground cover in early spring (Cropping of winter crops). |
| | Area of underground drainage | Maintain drainage canals and underground drainage periodically and renew old underground drainage facilities. |

# ZONE II. Malacky Plain

## Characteristics of the zone.

Various types of farming and cropping pattern are used in spite of the common basic type of mixed farming of cereal cropping with livestock farming. The available irrigation facilities are widely established in Zone II and in addition, the ratio of the irrigated area to the total farmland is high. Although high productivity is expected for highly profitable crops such as oil crops and spring barley in the fertile and water-abundant farm lands, feed crops may be cultivated in these farm lands by the mixed farmers for the purpose of stable supply of self-supplied feeds. In such conditions, high yields of feed will be required.

## Expected cultivation type

| Water conditions / Soil conditions | Irrigation available (1) | Irrigation not available | |
|---|---|---|---|
| | | Abundant soil moisture (2) | Soil moisture is poor. (3) |
| Good (A) | Cultivation of highly profitable crops using irrigation.<br>1. Possible combination of highly profitable crops.<br>Sunflower + s.barley /Food wheat<br>2. Intensive cultivation of vegetable and fruit using irrigation. | Cultivation of highly profitable crops without irrigation).<br>Possible combination of highly profitable crops.<br>Rape seeds + s. barley /Food wheat + maize | |
| Medium (B) | Cultivation of highly profitable crops using irrigation.<br>1. Possible combination of highly profitable crops and soil resting crops.<br>Sunflower + s. barley /food wheat + soybeans.<br>Option: grain maize, alfalfa.<br>2. Intensive cultivation of vegetable and fruit using irrigation. | Cultivation of crops considering maintenance of soil fertility.<br>Possible combination of highly profitable crops / feed crops and soil resting crops.<br>S. barley / food wheat + feed wheat / grain maize + alfalfa. | Cultivation of crops considering maintenance of soil fertility.<br>Possible combination of winter feed crops.<br>Rye, w. wheat, triticale. |
| Low (C) | Cultivation of highly profitable crops using irrigation.<br>Possible combination of highly profitable crops and soil resting crops.<br>S. barley / grain maize + alfalfa. | Cultivation of crops considering maintenance of soil fertility.<br>Possible combination of winter feed crops and soil resting crops.<br>Rye, w. wheat, triticale + alfalfa | Marginal areas for cropping.<br>Grasslands, meadows, ranch |

## Constraints in farmland protection.

| Cultivation type | Soil conditions | Matters to be considered or possible measures |
|---|---|---|
| Cultivation of crops considering land conservation | Susceptible to flooding | Introduce flood resistant crops and early harvesting crops (Ex. silage maize). |
| | Susceptible to wind erosion | Secure ground cover in early spring (Ex. Cropping of winter crops). |
| | Area with underground drainage | Maintain drainage canals and underground drainage periodically and renew old underground drainage facilities. |

# ZONE III. Flood plain

## Characteristics of the zone

In the flood plain of rivers with fertile soil in the Zone III, the development of irrigation and drainage facilities is regulated and the chemical fertilizers as well as agricultural chemicals will be regulated in the future because of location in the natural reservation area. Therefore, it will be important to introduce soybeans and other soil resting crops that have the capacity to fix gaseous nitrogen in order to avoid the application of chemical fertilizers although highly profitable and productive farming will be aimed at fully exploiting fertile soil conditions.

The regulation to these inputs will be a limiting factor to the high productive farming.

However, with efficient use of relatively abundant water availability of soil, it is possible to carry out organic farming (without farming chemicals) for high value-added agricultural products.

## Expected cultivation type

| Water conditions / Soil conditions | Irrigation available (1) | Irrigation not available | |
|---|---|---|---|
| | | Abundant soil moisture (2) | Soil moisture is poor. (3) |
| Good (A) | | Cultivation of crops considering protection of natural environment.<br>1. Highly profitable crops<br>Rape seeds, sunflower, s. barley, Food wheat , grain maize.<br><br>2. Organic farming without agricultural chemicals. | |
| Medium (B) | | Cultivation of crops considering protection of natural environment.<br>1. Feed crops and soil resting crops.<br>Feed wheat, grain maize + soybean<br><br>2. Organic farming without agricultural chemicals | . |
| Low (C) | | Inactive use of land for agriculture. (land for natural grass land) | |

## Constraints in farmland protection.

| Cultivation type | Soil conditions | Matters to be considered or possible measures |
|---|---|---|
| Cultivation of crops considering land conservation | Susceptible to flooding | Introduce flood resistant crops and early harvesting crops (Ex. Silage maize). |

# ZONE IV. Suburbs of Bratislava

## Characteristics of the zone

As the result of the fact that the area is located close to Bratislava, the farmland rent is high and the demand for land resources is high due to the competition with other industries in the Zone IV. The expansion of farmland for agriculture is limited and hence, it is difficult to develop large-scale extensive farming in this area. Consequently, land intensive agriculture is an appropriate type of farming in the region. If the farmland is abundant in an area, the highly profitable cropping with high productivity is applicable as well.

## Expected cultivation type

| Water conditions / Soil conditions | Irrigation available (1) | Irrigation not available | |
|---|---|---|---|
| | | Abundant soil moisture (2) | Soil moisture is poor. (3) |
| Good (A) | 1 Intensive cultivation of vegetable/fruit using irrigation<br><br>2. Cultivation of highly profitable crops using irrigation.<br>Possible combination of highly profitable crops.<br>Sunflower + s. barley / Food wheat | 1. Intensive cultivation of vegetable/fruit using irrigation (Irrigation by newly developed water sources).<br><br>2. Cultivation of highly profitable crops (without irrigation).<br>Possible combination of highly profitable crops.<br>Rape seeds + s. barley / Food wheat | |
| Medium (B) | 1 Intensive cultivation of vegetable/fruit using irrigation<br><br>2. Cultivation of highly profitable crops using irrigation.<br>Possible combination of highly profitable crops and soil resting crops.<br>Sunflower + s. barley / Food wheat + soybeans | 1. Intensive cultivation of vegetable/fruit using irrigation (Irrigation by newly developed water sources).<br>2.Cultivation of highly profitable crops.<br>Possible combination of highly profitable crops and soil resting crops.<br>S. barley / Food wheat + alfalfa. | 1.Intensive cultivation of vegetable/fruit using irrigation (Irrigation by newly developed water sources).<br><br>2. Others<br>The land here is not suitable for the aggressive development of extensive agriculture. In the intensive livestock farming and dairy farming, the efficient land use as meadows for grazing is expected. |
| Low (C) | Cultivation of highly profitable crops using irrigation.<br>Possible combination of highly profitable crops and soil resting crops.<br>S. barley / grain maize + alfalfa. | The land here is not suitable for the aggressive development of extensive agriculture. In the intensive livestock farming and dairy farming, the efficient land use as meadows for grazing is expected. | |

## Constraints in farmland protection.

| Cultivation type | Soil conditions | Matters to be considered or possible measures |
|---|---|---|
| Cultivation of crops considering land conservation | Susceptible to flooding | Introduce flood resistant crops and early harvesting crops (Ex. silage maize). |
| | Susceptible to wind erosion | Secure ground cover in early spring (Cropping of winter crops). |
| | Area with underground drainage | Maintain drainage canals and underground drainage periodically and renew old underground drainage facilities. |

## 3.6 CULTIVATION TYPE, FARMING SUBJECTS AND TECHNICAL MEASURES

The expected cultivation type / land use by evaluated condition are summarized below:

| Cultivating type | Code | Soil moisture and soil conditions |
|---|---|---|
| 1. Cultivation of Highly Profitable Crops Using Irrigation | 1-(1)-(A) | Irrigation: available (1), Soil condition: good (A) |
| | 1-(1)-(B)(C) | Irrigation: available (1), Soil condition: medium (B), low (C) |
| 2. Cultivation of Highly Profitable Crops (without Irrigation) | 2-(2)-(A) | Soil moisture condition: abundant (2), Soil condition: good (A) |
| 3. Cultivation of Crops Considering Maintenance of Soil Fertility | 3-(2)-(B)(C) | Soil moisture condition: abundant (2), Soil condition: medium (B), low (C) |
| | 3-(3)-(B) | Soil moisture condition: poor (3), Soil condition: medium (B) |
| | 3-(3)-(C) | Soil moisture condition: poor (3), Soil condition: low (C) |
| 4. Cultivation of Crops Considering Protection of Natural Environment | 4-(2)-(A) | Soil condition: good (A) |
| | 4-(2)-(B)(C) | Soil condition: medium (B), low (C) |
| | 4-Organic | - |
| 5. Intensive Cultivation of Vegetables/Fruits Using Irrigation | 5 | - |

The following tables show the expected problems on agriculture and farming in each cultivation type and technical measures proposed in the Guidelines. The ID number of each technical measure shows the number of description of measures in Chapter 4.

1-(1)-(A)

| | | |
|---|---|---|
| Cultivation Type | : | Cultivation of Highly Profitable Crops Using Irrigation |
| Condition | : | Irrigation : available (1) Soil condition : good (A) |

**Expected farming**

Highly profitable farming with various cropping technologies is possible owing to the irrigation water and fertile soil conditions. Highly profitable cash crops are planted to cover high input cost. High quality production of food crops or raw materials is aimed at. It is a precondition that self-consuming feed for animals can be secured in the other farmland within the mixed farming of cereal production with animal husbandry.

**Crop selection and cropping pattern**

Cropping pattern is based on the combination of cash crop with high irrigation effect on quantity and quality. Sunflower for oil crops, spring barley for raw material and winter wheat for food quality are nominated for major crops of this cultivation type.

[Sunflower] + [Spring barley / food quality wheat]

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Irrigation/drainage and water management | 1. Increasing actual irrigation area<br>Current actual irrigation area is only 10.7% of equipped area and it causes difficulties in formulating operation and maintenance plan. | 2.4 Improvement / increase of existing functions of irrigation facilities (Increasing flexibility of facility to cope with small and intensive cultivation, additional functions such as organic irrigation) |
| | 2. Sustainable irrigation water supply<br>It is pointed out that in stable water supply due to superannuated facilities and insufficient maintenance causes decreasing actual irrigation area. | 2.2 Rehabilitation of facilities<br>2.3 Strengthening operation and maintenance<br>2.5 Improvement of irrigation water management |
| | 3. Promotion of preparing field irrigation equipment on user side<br>Superannuated field irrigation equipment and stagnation of capital investment for them is pointed to cause decrease of actual irrigation use. | 2.6 Provision of irrigation equipment adaptable to farming<br>2.7 Improvement of on-farm irrigation system to cope with intensive farming |
| | 4. Improvement of function and operation/maintenance in the area with developed underdrains | 5.1.3 Improvement of operation/ maintenance of underdrains<br>5.1.4 Improvement of field drainage<br>5.1.5 Improvement of field drainage management |
| Soil management | 1. Prevention of damage by disease and pest such as soil nematoda | 7.3 Improvement of crop management (crop rotation, fertilization and crop protection) |
| | 2. Efficient maintaining and improving soil fertility with low input | 6.1 Practical use of cropping residues and livestock wastes |
| | 3. Prevention of plow sol compaction | 6.6 Prevention of plow sol compaction （Introducing upside down plowing, subsoil breaking, etc.） |
| Cropping system / farm management | 1. Establishing rotation system of highly profitable crops and proper crop management for intensive irrigation | 7.5 Development and extension of intensive irrigation of summer crops and leafy crops<br>7.3 Improvement of crop management (Introducing proper crop rotation) |
| | 2. High quality production | 7.4 Appropriate fertilizer application technology (Production and application of compost and liquid manure, sustainable supply of micronutrient, manuring practice) |
| | 3. Crop protection and weed control | 7.8 Prevention of damage by weeds (upside down plowing, proper application of agricultural chemicals) |

1-(1)-(B)(C)

| | | |
|---|---|---|
| Cultivation Type | : | Cultivation of Highly Profitable Crops Using Irrigation |
| Condition | : | Irrigation : available (1) Soil condition : medium (B), low (C) |

Expected farming

Highly profitable farming with various cropping technologies can be introduced owing to the irrigation water and fertile soil conditions. Highly profitable cash crops are planted to cover high input cost. High quality production of food crops or raw materials is aimed at. Due to relative low fertility of sandy soils, soil fertility management, such as introducing soil resting crops, is required in regular farming practice. It is a precondition that self-consuming feed for animals can be secured in the other farmland within the mixed farming of cereal production with animal husbandry.

Crop selection and cropping pattern

Cropping pattern is based on the combination of cash crop with high irrigation effect quantitatively and qualitatively. Sunflower for oil crops, spring barley for raw material and winter wheat for food quality are promoted for major crops of this cultivation type. Soil resting crop such as soybeans and alfalfa should be included in the rotation system to maintain soil fertility. Grain maize is also promoted in this type where necessary for securing self- consuming feed for animals.

Soil condition (B): [Sunflower / Spring barley / food quality wheat] + [soybeans / maize / alfalfa]
Soil condition (C): [Spring barley / food quality wheat] + [alfalfa]

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Irrigation/drainage and water management | 1. Increasing actual irrigation area<br>Current actual irrigation area is only 10.7% of equipped area and it causes difficulties in formulating operation and maintenance plan. | 2.4 Improvement / increase of existing functions of irrigation facilities (Increasing flexibility of facility to cope with small and intensive cultivation, additional functions such as organic irrigation) |
| | 2. Sustainable irrigation water supply<br>It is pointed out that in stable water supply due to superannuated facilities and insufficient maintenance causes decreasing actual irrigation area. | 2.2 Rehabilitation of facilities<br>2.3 Strengthening operation and maintenance<br>2.5 Improvement of irrigation water management |
| | 3. Promotion of preparing field irrigation equipment on user side<br>Superannuated field irrigation equipment and stagnation of capital investment for them is thought to cause decrease of actual irrigation use. | 2.6 Provision of irrigation equipment adaptable to farming<br>2.7 Improvement of on-farm irrigation system to cope with intensive farming |
| | 4. Improvement of function and operation/maintenance in the area with developed underdrains | 5.1.3 Improvement of operation/ maintenance of underdrains<br>5.1.4 Improvement of field drainage<br>5.1.5 Improvement of field drainage management |
| Soil management | 1. Identifying the areas having high risk potential of wind erosion in region and in fields | 4.1 Qualification of areas suffering from wind erosion |
| | 2. Establishing countermeasures to wind erosion in the fields planted summer crops, where soil surface becomes bare before seeding. | 4.3 Crop selection and rotation system considering land coverage in the spring season, when the risk potential of wind erosion is high.<br>4.2 Conservation of existing trees and forests to prevent damage |
| | 3. Establishing soil fertility management with low input and low cost as to maintain sustainability of farmland with sandy soils | 6.1 Practical use of cropping residues and livestock wastes<br>6.2 Introduction of soil resting crop |

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Cropping system/farm management | 1. Establishing rotation system of high profitable crops and proper crop management for intensive irrigation | 7.5 Development and extension of intensive irrigation of summer crops and leafy crops<br>7.3 Improvement of crop management (Introducing proper crop rotation) |
| | 2. High quality production | 7.4 Appropriate fertilizer application technology (Production and application of compost and liquid manure, sustainable supply of micronutrient, manuring practice) |
| | 3. Crop protection and weed control | 7.8 Prevention of damage by weeds (upside down plowing, proper application of agricultural chemicals) |

2-(2)-(A)

| | |
|---|---|
| Cultivation Type | : Cultivation of Highly Profitable Crops (without Irrigation) |
| Condition | : Soil moisture condition : abundant (2) Soil condition : good (A) |

**Expected farming**

This cultivation type is applied to the areas, which have an advantage in the soil fertility and soil moisture conditions. Highly profitable farming is expected using various cultivation methods. High quality production of food crops or raw materials is aimed at. It is a precondition that self consuming feed for animals can be secured in the other farmland within the mixed farming of cereal production with animal husbandry.

**Crop selection and cropping pattern**

Cash crop that has high profitability is expected to be introduced. Rapeseed for oil crops, spring barley for raw material and winter wheat for food quality are nominated for major crops of this cultivation type. Maize is also considered as one of major crops corresponding to necessary of feed production.

[Rapeseed] + [Spring barley / food quality wheat] + [maize]

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Water management | 1. Improvement of function and operation/maintenance in the area with developed underdrains | 5.1.3 Improvement of operation/ maintenance of underdrains<br>5.1.4 Improvement of field drainage<br>5.1.5 Improvement of field drainage management |
| Soil management | 1. Prevention of damage by disease and pest such as soil nematoda | 7.3 Improvement of crop management (crop rotation, fertilization and crop protection)<br>6.1 Practical use of cropping residues and livestock wastes |
| | 2. Efficient maintaining and improving soil fertility with low input | 6.1 Practical use of cropping residues and livestock wastes |
| | 3. Effective use of soil moisture and improvement of water retention capacity of soils | 5.2.2 Non-till sowing system can improve water balance |
| | 4. Prevention of plow sol compaction | 6.6 Prevention of plow sol compaction （Introducing upside down plowing, subsoil breaking, etc.） |
| Cropping system/farm management | 1. Establishing rotation system of high profitable crops | 7.3 Improvement of crop management (Introducing proper crop rotation) |
| | 2. High quality production | 7.4 Appropriate fertilizer application technology (Production and application of compost and liquid manure, sustainable supply of micronutrient, manuring practice) |
| | 3. Crop protection and weed control | 7.8 Prevention of damage by weeds (upside down plowing, proper application of agricultural chemicals) |

3-(2)-(B)(C)

| | | |
|---|---|---|
| Cultivation Type | : | Cultivation of Crops Considering Maintenance of Soil Fertility |
| Condition | : | Soil moisture condition : abundant (2) Soil condition : medium (B), low (C) |

Expected farming

Combination of relatively highly profitable crops such as wheat or maize and leguminous pasture which can improve or maintain soil fertility is promoted in the mixed farming of cereal production with animal husbandry. This cultivation type is in major part supporting the livestock farming through feed production.

Crop selection and cropping pattern

Feed crops of high productivity such as wheat and grain maize are promoted according to the soil conditions. In order to maintain the fertility of sandy soils, leguminous pasture such as alfalfa is included in crop rotation. Improvement of soil structure is also expected by introducing deep-rooted pasture in long term. In the relatively fertile and abundant soil moisture area, spring barley or wheat of food quality can be planted. Crop selection is decided considering the demand of feed crops and seasonal distribution of labor force.

[Feed] + [Soil resting crop]

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Water management | 1. Improvement of function and operation/maintenance in the area developed underdrains | 5.1.3 Improvement of operation/ maintenance of underdrains<br>5.1.4 Improvement of field drainage<br>5.1.5 Improvement of field drainage management |
| Soil management | 1. Identifying the areas having high risk potential of wind erosion in region and in fields | 4.1 Qualification of areas suffering from wind erosion |
| | 2. Establishing countermeasures to wind erosion in the fields planted with summer crops, where soil surface becomes bare before seeding. | 4.3 Crop selection and rotation system considering land coverage in the spring season, when the risk potential of wind erosion is high.<br>4.2 Conservation of existing trees and forests to prevent from damage |
| | 3. Establishing soil fertility management with low input and low cost to maintain sustainability of farmland with sandy soils | 6.1 Practical use of cropping residues and livestock wastes<br>6.2 Introduction of soil resting crop |
| | 4. Establishing cropping system considering maintaining soil moisture conditions in the field | 5.2.2 Non-till sowing system can improve water balance<br>5.2.3 Improvement of water balance in dried sand bed of crop root zone |
| Cropping system/farm management | 1. Establishing cropping system corresponding to soil conditions in order to stabilize production of self consuming feed for animals | 7.3 Improvement of crop management (Introducing various feed crops into rotation system) |
| | 2. Effective and efficient fertilizing to reduce production cost of feed | 7.4 Appropriate fertilizer application technology (Production and application of compost and liquid manure, sustainable supply of micronutrient, manuring practice) |

3-(3)-(B)

| | | |
|---|---|---|
| Cultivation Type | : | Cultivation of Crops Considering Maintenance of Soil Fertility |
| Condition | : | Soil moisture condition : poor (3) Soil condition : medium (B) |

Expected farming

Highly profitable crops such as food or raw material crops is not suitable for this type due to disadvantaged soil condition of low fertility. Instead of seeking high profitability, it is expected to contribute to fixed farming of cereal cultivation with animal husbandry through producing low cost feed considering maintenance of soil fertility. Soil moisture management is a priority to consider in cultivation so that limited soil moisture is used effectively. It is expected to prevent wind erosion because target crop of this type is winter crop.

Crop selection and cropping pattern

Drought tolerant winter crops such as wheat, rye and triticale, which are able to use rainfall and soil moisture effectively, are promoted as major crops. Leguminous pasture, which has high tolerance to water stress is expected as a soil resting crop, if available.

[Winter crop (Feed)] + [Leguminous pasture]

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Water management | 1. Improvement of function and operation/maintenance in the area developed underdrains | 5.1.3 Improvement of operation/ maintenance of underdrains<br>5.1.4 Improvement of field drainage<br>5.1.5 Improvement of field drainage management |
| Soil management | 1. Identifying the areas having high risk potential of wind erosion in region and in fields | 4.1 Qualification of areas suffering from wind erosion |
| | 2. Securing land coverage in the spring season by planting winter corps. | 4.3 Crop selection and rotation system considering land coverage in the spring season, when the risk potential of wind erosion is high.<br>4.2 Conservation of existing trees and forests to prevent from damage |
| | 3. Establishing soil fertility management with low input and low cost as to maintain sustainability of farmland with sandy soils | 6.1 Practical use of cropping residues and livestock wastes<br>6.2 Introduction of soil resting crop |
| | 4. Establishing cropping system considering maintaining soil moisture conditions in the field | 5.2.2 Non-till sowing system can improve water balance<br>5.2.3 Improvement of water balance in dried sand bed of crop root zone |
| Cropping system/farm management | 1. Crop selection and cropping system using crops with high tolerance to water stress | 7.3 Improvement of crop management (Introducing various feed crops into rotation system) |
| | 2. Effective and efficient fertilizing to reduce production cost of feed | 7.4 Appropriate fertilizer application technology (Production and application of compost and liquid manure, sustainable supply of micronutrient, manuring practice) |

3-(3)-(C)

| | | |
|---|---|---|
| Cultivation Type | : | Cultivation in Marginal Area for Cropping |
| Condition | : | Soil moisture condition : poor (3)　　Soil condition : low (C) |

Expected farming

The productivity of regular crops is extremely low due to low fertility and poor soil moisture conditions. Recovering soil fertility is expected in future through promotion of leguminous or gramineous grasses taking a time.

Crop selection and cropping pattern

[Pasture]

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Soil management | 1. Identifying the areas having high risk potential of wind erosion in region and in fields | 4.1 Qualification of areas suffering from wind erosion |
| | 2. Securing land coverage in the spring season by planting winter corps or perennial grasses. | 4.3 Crop selection and rotation system considering land coverage in the spring season, when the risk potential of wind erosion is high.<br>4.2 Conservation of existing trees and forests to prevent from damage |
| | 3. Maintaining and recovering soil fertility in purpose of prevention of farmland devastation | 6.2 Introduction of soil resting crop (Recovering soil fertility in long term though promoting grasses) |
| Cropping system/farm management | 1. Appropriate development and maintaining if grassland | 7.7 Management of meadows (Legume-grass mixture) |
| | 2. Use of grazing land | 6.3 Introduction of livestock grazing |

4-(2)-(A)

| | | |
|---|---|---|
| Cultivation Type | : | Cultivation of Crops Considering Protection of Natural Environment |
| Condition | : | Soil moisture condition : abundant (2) Soil condition : good (A) |

Expected farming

Farming based on abundant soil moisture condition and fertile soil, formed from flood plain, is expected. Large-scale development of irrigation and drainage facilities is restricted and input of chemical materials is expected to be restricted in future because this type is proposed mainly as the landscape protection area. Thus consideration of protection of natural environment is strongly required in farming there. Highly profitable crops can be introduced due to fertile soils but damage by weed or sick soil occurs easily.

Crop selection and cropping pattern

Highly profitable crops such as rapeseed and sunflower for oil crop, spring barley for raw material and wheat of food quality are promoted in the cropping system of this type. Maize, which has water tolerance and can be used as silage even when damaged, is promoted in frequently inundated or water damaged areas.

[Rapeseed/sunflower, spring barley, Food wheat, maize]

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Soil management | 1. Pretension of damage by disease and pest such as soil nematoda | 7.3 Improvement of crop management (crop rotation, fertilization and crop protection) |
| | 2. Prevention of plow sol compaction | 6.6 Prevention of plow sol compaction （Introducing upside down plowing, subsoil breaking, etc.） |
| | 3. Efficient maintaining and improving soil fertility besides reducing input of chemical fertilizer | 6.1 Practical use of cropping residues and livestock wastes |
| Cropping system/farm management | 1. Establishing rotation system of high profitable crops | 7.3 Improvement of crop management (Introducing proper crop rotation with highly profitable crops) |
| | 2. Establishing cropping system for preventing wet damage | 3.7 Introduction of a crop planting system based on the evaluation of land resources (Introducing water tolerant crops or maize which can be use as silage even when damaged) |
| | 3. Improvement of cultivation method for improving quality of production | 7.4 Appropriate fertilizer application technology (Production and application of compost and liquid manure, sustainable supply of micronutrient, manuring practice) |
| | 3. Crop protection and weed control with limited input of agricultural chemicals | 7.8 Prevention of damage by weeds (upside down plowing, proper application of agricultural chemicals) |

4-(2)-(B)

| | | |
|---|---|---|
| Cultivation Type | : | Cultivation of Crops Considering Protection of Natural Environment |
| Condition | : | Soil moisture condition : abundant (2) Soil condition : medium (B) |

Expected farming

Farming based on abundant soil moisture condition and fertile soil, formed from flood plain, is expected. Large-scale development of irrigation and drainage facilities is restricted and input of chemical materials is expected to be restricted in future because this type is proposed mainly as the landscape protection area. Thus consideration of protection of natural environment is strongly required in farming there. Damage by weed or sick soil occurs easily. Feed crops are promoted in this area due to comparatively low fertility and crop rotation system with soil resting crop is indispensable to maintain soil fertility.

Crop selection and cropping pattern

Wheat for animal feed is promoted as a major crop. Maize, which has water tolerance and can be used as silage even when damaged, is promoted in frequently inundated or water damaged area. Sol resting crop is important in the crop rotation system in this area.

[Wheat for feed, maize] + [Soybeans]

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Soil management | 1. Prevention of damage by disease and pest such as soil nematoda | 7.3 Improvement of crop management (crop rotation, fertilization and crop protection) |
| | 2. Prevention of plow sol compaction | 6.6 Prevention of plow sol compaction （Introducing upside down plowing, subsoil breaking, etc.） |
| | 3. Efficient maintaining and improving soil fertility besides reducing input of chemical fertilizer | 6.1 Practical use of cropping residues and livestock wastes<br>6.2 Introduction of soil resting crops |
| Cropping system/farm management | 1. Establishing rotation system of highly profitable crops | 7.3 Improvement of crop management (Introducing proper crop rotation with high profitable crops) |
| | 2. Establishing cropping system for preventing water damage | 3.7 Introduction of a crop planting system based on the evaluation of land resources (Introducing water tolerant crops or maize which can be use as silage when damaged) |
| | 3. Improvement of cultivation method for improving quality of production | 7.4 Appropriate fertilizer application technology (Production and application of compost and liquid manure, sustainable supply of micronutrient, manuring practice) |
| | 3. Crop protection and weed control with limited input of agricultural chemicals | 7.8 Prevention of damage by weeds (upside down plowing, proper application of agricultural chemicals) |

4-[Organic Farming]

| | | |
|---|---|---|
| Cultivation Type | : | Cultivation of Crops Considering Protection of Natural Environment |
| Condition | : | Soil moisture condition : abundant (2) Soil condition : good (A), medium (B) |

Expected farming

Farming based on abundant soil moisture condition and fertile soil formed from flood plain is expected. Large-scale development of irrigation and drainage facilities is restricted and input of chemical materials is expected to be restricted in future because this type is proposed mainly as the landscape protection area. Thus consideration to protection of natural environment is strongly required in farming there. Value added production by organic farming is expected fully utilizing fertile soils but damage by weed or sick soil occurs easily.

Crop selection and cropping pattern

Highly profitable crops in organic farming will be selected in the combination with crop contributing to maintenance of soil fertility.

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Soil management | 1. Prevention of damage by disease and pest such as soil nematoda | 7.3 Improvement of crop management (crop rotation, fertilization and crop protection) |
| | 2. Efficient maintaining and improving soil fertility besides without chemical fertilizer | 6.4 Establishing soil management technology for organic farming |
| Cropping system/farm management | 1. Establishing rotation system for organic farming | 7.3 Improvement of crop management (crop rotation for organic farming, introduction of resistant variety) |
| | 2. Crop protection and weed control without agricultural chemicals | 7.8 Prevention of damage by weeds (upside down plowing) |

5

| | | |
|---|---|---|
| Cultivation Type | : | Intensive Cultivation of Vegetables/Fruits Using Irrigation |
| Condition | : | |

Expected farming

In vegetable/fruit cultivation in the Zahorska Lowland, intensive cultivation is required because irrigation is indispensable due to the natural conditions and strict management in the field is required to produce high quality products accepted in market. Vegetable/fruit cultivation is considered as a sector for diversification of products in the farm management of the large-scale enterprise, as well as small scale enterprise and SHR aiming to develop farm management concentrating on them. Carrot, asparagus, cauliflower, onion, cabbage, potato, etc. are promoted in the area. Because marketing system including wholesale market has not yet developed and it will take a time to develop it, selling products in small market or direct to consumers is promoted to small scale farms and contract cultivation with food processing enterprise is promoted to large scale farms. Fruit cultivation is promoted to enterprise farm due to necessity of initial investment.

Crop selection and cropping pattern

Crops which have been cultivated in the area.

| Subject | Problem of agriculture and farming | Necessary countermeasures |
|---|---|---|
| Irrigation/drainage and water management | 1. Stabilizing irrigation water supply to stabilize production quantitatively and qualitatively | 2.4 Improvement / increase of existing functions of irrigation facilities (Increasing flexibility of facility to cope with small and intensive cultivation, additional functions such as organic irrigation)<br>2.5 Improvement of irrigation water management |
| | 2. Promotion of irrigation system to cope with intensive cultivation | 2.6 Provision of irrigation equipment adaptable to farming<br>2.7 Improvement of on-farm irrigation system to cope with intensive farming (introducing mixing apparatus for liquid manure or agricultural chemicals) |
| Soil management | 1. Prevention of wind erosion | 5.2.1 Mulching of soil surface on intensive farming field<br>4.1.2 Conservation of existing trees and forests to prevent from damage |
| | 2. Improving soil fertility of sandy soils | 6.1 Practical use of cropping residues and livestock wastes<br>5.2.4 Dressing of clay rich materials |
| | 3. Prevention of damage by disease and pest such as soil nematoda | 6.1 Practical use of cropping residues and livestock wastes<br>7.3 Improvement of crop management (crop rotation, fertilization and crop protection) |
| Cropping system/farm management | 1. Establishing cultivation practice of vegetable/fruit in the sandy soil | 7.6 Practice of vegetable/fruit cultivation |

# CHAPTER 4 TECHNICAL MEASURES

## SUBJECT-1 LAND RESOURCES EVALUATION AND APPROPRIATE LAND USE

### ITEM-1.1 LAND RESOURCES EVALUATION

The agricultural productivity of the Zahorska Lowland, where low fertility sandy soils are wide spread, is dominated by the soil conditions such as soil type or texture. It is necessary to take into account the contents of fine particles in the soil to evaluate the productivity and suitability for cultivation. The land resources evaluation system consists of three parts, i.e., productivity based on soil condition, possibility of irrigation, and various restrictions on land use from necessity of land conservation to circumstance of socio-economic conditions.

(1) Agricultural Productivity and Land Resources Evaluation

Please refer to Chapter 3.1~3.2.

(2) Potential of Irrigation

Please refer to Chapter 3.3.

(3) Various Restriction Factors

Please refer to Chapter 3.4.

Case of Land Resources Evaluation

(1) Evaluation of land productivity (soil unit)
Part 3 Chapter 2.1, Fig 3.3, Fig 3.9

(2) Possibility of irrigation (location of existing irrigation facilities)
Part 3 Chapter 2.2, Fig 3.4

(3) Other limiting factors (drainage problem, dry mound)
Part 3 Chapter 2.7.3, Fig 3.8

(4) Evaluation of Land Productivity

Under current condition of farming in the Zahorska lowland with certain disadvantage in their soil conditions, it is becoming much more important for each farming unit to convert rational land use based on the profitability analysis. Future program joining the European Community may accelerate approaching to the European standards, in the quality and price of products, increasing cost of labor and materials, and subsidy system. When land use was left to follow occasional situations,

it should result further degradation of land resources, and also destruction of rural environments of this area. Planned conversion of land use is key to assure sustainable development of agricultural development in the Zahorska lowland.

For this purpose, trial programmed-method of profitability analysis is proposed for common use on planning and judgment of land use. On the first step of this program, calculation and assumption is essential on the expected crop yield. This concept of expected yield represents expectable maximal yield which can be calculated from concrete productivity index on assumption of proper crop management under current economic and technical condition in this area. Through the analysis between the production cost and expected return, each farming unit becomes able to analyze their profitability of cropping, and to decide more reasonable use of their lands.

Slovak Republic developed their original point-values system of land evaluation. This system calculates the total points of the land capability using many kinds of factors accumulated in the soil database. This system is very valuable and useful for multipurpose judgment of land capability, particularly on the nation-wide level. However, it is also true that the evaluated point values represents the total of the multilateral properties of land, and can not give us direct and concrete information on the productivity of the land. In the study area, it is necessary to divide the sandy soils occupied nearly 80 or 90% of the land, and to find out useful method for calculation of the different levels of productivity index among the sandy soils.

Through the field survey and hearing survey from the farming units, it could be confirmed that limited water supply causes lower yield of crops in this area, and that growth and yield of crops on these sandy soils are mainly controlled by varying amount of water available from soil layer and effective rainfall. Relative water sufficiency, ratios between water requirement of crops and water supply, is major function of biomass yields in this case. Using Penman-Monteith equation (FAO revised 1998) these values were calculated based on recent meteorological monthly data and on the soil data measured in this survey.

In principle, this calculation is generally used for calculation of the amount of irrigation water required to fill up the water deficit between requirement and supply. When using this category for evaluating the probable effects on growth and yield of crop plants, particular attention must be paid.

It is also probable that productivity of the major sandy soils in this area is controlled mainly by one factor of soil texture or clay contents, for the clay contents that are generally paralleled with humus contents, show clear correlation with water holding and supplying capacity, as well as with nutrient holding and supplying capacity. The concept is set on the following assumption (1) proper timing of sowing, uniform emergence and normal growth of seedling (2) near saturation of field capacity at starting of the vegetative growth (3) adequate nutrient supply and proper pest and disease control. All of these assumptions may have some limitation.

Following to the calculation of the expected yield index, real values of the expected yield of crop were calculated using standard yield of crops. Category of the standard yield of crops should represent principally expectable maximal yield under sufficient water supply. In this trial calculation, the values of the standard yield were brought from the actual average maximal-yield of crops in this area collected from the farming units to assure reality in values of the expected yield.

Further examination of water physiology of crop plant population is also necessary. The first assumption is that the relative water sufficiency may have good correlation with total biomass production of the crop population. This assumption could be accepted under wide range of condition particularly for winter crops. The second assumption is that the grain yield of crops might be nearly proportional to the total biomass production. This assumption is not always true. Of cause, in the calculation equation different coefficient values are given for each stage of growth.

A slight degree of water deficit is generally rather essential for many kinds of cereal crop plant to complete their life cycle, for it is well known fact that the water deficit can accelerate conversion of growing pattern form the vegetative to reproductive one

such as bud formation, flowering and filling. On the contrary, severe water deficit causes wilting of crop population, and sometimes it results severe decrease in grain yield sometime near to zero. It is rather true that grain yield can be proportional to total biomass production only within limited range of conditions. In the reality of common cases, the correlation might be represented in logarithmic curve than liner one.

To complete more accurate equation to calculate the expected yield, more accurate data are necessary for depth of root zone, water requirement and also for the standard yield. These can be solved by technical measures, step by step, and must be not limiting factors for this concept.

(5) Trial Evaluation of Expected Grain Yield

1) Calculation of Expected Yield Index

It is known that there is a close relationship between the grain yield and water deficit ratio if crop has a sufficient condition on nutrient and dose not have restrictions other than water deficit ratio, such as disease and insect damage or drainage problem. In the Guidelines, the expected yield index is determined as the ratio of the expected grain yield under the water deficit ratio against the maximum expected grain yield. The following equation, expressing that relationship using crop evapotranspiration, was applied to calculate the expected yield index.

$$(1-Ya/Ym) = Ky\ (1-ETcadj/ETc)$$

| | |
|---|---|
| Ya/Ym: | Expected yield index |
| Ya: | Expected grain yield under water deficit |
| Ym: | Maximum expected grain yield |
| Ky: | Yield response factor |
| ETcadj: | Adjusted (actual) crop evapotranspiration during the growing period |
| ETc: | Reference crop evapotranspiration for standard conditions during the growing period |

Reference materials:

- FAO Irrigation and Drainage Paper No.33 “Yield Response to Water”, 1979
- FAO Irrigation and Drainage Paper No.56 “Crop Evapotranspiration - Guidelines for Computing Crop Water Requirement”, 1998

The expected yield index is calculated under the following assumptions:

- Irregular drought dose not occur in the certain period that crop is severely susceptible from water deficit ratio such as bud formation and flowering period.
- Irregular damage by the causes other than water deficit ratio such as drainage problem, disease and insect damage, etc. dose not occur.
- Neglect significant contribution of the groundwater to water supply to the root zone.

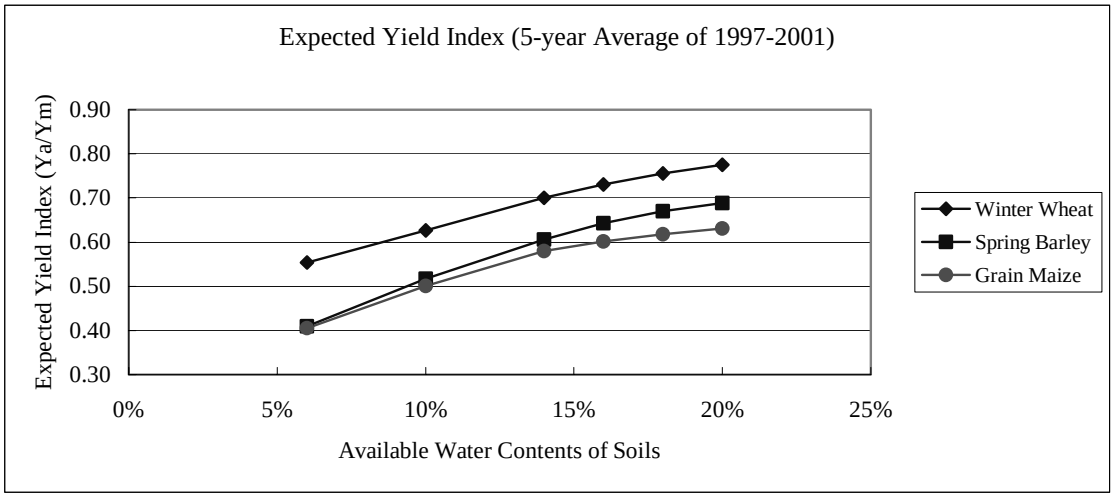
The evapotranspiration and crop water requirement are calculated on the method introduced by FAO. Necessary parameters for above calculation are also referred to the Irrigation and Drainage Technical Paper issued by FAO.

- ETo: Penman-Monteith Method
- Precipitation and other climatic data: Data observed in the Malacky Station prepared by SHMI
- Effective rainfall: USDA-SCS Method

In the trial evaluation, the expected yield index of winter wheat, which is considered as a dominant winter crop in the area, was calculated in 5 years from 1997 to 2001. The climatic and hydropedological data of observed in the case study and the Malacky Station were used for the calculation. The results are summarized as shown below:

Summary of Expected Yield Index

| | Available Water Contents of Soils | | | | | |
|---|---|---|---|---|---|---|
| | 6% | 10% | 14% | 16% | 18% | 20% |
| Winter Wheat | 0.55 | 0.63 | 0.70 | 0.73 | 0.76 | 0.78 |
| Spring Barley | 0.41 | 0.52 | 0.61 | 0.64 | 0.67 | 0.69 |
| Grain Maize | 0.41 | 0.50 | 0.58 | 0.60 | 0.62 | 0.63 |




Some of dominant summer crops in the Study Area, i.e., spring barley and grain maize are also calculated the expected yield index by same methodology in reference.

2) Conversion of Expected Yield Index to Expected Grain Yield

In order to convert the expected yield index to the expected grain yield, actual record of crop production and hydropedological data was collected at the certain field in the case study site. Based on the collected data through the case study, the maximum expected grain yield (Ym) is set as 5.5 ton/ha tentatively. To have further discussion on the value of the maximum expected grain yield and applicability of expected yield index, the field data has to be collected and analyzed in future.

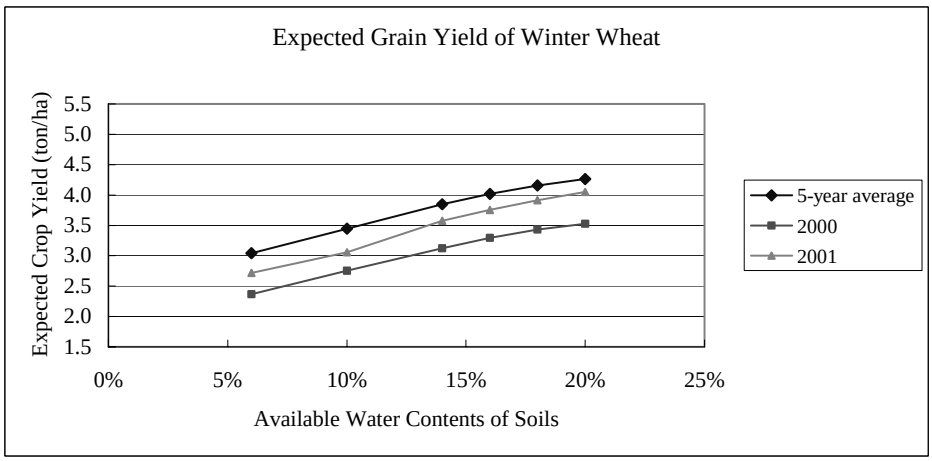
The tentative results of the expected grain yield of winter wheat are as shown below:

Summary of Expected Grain Yield Winter Wheat

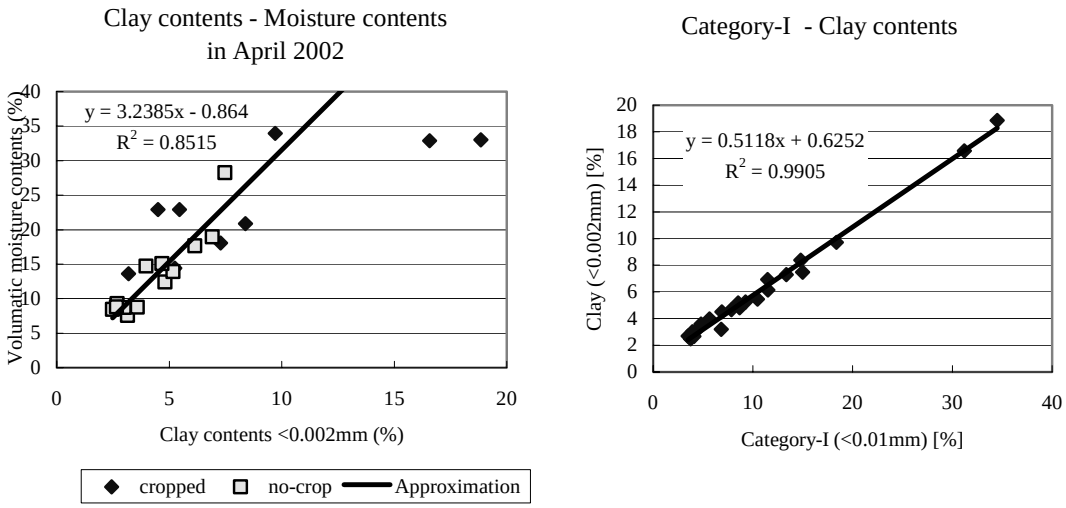
Tentative Ym = 5.5 ton/ha

(ton/ha)

| | Available Water Contents of Soils | | | | | |
|---|---|---|---|---|---|---|
| | 6% | 10% | 14% | 16% | 18% | 20% |
| 1997 | 3.3 | 3.5 | 3.8 | 3.9 | 4.0 | 4.1 |
| 1998 | 3.1 | 3.5 | 3.9 | 4.0 | 4.1 | 4.2 |
| 1999 | 3.7 | 4.4 | 4.9 | 5.1 | 5.3 | 5.5 |
| 2000 | 2.4 | 2.8 | 3.1 | 3.3 | 3.4 | 3.5 |
| 2001 | 2.7 | 3.1 | 3.6 | 3.8 | 3.9 | 4.0 |
| 5-year average | 3.0 | 3.4 | 3.8 | 4.0 | 4.2 | 4.3 |




According to the results of soil testing carried out in the field survey of the case study area in 2002, it was confirmed that there is a strong correlation between amount of fine particles and the water holding capacity, which is roughly represented by the field water contents just after precipitation, in the sandy soil area of the Zahorska Lowland, as shown below.




Relation between soil grain ditrubution and volumatic moisture contents based on the field data

## ITEM-1.2 EVALUATION OF PRESENT LAND USE

The present land use will be evaluated by comparing it with the result of the land resources evaluation mentioned above. Present land use is evaluated from the two aspects of effective use and sustainable use.

For the effective use of land resources, the following issues are to be examined:

- Resources such as existing irrigation facilities are used effectively.
- The appropriate crop is cultivated.

On the other hand, the sustainability of land use is examined considering the effort given to maintain the productivity.

- Unsuitable cropping is not carried out in marginal land for cultivation.
- Appropriate crop rotation system is introduced in the land requiring fertility management.
- Necessary measures for farmland conservation are carried out.

Rain-fed cultivation on sandy soils, which have low water holding capacity and low fertility and unstable and insufficient rainfall, requires the introduction of crop rotation systems including fallow fields, or the change of land use to pasture or meadows in the case of disadvantaged lands.

## ITEM-1.3 APPROPRIATE LAND USE THOUGH LAND RESOURCES EVALUATION AND LAND USE EVALUATION

The introduction of sustainable land use, which depends on appropriate land use evaluation, is indispensable to increasing productivity and protecting the environment. Based on this awareness, the following issues will be included in the Guidelines for effective use of existing data and rational land evaluation.

- Periodical updating of the land classification system based on new data from monitoring and continuous land use evaluation by the system.
- Technical guidelines for preparing land use guidelines based on land potential, reached by making full use of existing data and land evaluation.
- Guidelines for preparing the land use improvement plan of the area where land use change is necessary depending on the result of the land use evaluation.
- Guidelines on the effective use of abandoned farmland with suitable natural conditions, including identifying their distributions in the Study Area.

## SUBJECT-2 IRRIGATION

### ITEM-2.1 IDENTIFICATION OF AREAS WHERE IRRIGATION SYSTEMS CAN BE UTILIZED

Various crop cultivation and highly profitable management are possible on farmland where irrigation systems are applicable. Among factors such as land resources, the evaluation of the use of irrigation will be added as a potential or an attribute of land.

In Zahorska Lowland, irrigation is a major factor in productivity and productive stability of crops. Therefore, identification of areas with a high potential of irrigation use can contribute to agricultural development.

Identification of irrigation possibility in the Study Area
Part 1 Chapter 3.4.8, Fig 1.4
Identification of irrigation possibility in the Case Study Site
Part 3 Chapter 2.2, Fig 3.4

In the present study area, 16,224 ha of irrigated arable land have been developed by developing 21 irrigation systems, but some of the systems cannot be used due to malfunction, damage or loss of pumps. Potential of land where irrigation can be used will be evaluated according to the following criteria:

(1) Land where Irrigation can be Used

Land where irrigation can be used shall be in areas where the existing irrigation systems can be used or recovered relatively easily and economically.

- Areas where irrigation is used now
- Areas where the irrigation can be restored by replacement of parts.

(2) Land where Irrigation cannot be Used

Land where irrigation cannot be used shall be area where large-scale repairs of irrigation facilities are necessary and a restoration plan is not mapped out.

- Area where irrigation facilities have not developed
- Areas where main mechanical equipment, such as pumps, are damaged or lost

- Areas where irrigation facilities have not been used or have been abandoned for a long time

(3) Evaluation of the Potential of the Use of Irrigation

Among zones covered by the 2001 survey, those where irrigation facilities work and irrigation is possible (including those requiring small repairs), and those where irrigation is impossible due to malfunction of pump facilities, and their areas can be classified as shown in the table below.

Potential of Irrigation Use

Unit:ha

| Zones | Zone I Fan of the Male Karpaty | Zone II Malacky Plain | Zone III Flood Plain | Zone IV Suburbs of Bratislava | Total |
|---|---|---|---|---|---|
| Area with irrigation facilities | 2,399(6) | 9,652(7) | 622(2) | 3,551(6) | 16,224(21) |
| Irrigation available area | 800(2) | 7,885(4) | 0(0) | 1,295(2) | 9,980(8) |
| Irrigation not available area | 1,599(4) | 1,767(3) | 622(2) | 2,256(4) | 6,244 |
| Evaluated year | 2001 | 2001 | 2001 | 2001 | 2001 |

( ): Number of irrigation systems

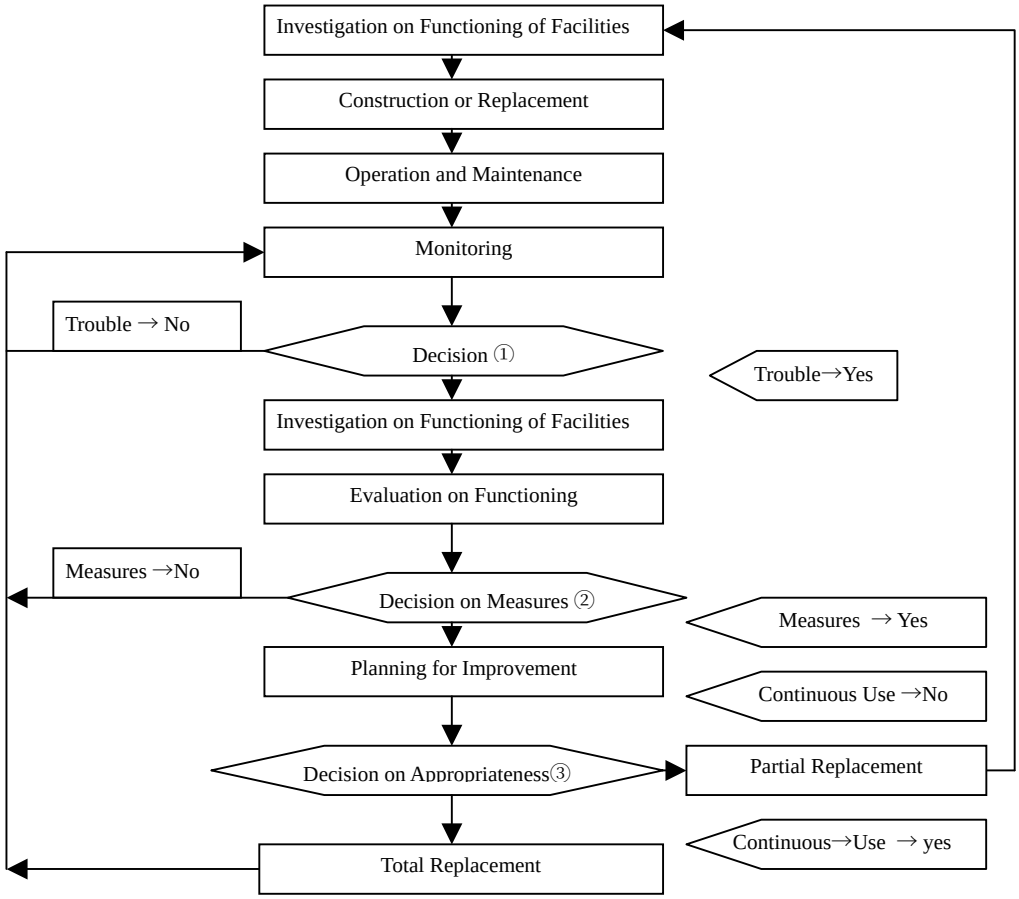
Evaluation of land where irrigation can be used must be updated every two or three years according to the functioning of these irrigation systems.

## ITEM-2.2 REHABILITATION OF FACILITIES

(1) Basic Concept on Rehabilitation of Facilities: Corrective Maintenance and Preventive Maintenance

So as to secure consistent supply of irrigation water, it is essential that the operation and maintenance of irrigation works should be carried out in a premeditated manner. An obsolescence in functioning of facilities, timing for replacement of improvement (partial replacement or total replacement) should be decided after taking account of economic viewpoint like life-cycle of facilities and integrated diagnosis on functioning of facilities that pays attention to risk management in case of damage, etc. In establishing the maintenance program of facilities, it is important to consider both idea of corrective maintenance, which is activity to cope with degradation failure, and that of preventive maintenance, which is activity to prevent degradation of facilities before actualization of failures.

An appropriate administration and information are focal factors for attaining longevity of facilities and minimization of global cost for operation and maintenance during total life of facilities. Based on the said concept, it is important to establish the Method and system that facilitate the procedure for evaluation on functioning of facilities and implementation of operation/maintenance and replacement is as illustrated in the flow chart below.




Flow chart
The procedure for evaluation on functioning of facilities and implementation of operation/maintenance and replacement
(The flow chart refer from Jour.JISIDRE MAY 2001)

Maintenance of facilities and equipment becomes costly and severely passing through years even in the life-cycle period. Maintenance work is carried out as a corrective maintenance, which is conducted after actualizing the degradation or

failures in general. In case of facility/equipment of which failure by degradation will give serious influence to agricultural production or rural livelihood, it is important to introduce the idea of preventive maintenance in maintenance program, which will reduce damage or influence to other facilities/equipment and will reduce the total amount of maintenance cost.

(2) Evaluation of Functions of Existing Facilities

To evaluate functions of irrigation facilities, facilities will be classified according to kinds of work, and the planned components and functions will be clarified. Inspection of the functioning of facilities, and checking of damage or loss will be done periodically and then a renewal plan will be made based on the evaluation, which will be made to contribute to smooth operation and maintenance.

1) Organization Evaluating Functions and Equipment of Facilities to be Inspected

Case of function evaluation of existing irrigation facilities
Part 3 Chapter 2.2.2

Main components of an irrigation system are a water intake, pump stations, a pipeline network and field irrigation facilities (sprinklers). Among these facilities, operation and maintenance of the water intake, the pump stations and the pipeline network and inspection of their functions are carried out by private management companies commissioned by the SWME-PD or the SWME-PD. Field irrigation facilities are operated and maintained by farmers who also inspect the functions.

As irrigation facilities have been used for 20 to 30 years as of 2002 and their deterioration is advancing, it is necessary to strengthen the periodical evaluation of facilities. After discussion and a field investigation with the maintenance agency in 2001, the standard frequency of inspection is proposed as the table below.

Proposed Standard Frequency of Inspection

| Facilities item | Check & maintenance organization | Content of facilities (Inspection of functional state and damage) | Frequency of checks | |
|---|---|---|---|---|
| | | | Amount check | Function check |
| Intake facilities | SWME-PD | Intake facilities, gates, screen, Pipe of apparatus | Once a year | Once in Two years |
| Pump Station | SWME-PD | Transformer, motor, pump, valves, control panels, pressure tanks and etc. | Once a year | Once a year |
| Pipeline facilities | SWME-PD | Pipeline (Water leak), valves (sluice and air), hydrant and etc. | Once a year | Once in Five years |
| On farm irrigation facilities | Farmer | Reel hose and Sprinkler | Once a year | Once a year |

2) Evaluation of Water Intake and Pump Station Functions

According to the record of the water intake and pump stations, their function and management conditions will be evaluated, which will contribute to basic materials for the recovery plan. In the present study area, recovery of some pump stations seems impossible by regular maintenance or repair work due to damage of pump station facilities or loss of mechanical equipment. Therefore, such a pump station will need a reconstruction program.

As it is difficult to get parts of pumps because their models are old, the remaining parts of each pump station can be used in other stations. Therefore, a plan for the effective utilization of parts will be required.

3) Evaluation of Pipeline Functions

As for pipeline functions, it is necessary that an inspection should be carried out regarding attached facilities such as underground pipes and valves, air valves and hydrants. The functional state of pipes will be confirmed by the water-flow test (water-leak test). The state of attached facilities will be examined visually and by operation because of structures in the ground. Their functions will also be confirmed by operation at the time of the water-flow test.

It is reported that, in implementation of road construction or installation of pipes to cross with gas pipeline, leakage of water takes place sometimes because pipes were not installed correctly once they had been removed temporarily. So as to avoid such

incident, it is prerequisite that demarcation of responsibilities among relevant public institutions should be clarified and the function of pipelines should be verified with water flow test after completion of construction works.

Water flow test was carried out in order to evaluate the function of pipelines in the Case Study Site as a part of the Study in 2001. The procedure including pressure to be applied, checkpoints during test and results of test are shown in Supporting Report B.9. The case will contribute to future implementation of water flow test as a sample.

4) Field Irrigation Facilities

Ninety five percent of mechanical irrigation equipment that farmers manage is of the reel hose sprinkler type. The equipment in the Zahorska Lowland is old; 30% of the equipment can be used now, 10% requires repair and 60% cannot be re-used. To expand irrigated agriculture, a key point is the improvement of irrigation facilities held by farmers and support in both techniques and funds.

The maintenance situation of field irrigation facilities is reported in the “Analyza Technologickeho Stavu Zavlahoveho Detailu Na Slovenskyu” (Published: Vyskumny Ustav Melioraccll A Krajinneho Inzinierstva). These information and data can be utilized for the planning of future maintenance, budgetary plan, etc.

(3) Preferential Evaluation of Facilities Function Recovery and Making Restoration Programs

Restoration programs for irrigation systems will be made after examining facilities function recovery from the technical and economic viewpoints, determining the priority, and considering farmer’s wishes regarding irrigated agriculture.

1) Preferential Evaluation of Facilities Function Recovery

Although there are 21 irrigation systems in the present study area, only eight systems operated and those remaining were out of operation in 2001. An irrigation system is a

combination of water intake, pumps and a pipeline network. There were no systems where irrigation stopped because the function of the water intake was bad. Though the pipeline has not been used for a long time in some zones, it can be judged that damage is small except for hydrants.

The main reason why the irrigation systems are not used is defective pump stations. Therefore, priorities will be determined according to the evaluation of the functioning condition of pump facilities, the use and recovery cost. The 21 irrigation systems in this area are grouped into the following four categories to evaluate the priority.

Evaluation of Function of Pump Facilities

| Category | Contents of facilities | Irrigation system | Pump station | Irrigation Area (ha) |
|---|---|---|---|---|
| Category I | Irrigation is carried out with pumps operated in 2001 with repairs. | 8 | 10 | 9,980 |
| Category II | Although pumps are not operated, they can be recovered by renewal/supply of parts. | 4 | 4 | 3,319 |
| Category III | Facilities have not been used for a long time and there is much equipment to be renewed, such as a pressure tank and a power distribution panel. | 4 | 4 | 1,179 |
| Category IV | The main equipment and the pump station are lost or severely damaged and their recovery is difficult. | 5 | 5 | 1,746 |

(Evaluated year: 2001)

Category I:

Pump stations, which had operated until 2001. Although some of them have damaged pumps or operate pumps with replacement components cannibalized from the same type of pump, their water supply system is judged to be running successfully on the whole. (The Zohoznik irrigation system completes the improvement of the pump equipment.)

Category II:

Pump stations that are not so heavily damaged as to need replacement of the pump itself, but which require the repair of a damaged motor, parts or transformer to make them operable.

Category III:

The pump is damaged and its parts are lost. These stations have not been operated for more than ten years. It is difficult to make them fit to resume operation by the simple replacement of parts or partial replacement of motor components.

Category IV:

The main pump and motor are damaged or lost and the provision of new equipment will be necessary. A reconstruction program based on a plan for new equipment is required.

Category I is the irrigation system to which the restoration plan should give top priority, where facility improvements seem economically most feasible. It is followed by Categories II, III and IV in that order.

2) Making Restoration Plans

a) Classification of Restoration Plans

Depending on damage to the facilities, the restoration plans may be classified into the Recovery Plan in which the function of the pump station can be recovered simply with repairs, and the Reconstruction Plan in which the pump station is heavily damaged to the extent of needing reconstruction, including the re-examination of irrigation plans. Based on the functional assessment of pump station facilities as in (2) above, it is advised to classify the respective pump stations into the Recovery Plan Group and the Reconstruction Plan Group, and start necessary improvements step by step.

The Recovery Plan will be executed as Phase I, then, the Reconstruction Plan will be proposed to be tackled with in Phase II. The table below shows the phased classification of the respective irrigation systems:

Restoration Plan of Irrigation System

| Stage of Restoration project | Category of facilities function | Irrigation area（ha） | Content of plan | Object pump station |
|---|---|---|---|---|
| Recovery plan project<br><br>(Phase I) | Category I, II<br>（11irrigation systems &12pump stations） | 13,299 | Replenishment and the improvement of Pump motors, transformer, other machine parts | StupavaI.Cs01, .Cs1, Cs2, Zahorska ves, Gajary, Dolecky, Kostoliste, Lozorno Cs1,Cs2, Plavecky, Sekule, Zavod, Male levare |
| Reconstruction plan project<br><br>（Phase II） | Category III, IV<br>（10 irrigation systems & 10 pump stations） | 2,616 | Review of irrigation plan, reconstruction plan of pump facilities, farmer's intention investigation of irrigation agriculture | Stupava.I. Cs1, Cs3, Stupava.II.Cs4, Cs5, Lozorno-Lintary, Jablonove, Jakubov, Kuchyna, Tomky, Vysoka Morava (Management by private company) |

Restoration programs will be made in accordance with the priority set for the need of facilities repair. Farmers have the following problems regarding irrigation other than repairing facilities:

- Farmers cannot prepare field irrigation equipment.
- Farmers cannot use an irrigation system because it is not what they need.
- Will to irrigate is weak because the benefit of increased production is too little for the investment.

Therefore, it is necessary to make irrigation restoration programs for the whole area after carrying out comprehensive discussions including the preferential evaluation of recovery of the functions of facilities and the above-mentioned problems that farmers have.

b) Priority of Recovery Plan

In the Recovery plan project, the irrigation systems of Category I, where irrigation is carried out now, is evaluated as a zone with higher priority because the pump and pipeline facilities are functioning on the whole and the farmer’s intentions favor irrigated agriculture. The total area of the irrigation systems in Category I is 9,980 ha, of which, the area where irrigation is used at present is 2,980 ha. The remaining 7,000 ha will be an area to be improved.

c) Implementation Procedure of Recovery Plan

In the Guidelines, the restoration program is proposed to implement by two phases; recovery plan and reconstruction plan, according to the assessment of facilities by 4 categories. A promotion of irrigation farming is realized by restoration program, which requires investment to implementation. The cost of restoration program in the Study Area was roughly estimated as shown in the table below, based on the estimation of recovery cost of facilities in the Case Study Area. It is necessary to establish the implementation plan efficiently through evaluating economic effect, budget allocation for restoration, user needs, etc. This rough cost estimation shown below is necessary to improve accuracy before examining the implementation plan.

Rough Cost Estimation of Restoraton of Irrigation Facilities

| Ctegory | Area | Unit Repair Cost | Total Repair Cost | Remarks |
|---|---|---|---|---|
| | (ha) | (SKK/ha) | (SKK) | (US$) |
| Category-I | 9,980 | 6,000 | 59,880,000 | 1,330,667 |
| Category-II | 3,319 | 21,600 | 71,690,400 | 1,593,120 |
| Category-III | 1,179 | 50,800 | 59,893,200 | 1,330,960 |
| Category-IV | 1,746 | 72,600 | 126,759,600 | 2,816,880 |
| Total | 16,224 | | 318,223,200 | 7,071,627 |

Source: JICA Study Team 2002

Case Study on Economic Viability of Irrigation Recovery

According to the assessment in the Case Study, it is considered that the facilities in Category I to III are economically feasible on the assumption of maximum use of irrigation (Scenario A), on the contrary, only those in Category I are considered economically feasible if irrigation would not be used widely even recovered (Scenario B and C). It shall be assessed based on mode accurate cost and benefit estimation in future.

## ITEM-2.3 STRENGTHENING OPERATION AND MAINTENANCE

### (1) Stabilise Supply of Irrigation Water by Strengthening Operation and Maintenance of Pump Facilities

Pumps are key pieces of equipment of irrigation facilities. Periodic inspections of functions and suitable maintenance and management are necessary for safe operation of pumps. In order to carry out repairs smoothly, unification of parts is required.

The operation and maintenance of pump facilities, including the pumps now operating, should be strengthened with priority given to the preferential zone with the highest investment effect, to effectively use the budget. Efficient use should be aimed at by intensive budget appropriation and unification of parts, and not treating all irrigation systems equally. Pumps are manufactured in Czech and parts will be purchased from Czech. Therefore, as a long period is necessary for recovery, it is desirable to carry out improvement work in winter.

(2) Appropriate Management of Terminal Facilities (Unification and Land Use Rights)

Of pipeline problems, the most frequent are caused by big machines crashing into a valve for water management, an air valve or a hydrant. In this regard, it is of importance to get consensus from the part of farmers in relation with functions of terminal facilities and operation and maintenance of these facilities.

The irrigation facilities are state assets owned by the SWME-PD from the water intake to the pipeline terminals (hydrants), and are managed by the SWME-PD (SWME-ID after the organization revision). However, terminal irrigation facilities of gate valves, air valves and hydrants are set up in farmland and are often hit by big machines during farming work. These accidents cause leakage of water from, and damage to, the pipeline. In view of this, maps and manuals showing the location and structure of the pipeline and terminal facilities should be distributed to farmers so that they may understand the functions of facilities and be willing to offer cooperation in avoidance of the said accidents.

Points in management manuals:

- Pipeline drawings for the purpose of safe management
- Management and use of the terminal facilities, and explanations and short courses on their operation
- Instruction of safety operation of agricultural machinery to protect hydrant and other facilities
- Farmers reporting damage, breakage, problems, etc. of the facilities

## ITEM-2.4 IMPROVEMENT OF THE FUNCTIONS OF FACILITIES

### (1) Improvement/Change to Realize Irrigation Facilities that can Meet Requirements of Small Intensive Irrigation Zones

| |
|---|
| In Zahorska Lowland, accompanying the progress of the market economy, intensive agriculture using irrigation for vegetables and fruit trees has been introduced in recent years. For effective use of irrigation facilities, improvement/change is needed to meet the requirements of small intensive irrigation zones. |

The existing pump irrigation system is a basic system intended for cereals, and sprinklers in fields have been constructed to use reel hoses and center pivots. The pipeline network is a reticulated pipeline system. Several pumps are set and the volume of water sent from the pumps to the field is controlled by the number of operating pumps.

The water discharge volume per pump is in the range of 3,000 to 7,000 l/min on average, and the irrigation area that can be covered is 20 ha to 100 ha. The pipeline pressure is as high as 5 to 7 kg/cm$^2$.

Flows of 15 to 20 l/sec are supplied from one hydrant. Such an irrigation system is unsuitable for small intensive irrigation. To ensure a steady but non-extravagant supply of irrigation water and to fill the requirements for intensive irrigation, the following measures are necessary.

- Installation of small pumps to control amount of flow
  - Equipment supporting to control the amount of flow of main pump
- Installation of farm ponds and small pumps
  - Facility/equipment aiming to cope with the fluctuation of water use in the field and to give flexibility
  - Small pumps to supply water to the fields where farm ponds cover.

- Installation of decompression devices
  - Equipment to enable to introduce irrigation system requiring low pressure such as drip irrigation to the existing high pressure system

In addition, small intensive irrigation systems can introduce a device which injects fertilizers and pesticides and are effective in reducing labor for fertilization and extermination of harmful insects and diseases.

In the irrigation plan of the Case Study, the existing hydrant is proposed to be used as it is and a reel horse type sprinkler is proposed for cereal crops and sunflowers besides reel horse sprinkler with spray type nozzle is proposed for vegetables, according to the characters of target crops and effective use of existing facilities.

(2) Low-Pressure Irrigation using Natural Pressure

| |
|---|
| It is possible to improve irrigation systems with a reservoir to allow irrigation with natural (gravity) pressure to be used in zones with a difference in altitude between the level of the reservoir water and farmland. |

Zone I located northwest of Male Karpaty depends on reservoirs as an irrigation water source. There is a difference in altitude between the reservoirs and the cultivated fields. It is possible to use low-pressure spray and drip irrigation for vegetables and fruit trees, which are cultivated intensively, with this drop (a difference in altitude), although potential zones are limited (Lozorno, Kuchyna and Plavecky). To use this irrigation method, a plan based on surveys of the potential zone, selection of crops and irrigation equipment, will be required.

## ITEM-2.5 IMPROVEMENT OF WATER MANAGEMENT

### (1) Water Management by User Participation

Recently, the requirement for usage of irrigation water is becoming severe due to diversification of cultivation and increase of intensive agriculture. Therefore, water management by user participation is important to satisfy farmers' demands for water.

The existing irrigation facilities are designed in line with the irrigation plan of a crop rotation system of summer crop and winter crop, which would not conflict in water use. The dimensions of design, such as pump capacity or amount of water permission, are planned to cover 40% of the total regulated area using the above irrigation plan. Irrigation farming is changing from the style considered originally, and a new irrigation plan is necessary. In preparing the new irrigation plan for the restoration and improvement program of irrigation facilities, it is necessary to arrange among stakeholders that the plan for field irrigation does not exceed capacity, especially where there are several users.

Irrigation water is supplied by the water management entity (SWME-ID, Private company), and farmers use water from the hydrants. All water stops if there is any trouble with pump facilities or power saving. This is one factor restricting expansion of irrigated agriculture.

If farmers were allowed to participate in water management, the water management entity would be able to gain information about the crop irrigation water needs and emergencies from the farmers, and thus more timely and effectively distribute water supply. In addition, the water management entity could also obtain precise information about any damage to trunk-line pipes, hydrants or valves. On the other hand, farmers' requests for the use of irrigation facilities include:

- Determination of zones where irrigation facilities can be used
- Measures for the improvement of intensive-type irrigation facilities
- Clarification of periods when irrigation water will be used (seasons and time)

Therefore, water-managing entities should intensify their water management to respond to a wide range of farmer's wishes and needs in water use.

A rotation irrigation, that is, water user uses irrigation water in order to reduce peak discharge of system, is required to introduce in the field when the irrigation will be expanded. In addition, a limitation that 4 or 5 hydrants are allowed to use at once in certain rotation block will occur. In order to solve conflicts of water use in such circumstance, the coordination of water use between water users becomes important. Farmers' council for water use is proposed to establish by participation of farming bodies in rotation block or pump covering area and it will be promoted under instruction of water management company and SWME-ID.

(2) Establishment of a Water Management Council on a Regional Level

When multiple irrigation systems use water from one water source (canal, reservoir and pump designed specifically for water intake), it is necessary to establish a water management council on a regional level from the viewpoint of rational water distribution and effective use of the water source.

In this study area of Zahorska Lowland, there are the following five cases where one water source is used by multiple irrigation systems:

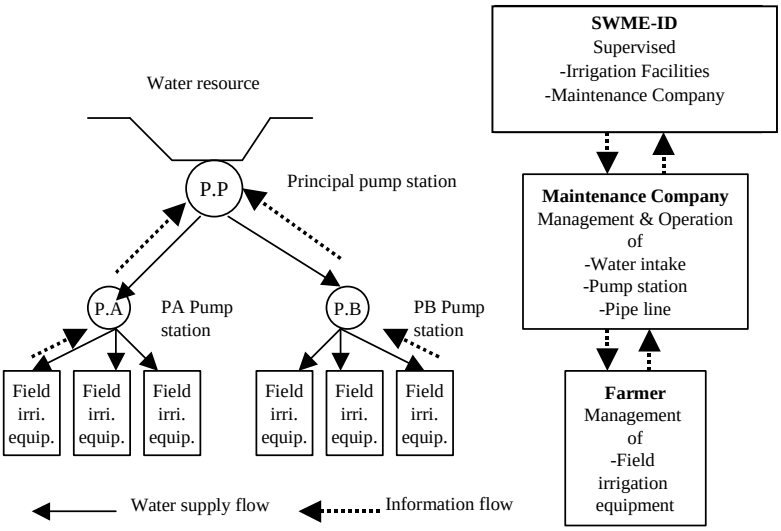
Water Resources Used by Multiple Irrigation Systems

| No. | Water resources | Number & location of Irrigation system | | Irrigation area (ha) |
|---|---|---|---|---|
| | | No. of System | Related irrigation system | |
| 1) | Malolevarsky canal | 3 | Secle-Male levare cv3, V4 zavd, csv5 | 2,540 |
| 2) | Morava（Stupapa:P1） | 3 | Stupava cs1, cs2, cs3 | 2,440 |
| 3) | Morava（Stupapa:P5） | 2 | Stupava cs1, cs4, cs5 | 670 |
| 4) | Morava (Gajary:P11) | 2 | Malacky Ics Dolecky, Iics Kostoliste | 6,670 |
| 5) | Lozorno Reservoir | 2 | Lozorno cs1, cs2 | 1,380 |

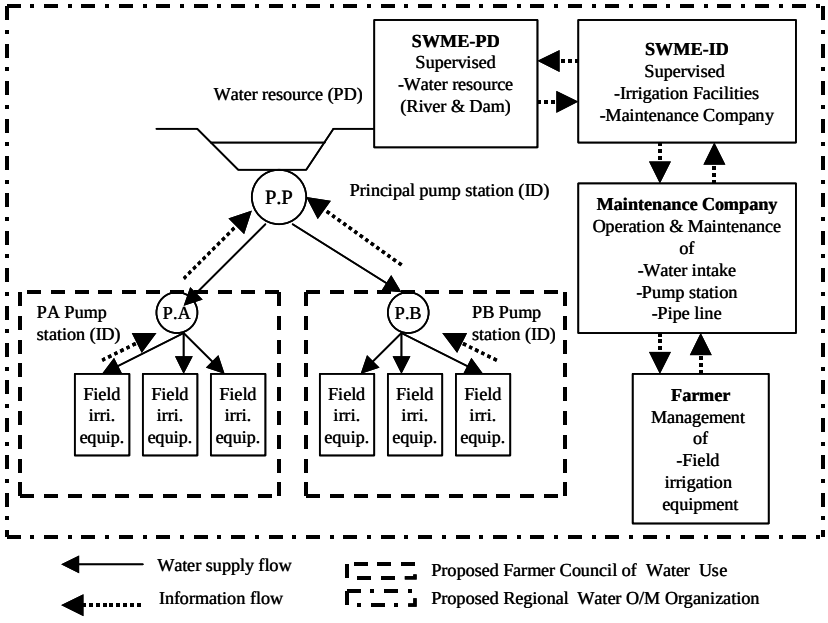
In such a case where multiple irrigation systems use one water source, it is anticipated that the water management of a single irrigation system alone will not be able to undertake equitable and rational distribution throughout the entire zone. To be specific, in the summer when water consumption is extremely high or in the case of a shortage of water at the source, problems may occur as to how water should be equally distributed to each irrigation system (whether the priority should be given to

upstream users or whether it should be given to specific crops).

Therefore, if the demand for water increases in the future, it is essential that the council in question with participation of farmers and water management company should take charge of an effective and equitable distribution of water with attention paid to water demand and distribution by source of water, operation time of pumps, water supply volume, rotation irrigation, etc.




**Existing Water Management for Irrigation System**




**Water Management Organization of Pump Irrigation System**

## ITEM-2.6 PROVISION OF IRRIGATION EQUIPMENT MEETING REQUIREMENTS OF CULTIVATION

Consciousness of irrigated cultivation is rising as a result of multiple agricultural operations and intensive cultivation. It is necessary to provided irrigation methods and equipment, which are suitable for cultivation of vegetables and fruit trees.

### (1) Preparation Plan of Irrigation Equipment

In Zahorska Lowland, more than 93% of irrigation facilities are large sprinklers of the reel-hose type. Reel-hose sprinklers are suitable for cereals, but unsuitable for vegetables because their pressure is too high for vegetables and the size of waterdrops is large. They are also unfit for fruit trees from the viewpoint of water saving. In the future, diversification of cultivation will require provision of irrigation equipment to suit prospective crops. Accordingly, the following basic conditions will be determined to improve irrigation equipment:

- Selection of crops to be cultivated (vegetables, fruit trees)
- Selection of zones to be irrigated (locations of the pipeline and hydrants)
- Determination of area of cultivation, funds to be invested, and manpower

### (2) Selection of Irrigation Equipment

Irrigation equipment, including hydrants and subsequent materials in the fields, will be improved and maintained by farmers themselves. Farmers must be taught about application, selection, benefits, steps of improvement, maintenance and budgets for the irrigation equipment.

Although the SWME-ID is a central organization for the technical spread of irrigation equipment, it is also possible to ask consultants to, for example, design the installation of equipment. The following table shows examples of conditions of uses such as suitability of irrigation equipment for crops, labor for irrigation and the volume of sprinkled water.

Application of Field Irrigated Equipment

| Type of irrigation system | | Applicable crops | Max. Height of crop (m) | Max. Slope of field (%) | Shape of field | Field Surface condition | Size of unite system (ha ) | Labor required (hr/ha) | Water application rate (mm/hr) |
|---|---|---|---|---|---|---|---|---|---|
| Sprinkler system | Solid | Vegetable & fruit | No limit | No limit | No limit | No limit | 1 or more | 0.1-0.2 | 1.3-50 |
| | Reel hose | Vegetable & fruit | 1.2 | 5-10 | Rectan-gular | Clear of Path for tower | 10-30 | 0.2-0.7 | 2.5-50 |
| | Hand move | Vegetable | No limit | 20 | Rectan-gular | No limit | 1-25 | 1.2-3.7 | 2.5-50 |
| Micro-irrigation | Drip | Vegetable & fruit | No limit | No limit | No limit | No limit | 1 or more | 0.1-0.2 | 2-8 l/hr .pc |
| | Spray | Vegetable & flower | No limit | No limit | No limit | No limit | 1 or more | 0.1-0.2 | Max120 l/hr .pc |
| | Perforated tube | Vegetable & nursery | No limit | No limit | No limit | No limit | 1 or more | 0.1-0.2 | Max12 l/hr .pc |
| | Under Ground drip | Vegetable | No limit | No limit | No limit | No limit | 1 or more | 0.1-0.2 | 2-8 l/hr .pc |

As field irrigation equipment, large-scale sprinkler system with high pressure such as reel hose sprinkler or center pivot system is recommended to crops of wheat, maize and sunflower. On the contrary, spray type sprinkler and mid-low pressure sprinkler system are recommended to vegetable cultivation and drip irrigation is recommended to fruit trees. The cost of equipment is roughly estimated as shown below:

Rough Cost Estimtion of Field Irrigation Equipment

| Items | Uit | Reel hose sprnkler | Reel hose sprinkler with spray type nozzle | Removal sprinkler type | Drip irrigation |
|---|---|---|---|---|---|
| Equipment cost | SKK/set | 450,000 | 568,122 | 84,600 | 180,000 |
| After subsidypric (30%) | " | 135,000 | 170,437 | 25,380 | 54,000 |
| Life of equipment | yar | 12 | 12 | 12 | 12 |
| Irrigation are /year | ha | 18.2 | 10.4 | 1.0 | 1.0 |
| Expense | SKK/ha/year | 618 | 1,366 | 2,115 | 4,500 |
| Maintenance cost | SKK/ha/year | 31 | 68 | 106 | 225 |
| Total cost | SKK/ha/year | 679 | 1,456 | 2,234 | 4,738 |

Cost estimte in 2002

## ITEM-2.7 IMPROVEMENT OF FIELD IRRIGATION SYSTEMS TO COPE WITH INTENSIVE AGRICULTURE

Intensive agriculture enables farming that brings about a high added value, but an irrigation system suitable for crops is necessary. Proper selection and utilization technology for irrigation equipment as well as regulation water tank aiming at multi-purpose use of irrigation water are required.

### (1) Field Irrigation System

In intensive agriculture, irrigated agriculture is indispensable from the viewpoint of quality control and productivity. For irrigation, middle to low-pressure water supply system which enables stricter control of the water flow will be employed. Therefore, pressure reducing devices and facilities for control of the water-flow will be necessary at the point joining the existing pipeline.

Drip irrigation and micro sprinklers will be used for low-pressure irrigation and sprinklers will be used for middle-pressure irrigation. The irrigation equipment will be selected according to species of crops, methods of cultivation, and workability of both agricultural land and irrigation. If a multi-purpose sprinkling plant is introduced into the irrigation system, it will enable supply of moisture, as well as liquid fertilizer and insect-controlling chemicals, and reduce labor.

### (2) Water Supply System

As field irrigation systems for intensive agriculture require fine control of the volume of irrigation water and irrigation time, it is difficult for the scale and structure of existing pump-pipeline systems to satisfy this requirement and the following measures are necessary:

- Application of small pumps for control of flow amount
- Application of regulating water tanks (farm ponds) and pumps to control irrigation freely

## ITEM-2.8 ESTABLISHMENT OF WATER-SAVING TECHNIQUE

Water-saving irrigation greatly contributes to effective use of water sources and saving of irrigation costs (for electric power and irrigation work). Establishment of water-saving techniques based on soil moisture control and the countermeasure of water management with water meters and improvement of the water supply system is important for the spread of water-saving irrigation.

### (1) Water-Saving Cultivation according to Evaluation of Soil Moisture

Irrigation water is sent from a pump station at the water source to fields through pipes, and irrigation by means of sprinklers is used in fields. Under this irrigation system, there is a very little loss of water due to the system itself. But, because electric power is used for water supply, water-saving in irrigation contributes to saving of agricultural operation costs.

Therefore, an important point of water-saving irrigation is soil moisture control to irrigate efficiently within the range of field capacity. Water will be saved by clarifying the field capacity of each soil type and then controlling the irrigation water requirements (which can be obtained from the relation between the field capacity and available moisture obtained from the crop-root zone), the number of irrigation intervals, and strength of spray irrigation. For this purpose, it is necessary to collect and accumulate basic materials regarding techniques related to soil and crops for water-saving irrigation in Zahorska Lowland. Soil moisture control by proper volume needs soil moisture meters and the soil moisture management, which the farmer uses, becomes important.

### (2) Water-Saving Sprinkling Facilities and Water Meters

Sprinkling facilities to be introduced into intensive agriculture are water-saving irrigation systems such as drip irrigation and micro-sprinklers. Therefore, a water meter will be placed in the inlet pipe so that farmers themselves can control irrigation water. Water meters are also important to confirm water-saving irrigation by the farmer himself.

(3) Improvement of Water Supply Facilities

In addition to water-saving irrigation facilities in the fields, other key facilities such as pumps and the pipeline must be suitable for water-saving irrigation. Unless a water supply system can satisfy the farmer's immediate demand for water, water sent from a pump station will be discharged ineffectively and electric power will be consumed uselessly. In order to send irrigation water quickly in a manner suitable for cultivation, it is necessary to take measures from the viewpoint of both management and hardware. This includes improvement of water supply management techniques based on information in the farmer's plan of use, increase of small-sized pumps and installation of regulating ponds.

## SUBJECT-3 DRAINAGE

### ITEM-3.1 EVALUATION OF LAND RESOURCES IN TERMS OF DRAINAGE MEASURES

For drainage capability of land, zones with risks of floods and ponding, those with risk of inundation and those where natural (gravity) drainage is possible will be specified, and circumstances of drainage improvement and risks to farming in each zone will be evaluated, and these results will be added to the items of land resources evaluation.

This study area located in Zahorska Lowland is divided into three zones in the terms of drainage circumstances. Functions and risks in farming can be evaluated as follows according to drainage measures in each zone:

(1) Flood and Ponding Tolerance Zone I (The Morava River Land)

This zone consists of the Morava River land and its flood storage basin. The farmland has a risk of deluges during flooding and a risk of inundation during thawing, and has actually been damaged. However, as it is in a basin and inside banks, measures for improvement by drainage canals is limited (it is, in fact a zone which cannot have measures for drainage). Accordingly, this zone farmland should be planted anticipating such risks as a precondition.

(2) Pump Drainage Zone (The Environment Protection District)

This zone is an environment protection zone located between the Morava River bank and the Malolevarsky/Zohorsky Canal. In the period of thaw from March to May in spring and in the period of floods in summer, pump drainage is constantly required. At present, there is no risk of floods or ponding because of drainage at two drainage pump stations, and ponding occurs only in a limited small range. As this zone will have ponding without pump drainage, the risk of ponding depends on the possibility of pump operation. Therefore, this zone is farmland that requires large costs for drainage improvement.

(3) Natural Drainage Zone (The East zone)

This zone is located to the east side of Malolevarsky/Zohorsky Canal. Water is drained by natural drainage to the Myjava, Malina and Rudava drainage rivers and to drainage canals constructed artificially. Since the downstream areas of these rivers are affected by backwaters of the Morava River during flooding, there are zones where inundation is prevented by contraflow-prevention gates and those where water is drained to the pump drainage zone by siphons. Therefore, this zone uses natural drainage as a basis and is farmland with a low risk of flooding.

The area and risk to farming of the above three zones are evaluated as shown in the following table.

Drainage Zones and Farming Risks

| District | The Morava River land | The Environment Protection District | The East zone | Total ($km^2$) |
|---|---|---|---|---|
| Drainage characteristic of district | District where received flood & ponding | District with necessity of pump drain | District where possible to drain by gravity | |
| Area ($km^2$) | 40.8 | 175.1 | 395.3 | 611.2 |
| Farming risk | The risk to farming is high due to lack of drainage facilities. | The risk to farming depends on the pump drain. | The farming risk is small. | - |

## ITEM-3.2 MAINTAINING DEVELOPMENT REGULATIONS IN THE PROTECTED LANDSCAPE AREA

The Morava River land and its coast are designated as an environment protection district but they are appropriate for agriculture and also there is a lot of private land. Because the district is swampy, construction of facilities for irrigation and under-drainage is restricted. Agriculture sustaining and harmonizing with nature is demanded.

The Morava River land and the area located between Malolevarsky-Zohorsky Canal are designated as an environment protection district to avoid deterioration and loss of valuable biological resources and habitats. For the farmland in the environment protection district, there is no regulation about input of fertilizers and agricultural chemicals, but the development of facilities for irrigation and under-drainage is regulated. Surface water is collected by the Malolevarsky-Zorsky Canal and drained by pumping.

The Environmental Protection Agency protects valuable species of local animals and plants, and is acting vigorously to achieve environmental conservation of the ecosystem. The SWME-PD operates the pumps that control the water level of drainage canals and the level of underground water to prevent over-drainage in the environment protection district, and also teaches people not to cut down valuable species of plants along water courses. Therefore, it is important that agriculture in the environment protection district should be operated with the following consideration given to maintenance and management of water courses.

Environmental Management in Drainage Facilities

| Management structures | Environment management system |
|---|---|
| Pump operation and maintenance | - Management of pump operation based on the management of levels of drainage channel water and underground water<br>- Management of pump operation with consideration given to preservation of moisture in the protected marshy district |
| Canal maintenance (Malolevarsky – Zohorsky canal) | - Management of information to protect the ecosystem inside water channels (list and location of valuable species)<br>- Management of water courses with consideration given to environmental preservation (cleaning and repair) |

## ITEM-3.3 GUIDELINE FOR DRAINAGE IMPROVEMENT

### (1) Drainage Classification and The Unit Drainage Discharge

Drainage is roughly divided into three areas from the viewpoint of catchment areas and drainage capability, and these classes are further divided into 17 sub-drainage areas (refer to Supporting report-1.B.9.2; P265). The drainage discharge in each drainage area, which is basic to drainage management, will be calculated with the unit drainage discharge for each of the Myjava, Rudava and Malina river basins.

#### 1) Classification of Drainage

Catchment areas, sub-drainage areas, drainage methods and characteristics of facilities for drainage management of three catchment areas in the study area are as follows:

Classification of Drainage

| Drainage area | Catchment area（$km^2$） | Sub-drainage district | Drainage method | Drainage Facilities |
|---|---|---|---|---|
| Morava river land and flood storage basin | 40.8 | — | Natural drainage | None drainage facilities (Morava basin) |
| Environment protection area (pump drainage) | 175.1 | 2 | Pump drainage | Pump station, drainage canal, siphon, and sluice gate (Malolevarsky & Zohorsky canal) |
| Natural drainage area | 395.3 | 15 | Natural drainage | Drainage river and canal, siphon, counter sluice gate, etc.（Mlaka、Malina、Rudava、Myjava） |

a) Morava River Land and flood storage basin (Area where Drainage Measures cannot be taken)

This area is comprised of the Morava River land and the flood storage basin, and has an area of 40.8 $km^2$. There are farmlands and forests in the higher levels of the basin. Although high risk agriculture is carried out in farmland at the higher level, artificial improvement of drainage cannot be executed in this area.

b) Environmental Protection Area (The Pump Drainage Area)

The pump drainage area is sandwiched between the bank of the Morava River and the Myjava River, the Rudava River and the Malina River with an area of 175.1 $km^2$. Surface water in this area is collected by the Malolevarsky Canal and the Zohorsky Canal running from north to south, and drained into the Morava River.

During the snow melting period from the end of February to the end of April, and during the flood in the summertime, the water level of these canals becomes lower than the high water level of the Morava River, making natural drainage impossible. Consequently, for drainage during this period, pump stations were built at two sites to drain water with pumps. For the good conservation of farmland in this area, successful operation and maintenance of these pumps are of vital importance. Also, the maintenance and management of Malolevarsky Canal and Zohorsky Canal, which are water-collecting canals to pump stations, are important.

c) The Natural Drainage Area

Water in the left side area of the Rudava River and the Malina River and in the Mlaka River basin is drained to the Morava River by natural drainage. Since the downstream areas of these rivers are affected by high water levels of the Morava River, they are equipped with high banks in addition to contraflow-prevention gates and siphons to effect natural drainage. Management of these facilities is indispensable to maintain natural drainage in this area.

2) Design Parameters of Unit Drainage Discharge

For the above three rivers in the zone, long-term observation of the flow rate has been conducted. Based on observation, the parameters such as unit drainage discharge can be summarized as follows. These unit drainage discharges are to be used as basic parameters for examining maintenance plan of drainage facilities.

Unit Drainage Discharge of Major Rivers

| River name | Malina & Rudava | | | Myjava | | |
|---|---|---|---|---|---|---|
| | Return Period 1/2 | Return Period 1/5 | Return Period 1/10 | Return Period 1/2 | Return Period 1/5 | Return Period 1/10 |
| Unit discharge of area ($m3/s/km^2$) | 0.030 | 0.045 | 0.062 | 0.070 | 0.135 | 0.215 |

The unit drainage discharge for repair of drainage facilities shall be about 1/5 probability year in Sub-main canal and about 1/10 probability year in main drainage canals. Past observation data, if any, will be also taken into consideration. Above unit drainage discharge are obtained by observed discharge of the Rudava, Myjava and Malina rivers. The detail of the unit drainage discharge is described in Supporting Report B.8.

3) Maintenance Plan of Drainage Canal

In the maintenance plan of drainage canals in the Zahorska Lowland, dredging or sand wash of canal in consideration with maintaining the function of underdrains is important. The points in the plan shall be:

- Calculation of discharge at point using unit drainage discharge
- Assessment of flow capacity of canal at present condition using surveyed cross section and estimation of water level at regular drainage
- Check the elevation of outlet of underain
- Judging necessity of maintenance work such as dredging by comparing elevation of outlet and estimated water level

(2) Mitigation of Damage from Flooding or Inundation

The quick repair of the Morava River bank is the main measure against floods, and mitigation of damage from inundation should strengthen and improve maintenance and management of draining rivers, water-collecting canals leading to pump stations, siphons, gates and artificial drainage canals.

1) Repair of Bank of Morava River

The bank of the Morava River, which provides the final drainage means in the present study area, is being improved up to 2003 (by raising the riverbank on a plan to control any flood comparable to the 1997 flood that was the biggest ever recorded). Damage by flooding or ponding will thus be prevented in this area as a result of completion of this bank. Therefore, it is necessary to complete the bank quickly and to maintain and manage it after its completion.

2) Maintenance and Management of Water-Collecting Canal (The Pump Drainage Area)

The catchment area (175.07 $km^2$) on the west side of the pump drainage area has the negative factor that the water level of the Morava River becomes higher than in this zone. Although drainage is continuously managed using pumps, ponding occurs locally in lower fields. It is important in ponding zones to maintain and manage water-collecting canals to send water to pumps. In practice, efficient drainage will be

achieved by removing weeds and accumulated sand, both of which may obstruct the water flow in water-collecting canals.

3) Improvement of Drainage Facilities (The Natural Drainage Area)

The lowland of the downstream of Malina, Rudava and Laksarsky Rivers, which is a natural drainage area, is land where drainage is poor during flooding due to the influence of the high water level of Morava River. In such lowland, the following measures for drainage are taken:

- Natural drainage to lower drainage canals using siphons
- Installation of contraflow-prevention gates to shut out the influence of the high level water of Morava River and gravity drainage at low water level
- Gravity drainage to lower drainage canal using artificial drainage canal

Part of these facilities is, however, damaged or does not function. The following countermeasure works of rehabilitation are required.

Improvement of Drainage Facilities

| Poor drainage area | Existing facilities | Strengthened and expanded facilities |
|---|---|---|
| Zohor southern part | Counter sluice gate, siphon | Reconstruction of counter sluice gate, cleaning |
| Plavecky stvrtok | Siphon | Cleaning of siphon, repair of inlet and outlet of siphon |
| Mare levare | Counter sluice gate, siphon | Repair gate, Cleaning of siphon |
| Borsky svaty jur | Ditch canal | Cleaning of drainage canal and Reforming of canal section |

## ITEM-3.4 RATIONALIZATION OF OPERATION OF DRAINAGE SYSTEMS

### (1) Proper Operation, Management and Maintenance of Drainage Systems

Operation and maintenance of drainage systems require systematic arrangement of the list of facilities, periodic checks of functions, and appropriate repair and improvement. It is important to check the entire drainage system while obtaining the mutual understanding of different management entities of respective facilities.

1) Systematic Arrangement of the List of Drainage Facilities

Drainage facilities consist of drainage rivers, drainage pump stations, main drainage canals, lateral canal, siphons, gates, and underdrains. For drainage pump facilities, a facilities management system has been completed because they were repaired by Male Levare in 1997 and by Zohor in 2001. Other drainage facilities, however, are old and some have insufficient equipment.

Some drainage facilities such as gates, siphons and underdrains have become decrepit and do not function. In order to strengthen maintenance and management of facilities, materials regarding the facilities need to be organized and available so that people concerned can use them easily.

2) Periodic Checks of Functions

To confirm the proper functioning of facilities periodically, functions of respective facilities should be checked according to the facilities list systematically organized as mentioned in 1) above. Frequency of functional checks should be determined for each piece of equipment of respective facilities. The following table shows standard frequency of function checks and details of facilities (e.g. sizes and damage).

Proposed Standard Frequency of Function Check

| Drainage facilities | Drainage river | Pump station | Drainage canal | Siphon, g ate and etc. | Under-drainage |
|---|---|---|---|---|---|
| Function check of facilities | Once a year | Once a year | Once a year | Once a year | Once for five years |
| Structure check of facilities | Once for three years | Once a year | Once for three years | Once for three years | Once for five years |

3) Appropriate Repair and Improvement

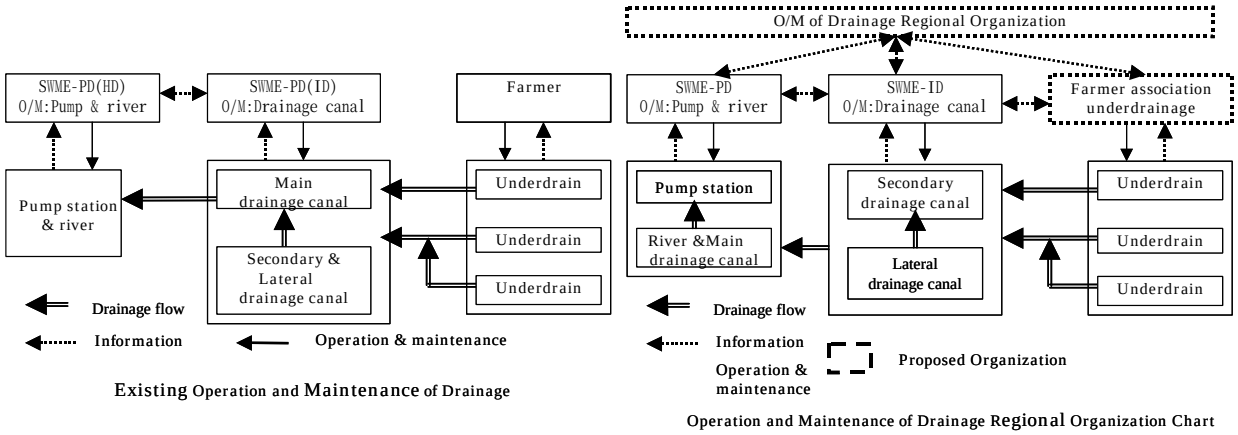
Deterioration will be evaluated based on periodic checks of facility functions, and repair or improvement will be carried out within the budget in the order of priority. It is important to improve these facilities with consideration given not only to repair of the existing facilities but to changes of facility utilization and technical innovation. It is also required to investigate the drainage conditions in the area not developed underains and to formulate the drainage improvement plan.

(2) Coordination between the Field Level and the Regional Level of Drainage

Drainage facilities of the field level (e.g. underdrains) and those of the regional level are managed by different entities, but the purpose of facilities functions is to drain water from fields to draining rivers quickly. Therefore, organizations managing these facilities are required to cooperate each other for operation and maintenance of facilities.

Lateral canals and main drainage canals are managed by SWME-ID, while the drainage pump, the Morava River and the other natural rivers in the area are managed by the Hydraulic Section and underdrains are managed by farmers. Surplus water (underground and surface water) in fields is collected to main drainage canals through underdrains or lateral canals and further to natural rivers. As the management entities of respective facilities are different, facilities management must be carried so that inconsistency does not occur at a point of contact.

Underdrains are facilities of land owners. Many land owners are now involved in one underdrain facilities system. Therefore, if only one farmhouse repairs an underdrain, the effect will be small. It is necessary to repair the whole under-drainage system. Hence, in order to manage these facilities in a functional manner, it is necessary to set up a cooperative system for drainage management including field managers (farmer), SWME-ID and SWME-PD as a drainage management organization.



## ITEM-3.5 REHABILITATION OF DRAINAGE FACILITIES

### (1) Rehabilitation of Drainage Canals

Through drainage canals (natural canal and artificial canal), surface water and water of underdrains is collected and sent to the Morava River or pump stations. Rehabilitation of these drainage canals is important to heighten the effect.

Case of investigation and assessment of drainage facilities
Part 3 Chapter 2.3.2
Fig 3.5

Recently, frequency of repairs of drainage canals has fallen and functions have deteriorated remarkably. About 70% of the artificial canals (lateral canal) and natural canals sending water from the fields to the Morava River have been improved with concrete block structures or masonry. Due to poor maintenance, however, they are covered with a thick growth of weeds and shrubs that make the cross-section of canals small and disturb water flow. According to the observation survey by the SWME-ID on canal roughness coefficient, if weeds grow in a canal, its roughness coefficient will decrease from n = 0.025 (planned value) to n = 0.04 to 0.06. In other words, the growth of weeds will reduce the water flow capability of a channel by nearly 50%. In 2001, more than 80% of the canals have weed growth and suffer from obstructed water flow. For the rehabilitation of drainage canals, it is recommended to remove weeds and settled materials and maintains protective concrete on the slopes and the bottom of canals. The responsible organization, SWME-ID, should carry out the periodic diagnostics and adequate maintenance work.

### (2) Introduction of Management with Participation of Farmers

Lateral canals or natural canals receiving under-drainage adjoin the fields. Operation and maintenance of drainage canals requires collaboration from the part of farmers.

Case of operation and maintenance plan of drainage facilities
Part 3 Chapter 3.3.2.2

In Slovakia, since the reform to a market economy, in management of drainage system the

SWME-ID has given priority to drainage rivers, leaving the operation and maintenance of drainage canals to limited proportion. In this connection, if timely improvement of facilities and effective operation and maintenance of facilities are sought for, the participation and collaboration of farmers in operation and maintenance of facilities shall be essential.

- Report of trouble information on drainage canal
- Drainage canal collapse prevention from agricultural machinery
- Weed and deposit removal at outlet box

It is required to SWME-ID to establish a management system integrated with users through introducing management and monitoring practices mentioned above.

## ITEM-3.6 REGULAR MONITORING OF THE CONDITIONS OF CANALS

| |
|---|
| As drainage canals are widely distributed, it is important to maintain and manage them based on accurate information obtained by asking farmers to monitor functional conditions of facilities and land with poor drainage. |

Major rivers in the study area are managed by the SWME-ID and periodically cleaned. On the other hand, the management situation of lateral canals and natural streams is not well managed because they extend for a long distance over a wide range of land. Hence, the actual conditions of these lateral canals must be monitored with farmer participation in order to gain information (accumulation of earth and sand, conditions of weeds in canals, driftwood, waste and damage of canal) that will be serviceable for their maintenance, management and improvement projects. Participation in monitoring will raise the consciousness of canal management and also contribute to canal environmental preservation.

Monitoring of Canals

| Monitoring item | Monitor |
|---|---|
| -Presence of obstructions (settled sand, driftwood, etc.)<br>-Growth of weeds<br>-Any obstruction in the canal | -Farmer in the study area<br>(Town and village offices ) |

In the Case Study, the monitoring points are proposed to set at confluences of canals and major drainage facilities such as siphon. Those monitoring points are allotted in each 300~500 ha of drainage area or in each 3.0~5.0 km length of canal.

## ITEM-3.7 INTRODUCTION OF A CROP PLANTING SYSTEM BASED ON THE EVALUATION OF LAND RESOURCES

Farming techniques can be proposed for basins where improvement of drainage is restricted and land with drainage problems is in the nature protection district. Countermeasures include selection of crops and species that are resistant to moisture (flooding and ponding) damage and by change from edible crops to animal feed when flooding or ponding takes place.

In areas liable to damage due to drainage problems (flooding or ponding), the following farming techniques are proposed as a countermeasure to mitigate such damage that may arise at the probability of once in five to six years.

Case of investigation of crop damage by drainage problems and identifying field facing limiting factor
Part 3 Chapter 2.7.3
Fig 3.6, Fig 3.7, Fig 3.8

- Selection of crops and species that are resistant to moisture damage (flooding and ponding damage)
- Changing their use from edible crops to animal feed (in areas where drainage problems (flooding and ponding) are anticipated)

Crop Planting System to Cope with Drainage Problem

| Farming | Target crops | Poor drainage area |
|---|---|---|
| Crop and species that are resistant to moisture damage | Barley and maize | Morava basin and Low land of environment protection area and natural drainage area |
| Crop which can substitute usage from food crop to fodder when it is damaged | Maize | ditto |

## SUBJECT-4 SOIL CONSERVATION

Soil conservation, countermeasures for soil erosion is essential practices for sustainable development of agricultural production. Soil erosion, removal of fertile topsoils of agricultural land, is brought about by surface water run-off and strong wind. Zahorska lowland can be characterized flat plain fields, permeable sandy soil and low annual precipitation around 600mm with low intensity. Consequently, occurrence of surface-running water which causes water erosion, is not common, and is found only at limited spots at the foot of the Male Karpaty. On the other hand, this area has been classified as the highest level of wind damage and erosion potential in the Slovakia. Wind damage means direct physical damage by blowing wind and soil particles. Young seedlings of crop plants are susceptible to damage by wind and blowing soil. Wind erosion means removal of fertile surface soil as result of scattering of dried soil particles by strong wind. Scattering of soil particles can occur when dried bare soil surface is exposed to strong wind.

Sufficient wind velocity to scatter fine particles in this district has been confirmed at around 6, or 7 m per second. The fine particles in the soils of this area are composed of quartz sand and silt with low specific gravity of around 2.0. This level of wind velocity is nearly the same as for sand particles in a sand desert. This level of wind velocity is very common throughout the year in this district. Furthermore, major parts of the soil are classified as sandy soils with low clay content. The sandy soil has very little water retention capacity in field capacity, and has a strong tendency to dry up, even within a few days after rainfall. Under conditions of high velocity wind, enough to scatter soil particles, and widespread sandy soils liable to dry up, high levels of wind erosion can occur when the surface of the field is kept bare and directly exposed to wind.

### ITEM-4.1 SPECIFICATION OF DANGEROUS AREAS OF WIND DAMAGE AND EROSION

As described previously, the major part of this area has a high level of wind damage and erosion risk-potential. It is important to know the actual levels of wind damage and erosion and to specify dangerous areas in this district.

In order to specify the actual level of wind damage and erosion, a series of field surveys is being conducted for selected farm fields in the case study areas, where moisture contents, clay content, pF values of soil, and plant cover are being investigated in detail.

Within the case study areas, soil moisture contents in early spring vary from spot to spot, reflecting differences in clay contents and water retention capacity. Plant cover is also different; some are covered by vigorous growth of rapeseed crop, some by poor growth of wheat or barley, some are bare and so on. The type of plant is important. Low and thick-growing plants like grasses and clover are more effective and completely cover the surface of the land. On the contrary, coarse and tall plants like maize are not so effective. Based on these results and previously reported data, actual and real situation of wind damage and erosion, not only risk potential, can be specified.

## ITEM-4.2 PRESERVATION AND AFFORESTATION OF WINDBREAK FOREST AND TREE BELT

Many boundary and windbreak forests and trees had been cut down when combining farms and enlarging fields under the planned economy. Later, windbreak tree belts were planted along the newly excavated water canal. The windbreak effect of trees is considered to reach ten times the tree height. The huge size of farms, sometimes 2, or 3 km in length, restricts the breaking effect and most parts of the land are exposed directly to the risk of strong wind. Preservation of the existing forest and tree cover has the first priority; afforestation is also recommended, particularly at the high risk points where the predominant wind direction is wide open.

## ITEM-4.3 PLANT COVER

The most effective countermeasure to prevent wind damage and erosion is to keep continuous plant cover, or at least, during the time when strong wind blows and soil tends to dry. Plant cover can reduce wind velocity, and catch soil particles in their roots. Growing crops can effectively cover the surface of

Case of introduction of crop rotation considering crop coverage to prevent wind erosion
Part 3 Chapter 3.2.4

farm land during their growing season. Mature crops sometimes cover the whole surface of the land and the risk of wind damage and erosion becomes negligible. Even immature crops can cover to some extent. Coverage with root stubble and crop residue after harvesting is also effective in preventing scattering of soil particles.

In accordance with the reference materials, the risk potential of wind erosion in the area is recognized high in the spring season of April and May due to the strong wind of the north-west direction. During this period, the soil surface of the winter crop field is covered by crops such as rapeseeds, rye and wheat, even the coverage ratio depends on the plant type and the condition of growth. In the field for summer crops, some area have been plowed and exposed to wind in that period. If plant residue is remained just before plowing, it is expected to contribute to reduce the damage by wind erosion. Since the sandy soil in this area has high risk potential of wind damage and erosion, farmers should pay much attention to following items;

1) The surface of farmland should be covered by growing crop plants or residues of previous crops during the periods when strong winds blow such as early spring. Grasses and clovers are more effective in coverage, rapeseed plant is also effective with its low and wide leaf, while wheat is less effective with its tall and straight thin leaf.

2) The stubble and residue should be left on the field as long as possible without interfering with the sowing of the next crop. The period of bare field, duration between tillage and sowing, should be as short as possible.

3) Application of non till sowing is worth consideration. Non till sowing sometimes results in 20 or 30% yield reduction. However, scattering of soil particles can be effectively prevented and the wind damage to seedling crops on adjacent fields can be minimized.

## SUBJECT-5 SOIL MOISTURE MANAGEMENT

### ITEM-5.1 FIELD DRAINAGE

### ITEM-5.1.1 MANAGEMENT PLAN OF DRAINAGE CANALS

The causal relation of drainage problems will be investigated, the drainage canals network and facilities equipment will be surveyed, and their functions will be diagnosed and evaluated periodically. In planning improvement of facilities, it is focal that the priority in implementation should be determined from the viewpoint of cost-benefit ratio of investment.

Case of management plan of drainage canals
Part 3 Chapter 3.3.2.2

On-farm rainfall is in part drained from the ground surface to lateral canals and in part from underdrains to lateral canals. The drainage, then, goes from lateral canals through main drainage canals to natural rivers. In the survey area, construction and repairs of lateral canals (artificial canal) of 367 km and main drainage canals of 578 km (including a part of natural canals) are now under way. For all that, the maintenance of these drainage canals still fails to be satisfactory; 80% of them need further weed removal and cleaning and another 30 to 40% still need restoration of lining such as their slope protection structures. For the drainage canals management plan, it is effective way that canal functions should be diagnosed from the scale of land with poor drainage and from flooding or inundation damage and then the order of priority of zones to be improved will be determined. The following issues are pointed out to assess the priority:

- Degradation of canal functions
- Scale and amount of crop damage
- Productivity and profitability of the field (land productivity, irrigation possibility, etc.)

## ITEM-5.1.2 COORDINATED MANAGEMENT OF BOTH DRAINAGE CANALS AND FIELD UNDERDRAINS

The discharge port of underdrains is connected to a drainage canal. If water-flowing capability of a drainage canal stops, water in underdrains will not be drained either. Therefore, the coordinated management of both drainage canals and field underdrains is of importance.

Since water in underdrains is drained to drainage canals, the function of underdrains is affected by the maintenance condition of drainage canals. If a drainage canal is closed by the growth of weeds, sand will settle in the relevant underdrains and stop their functioning. Therefore, coordinated management of both drainage canals and field underdrains is desired. Lateral canals placed in the fields are managed by the SWME-PD (managed by SWME-ID after the organization revision). On the other hand, the SWME-ID does not manage field underdrains because farmers own them since the land was returned to land owners.

For efficient management of drainage channels and underdrains, it is expected that all parties concerned work toward improvement as one body by frequently exchanging information between the SWME-ID and farmers or between farmers and then clarifying obstacles in the draining function.

## ITEM-5.1.3 MAINTENANCE AND MANAGEMENT OF UNDERDRAIN

To make underdrains exert their effect fully, it is necessary to maintain and manage them to prevent blocking of pipes and closing of the outlets, to keep underdrain facilities functioning well.

### (1) Maintenance, Management and Improvement Technique of Field Underdrains

Although leakage of water to some degree is permissible, unlike irrigation pipes, repairing damaged or blocked parts of drain pipe allow it to last a long time in sound condition. If the outlet of an underdrain is below the water level or buried in the soil, the function is greatly reduced and causes blockage by settling sand. Hence, it is

important to check the outlet of underdrains and manage them, such as by removing weeds, earth and sand to maintain good water flow into drainage canals. Also, marking the outlets of underdrains can prevent them from being damaged or buried, and improve maintenance.

In cases where outflow is not seen from outlets of underdrains, a problem such as rupture, closing or blocking is presumed. The location of the damage should be determined from moistness of the ground surface and then should be repaired. Large underdrain networks can be modified to underdrain systems that allow easy cleaning by installing additional manholes or relief wells. The relief well can also be used to prevent the inflow of water from the drainage canal to the underdrain and to control the soil moisture.

With utilization of a cleaning machine operating on pressurized water, the SWME-ID is experimentally cleaning earth and sand from underdrains. If the machine goes into actual use, maintenance and management of drain pipes will be improved.

(2) Periodic Diagnosis and Maintenance of Underdrains by Farmers

As underdrains are structures buried underground, it is difficult to check their functions by ordinary means. The following are some of the suggested diagnostic methods:

a) Identifying the location of outlets of underdrains

b) Periodic checking of the flow rate and function of structures at the outlet of underdrains
(Check with eyes of condition of structures, flow of outlet after rainfall)

c) Checking of water flow at junction of underdrains (manhole and relief well)
(Check with eyes of condition and cleaning of manholes)

d) When trouble or problem is observed, farmer will ask technical consultation from SWME-ID and will consign maintenance work to SWME-ID if necessary

The above will be helpful as a means to check the flow of water. Items b) and c) are needed about once per year. The periodic diagnosis of underdrain functions will enable effective management through early discovery and improvement of places with troubles and defects.

(3) Technical Instructions to Farmers on Maintenance and Repair for Under-Drainage

In the study area, underdrain facilities are laid out over an area of about 10,570 ha. As these underdrain facilities were constructed from the 1930s and many facilities are old, maintenance and management, such as repair and improvement, are important matters now. Since underdrain facilities are the property of farmers, the farmers themselves are responsible for their management. Consequently, it is important that SWME-ID exhibits material concerning the underdrain to farmers and that farmers should learn to maintain and repair underdrains. The SWME-ID will teach farmers repair techniques.

(4) Maintenance of Underdrains Using GIS

SWME-ID has a responsibility of maintenance of drainage canals. However, it was pointed out that frequency of maintenance work becomes few in accordance with results of the Case Study. It causes sedimentation in canal and some of outlets of underdrains are buried. On the other hand, the maintenance of underdrains is role of farmers but they meet difficulty due to lack of information on location of facilities and maintenance techniques. In the Case Study, the location of drainage canals and outlets of underdrains were surveyed and they were arranged into the GIS database for efficiency improvement of management. SWME-ID is recommended to proceed arranging information using GIS, to provide this information to farmers, and to provide periodical technical instruction of maintenance of underdrains.

## ITEM-5.1.4 IMPROVEMENT OF FIELD DRAINAGE

Improvement of field drainage will be executed by the management entity after clarifying a repair plan, procedures and budgets after the diagnosis of functions of drainage facilities.

### (1) Rehabilitation of Underdrain Facilities

The rehabilitation of underdrains will vary depending on the degree of damage suffered. For example, there may be a case in which underdrains can be improved within the unit of a farmer's field, or there may be a case in which improvement is needed in a wider area than the unit of a drainage system. The particulars of improvements of these cases are as follows:

Rehabilitation of Underdrain

| Scale of function recovery | Recovery scale of Farmers' field | Recovery scale of one drainage system |
|---|---|---|
| Facilities contents | Outlet of underdrain, cleaning of underdrain, Repair of damaged part | Outlet of underdrains, cleaning of underdrain and canal, Repair of damaged part of underdrain and canal |
| Client | Farmers | SWME-ID, Farmers |
| Support organization (SWME-ID, MOA, Consultant) | Technical assistance and the capital support | Plan, design, and the capital support |

Improvement of a drainage system involves multiple farmers, so such improvement requires consensus among the farmers involved. Also, as the making of a rebuilding plan and design is a difficult task for a farmer group, support from the SWME-ID or commission to consultants will be necessary. Information regarding legal procedures or supporting systems for the rebuilding of underdrains must be prepared and given to farmers.

### (2) Benefits and Awareness of Drainage Improvement

The maintenance and improvement of under-drainage are likely to be neglected since the chances of directly evaluating underdrain functions do not arise often in comparison with those of irrigation. Agricultural production in farmland troubled

with drainage problems, for example, is 20 to 30% lower than that of improved farmland. In addition, the construction of new underdrains is expensive. Consequently, the maintenance and management of underdrain facilities to ensure their use over the longest possible period of time is of vital importance. In order to make farmers aware of this fact, it is essential to educate them on the merits of drainage and to transfer repair skills to farmers.

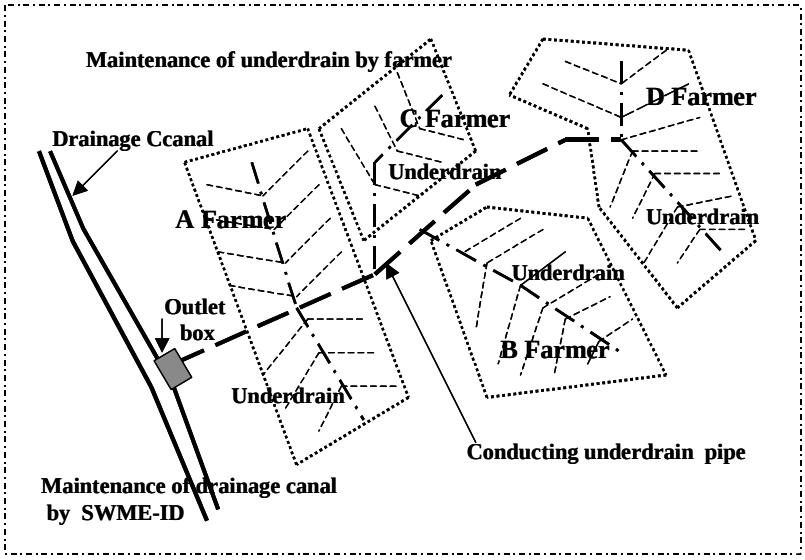
### ITEM-5.1.5 IMPROVEMENT OF FIELD DRAINAGE MANAGEMENT

If underdrains and drainage canals for field drainage management are maintained, managed and improved only by a farming unit, the effect will be small and will not be complete. Therefore, it is desirable for improvement of field drainage that it is managed by the unit of a whole drainage system. For this purpose, a drainage management organization is indispensable.

Underdrain facilities were laid over a period from the 1930s to 1990. Many of them were installed during the time of Socialist administration, from 1960 through 1990 in particular. At that time, agriculture was operated in the form of large collective farms, and a drainage network (drainage canals, underdrains) was arranged over all the fields. With the subsequent change of the social system, however, the state farms were restored to former owners, and SHR and Agricultural Companies are using the land as each independent farm.

As a result, cases have increased in which multiple farmers have land in one drainage system. Therefore, even though a farmer may wish to rebuild underdrains in his/her own section, if the upstream or downstream underdrains are not rebuilt, the effects of the farmer's rebuilding efforts will only be slight. Improvement of the entire system is needed with an organization managing it.

To improve field drainage, improvements that allow the entire system, including drainage channels, to function well must be made. For this purpose, it is important that, managing organizations of respective facilities (SWME-ID and farmers) should identify and classify problems and improve functions as one body.




**Drainage Management of SWME-ID & Farmer**

## ITEM-5.2 IMPROVEMENT OF WATER RETENTION CAPACITY OF SOIL

The water retention capacity of the sandy soils in this area is very small, and the water supply from these soils, together with effective rain fall during the growing season, is not enough to support vigorous growth of crop plants with a reasonable yield. Improvement of water retention capacity, though not easy, is desirable.

### ITEM-5.2.1 MULCHING

Mulching means the practice of covering the surface of farmland with crop residues or some other materials. Mulch farming is effective not only for water saving but also erosion control, weed control, and maintenance of soil organic matter. In large scale farming, use of the mulch planter for row crops is a reality. Mulching with crop wastes is also available for labor intensive farming for vegetable and fruit production.

### ITEM-5.2.2 NON TILL FARMING

Non till farming is the best way to keep cover on farmland. Under normal crop rotation it is unavoidable to keep the surface of farmland bare during certain periods between tillage

and cover from the next crop. Non till farming saves water losses and also controls erosion. On the other hand, application of non till sowing sometimes gives thin emergence and uneven growth of seedling with poor water supply. This may result in severe yield reduction. Another difficulty in non till farming is weed control. Tillage and plowing is effective for weed control through cutting weeds and rolling over the soil surface. Careful consideration is necessary for the actual application of non till farming in this area.

### ITEM-5.2.3 RECLAMATION OF SAND BED

Sand beds spread widely in the subsoil layer under the plowed soil in the Zahorska Lowland. They limit the water-supply capacity of soils during the later stage of plant growing, so that they cause to abandon harvesting in the field due to sterility or poor grain filling. The presence of sand beds in the subsoil layer brings very serious difficulty in water management of crops in the late stage of growth. Even if crops can achieve satisfactory growth of early stages with enough water-supply from top soil, the sand bed has very poor water holding and supplying capacity, and can not support water demand by the grown crops in their late stage when the plant is more susceptible to water deficit, in bud formation, fertilization, and grain filling. Furthermore, the plant roots cannot penetrate into this sand bed. This may bring failure of fertilization, poor grain filling, and results in abandonment of harvesting. The sand beds in the subsoil layer is to be investigated and the countermeasures such as subsoil plowing or crashing are to be examined to apply.

### ITEM-5.2.4 MUD DRESSING

A fundamental reclamation practice for sandy soils requires enrichment of clay contents by incorporation of muddy materials. Mud dressing is one of the most difficult practices from the economic aspect. Digging, transport, and spreading of large amounts of mud into wide areas of farmland needs a huge budget and is not practical under present circumstances. Self support practice could be observed in some spots, where mud resources, the weathering product of male or limestone in Male Karpaty, were piled in a

corner of the field, and were incorporated step by step into adjacent spots by wind and water.

Individual incorporation of organic matter into sandy soil can only give a limited effect. Enrichment of soil humus, which is more stable and resistant to further microbial decomposition, can be achieved by simultaneous occurrence of clay and organic matter together, because the organic matter in soil can form stable soil humus only in the form of a clay-humus complex. In the absence of clay in the soil, organic matter decomposes in a short period.

## SUBJECT-6 SOIL FERTILITY MANAGEMENT

Virgin soils have their own native fertility accumulated over a long time under natural plant cover. However, because of long term cropping, soils are rapidly losing their fertility, nutrients and organic matter. Soil fertility management is essential practice to maintain sustainable development of agricultural production.

Plant cover can be divided into two categories; soil depleting and soil improving plants. Soil depleting crops remove large amounts of nutrients and accelerate decomposition of soil organic matter. On the other hand, soil improving or resting crops, preserve organic matter in the soil. Even in grass land farming removal of nutrients is unavoidable, but they can give the indispensable benefit of increasing organic matter content of soils through leaving huge amounts of deep roots.

Proper land use depending on soil properties and land classification has the first priority, and suitable soil fertility management practices should be applied in each farming system. Particularly as this area is characterized by widespread sandy soil which has poor clay and humus contents. The following items are considered important in such area.

Important items are:

1) Conversion of land use system. Under the planned economy, accomplishment of the target for planted areas and total yields of grain crops had the first priority and rational land use was not considered. Under the market economy, conversion to rational and more profitable land use and farming systems is unavoidable. Depending on soil properties, the following categories of land uses can be recommended; grain crop farming, grass land farming, grazing farming, wood farming, and unsuitable for farming. Even in grain crop farming, the crop rotation system comprising soil resting crops such as legumes and grasses is expected to be introduced widely.

2) Even for the land categorized as suitable for grain crop farming, intermittent introduction of soil improving or resting crops in crop rotation is essential,

because degradation of soil fertility is very common for all types of soil in this area due to long-term continuous cropping of grains. For example, most of the Fluvic soils, originally favored by native high fertility in the lowland along the Morava River, have now lost aggregate and granular structure and sometimes showed signs of soil compaction. Introduction of grasses and legumes is only one practical measure to recover the soil structure. Land use and farming systems listed above should not be considered fixed, they should be combined and converted one to the other depending on the degree of recovery in fertility levels of the soils.

3) Although the use of large amounts of chemical fertilizer, together with irrigation, can support higher yields of grain crops in the sandy soil areas, use of chemical fertilizer necessarily brings nitrate pollution of ground water due to poor water and nutrient retention capacities. Nutrient supply by chemical fertilizer should be reduced to as low levels as possible to avoid environmental hazard. From the long term view point, conversion of resources from the artificial to the natural is unavoidable.

## ITEM-6.1 USE OF RECYCLED ORGANIC MATTER

Case of promotion of manure application
Part 3 Chapter 3.2.6 (2)

It is very important for fertility management to return back crop residues and rotted farmyard manures to farm fields. Efficient recycled return of nutrients and organic matter has a key role for sustainable development of agricultural production for both resources and environment. Even now, crop residues and discharges from animal husbandry are effectively returned back to farm fields. Crop residues and animal wastes are piled in the corner of the field, spread on field, and ploughed into the soil.

The most important problem of recycling organic matter is the very heavy labor of transporting, piling and spreading. In mechanized large scale farming of grain crops these tasks may occupy 80% of the total labor tasks. With an increase of labor cost, it is

necessary to develop a labor-saving technology for returning these organic manures back to the field.

## ITEM-6.2 GRASS LAND FARMING

Case of introduction of crop rotation including alfalfa
Part 3 Chapter 3.2.6 (1)

Grass land farming should be recommended for fields that do not have enough fertility to support a stable and profitable yield of crops. Most grasses and legumes have their origin in native plants adapted to semi-arid and semi-arctic conditions, and have the ability to take up water from the deep horizon of soil as the result of adaptive evolution to the environment. They can develop deep and dense root systems, and it is not rare that the root biomass accounts for ten times the top, aerial part of the biomass. Abundant supply of organic matter contributes to early recovery of soil fertility together with improvement of the water economy, and within a few years aggregate structure will be recovered. Grassland farming is the most effective way to recover and improve soil fertility. After several years, part of the land, which had been used for grassland farming and recovered its fertility, can be converted to land for grain crop farming.

An important problem in grass land farming is to prove its profitability. Development of high yielding grass land must be more profitable than the unstable and low production levels of other crops. Sowing and fertilizer application are necessary to develop favorable grass land where testable species of plants grow vigorously. It is important to prove that grass land farming is not the same as abandonment of cropping, but more rational and profitable land use. Selection of species and varieties of grasses and legumes is an important subject of investigation, together with management practices of grassland.

## ITEM-6.3 GRAZING FARMING

Under grazing farming, discharges from animals, dung and urine, are passively returned to the field. Pasturing of cattle, horse and sheep on range is recommended for the land where soils are poor in nutrients. Grazing farming is not so common in this area now in

spite of the favorable conditions of wide plain fields and medium precipitation. Only a few cases of cattle, race horse and sheep grazing could be found and most livestock are bred in pens.

## ITEM-6.4 ORGANIC FARMING

Extensive and abundant use of chemical fertilizer and agricultural chemicals has attracted much attention and criticism in terms of both environmental pollution and food contamination. Scattered use of chemicals in an open eco-system of agricultural production has brought apparent world-wide environmental pollution. Pollution of crop products with remnant chemical and other contaminants, and nitrate pollution of ground water, became a clear threat to the daily life of consumers. A consumer movement seeking safer food and drinking water has taken root, particularly in European societies, and has encouraged the development of organic farming where uses of synthetic chemicals is strictly prohibited.

Agricultural products of organic farming have the advantage of additional value in the market and the possibility of many more benefits. Since organic farming has a bright future in European countries, intensive investigation of the technology and farm management is important. However, it needs much more labor and the yield of crops is generally lower. Further, application of organic farming may be restricted to more fertile soils, as fertile soil can support sufficient growth without the use of chemical fertilizers. Introduction of organic farming in the wild protection areas along Morava river has the advantage of their fertile soils and no use of chemicals.

## SUBJECT-7 CROP CULTIVATION TECHNIQUES

From the results of collection and analysis of field surveys on crop cultivation and animal husbandry and the interviews by the Farming unit survey (JICA, 2001), the common approaches to the development of crop cultivation are summarized below. The technical guidelines on crop cultivation will be produced based on these approaches.

1) The crop-livestock mixed farming will be maintained as a fundamental farming pattern with cash crops as supplementary products in the Zahorska area in the future.

2) On the basis of potential surplus agricultural production and facing entry to EU, the agriculture in Zahorska needs “good farming practices” in which higher priority is given to productivity and profitability than to production.

3) Since the agriculture in Zahorska faces severe environmental stresses, sustainable agriculture requires appropriate cultivation techniques. Winter crops and perennial feed crops have more adaptability.

4) Intensive irrigation will be strengthened with a focus of highly profitable crops such as oil crops, vegetables, alfalfa and fruits.

5) Market-oriented farming will be developed through the improvement and introduction of cultivation techniques for high value-added crops, improvement of productivity and reduction of production cost.

6) Environment friendly and sustainable agriculture should be improved and maintained as a main principle of farming.

7) The major supporters of agriculture in the Zahorska area are several large scale farming enterprises which have strong financial power and high technical skills and at the same time public subsidies are diminishing with privatization of governmental duties. The need for independent activities by these enterprises will increase in the management of soil, water, facilities and production activities.

## ITEM-7.1 INTRODUCTION OF CROPPING PATTERN SUITED TO LAND CHARACTERISTICS (RIGHT CROP FOR RIGHT PLACE)

In the Zahorska area natural conditions such as soil characteristics, irrigation facilities and susceptible areas to wind erosion and crop characteristics such as resistances to damages by continuous cropping, drought and flooding are identified. The current cropping pattern is rather well organized corresponding to these conditions. However, to develop the stability of crop production, lowering of production costs and good use of agricultural resources, it is necessary to select crop groups of common characteristics and establish improved cropping systems with these crops for efficient land use and high value-added cropping.

### (1) Current Major Problem Areas

- The current crop rotation is composed of various crops with different cropping characteristics. This results in the inefficiency of irrigation and agricultural performance.
- To select crops by “Right place for right crop”, it is necessary to put priority to factors that strengthen market-competitiveness; profitability, low-cost and enlargement of commodity lots, as well as amount of products.
- High value-added products suitable to cultivation conditions need to be explored.

Case of introduction of cropping pattern suited to land characteristics
Part 3 Chapter 2.7.1
Part 3 Chapter 3.2.3
Fig 3.11 ~ Fig 3.14

### (2) Aim of Countermeasures

1) Consider the Following Items on Soil Characteristics for Appropriate Land Use.

- Sandy soil with low productivity,
- Susceptible areas to wind erosion,
- High soil moisture areas,
- Areas installed with irrigation facilities,
- Relatively fertile areas with high clay contents.

2) Make Good Use of The Crop Characteristics for the Crop Rotation.

- Put importance to crop profitability and market needs.
- Resistance to drought, water logging, low fertility, weed damages, etc.
- Advantages of winter crops. *
- Adaptability to high soil moisture contents.
- High response to irrigation to achieve efficient irrigation.
- Advantages of sandy soils and location close to large consuming areas.

* <Reference> Advantages of winter crops in the Zahorska area.

1) Autumn and winter seasons have relatively abundant water supply due to the moderate rainfall under low temperature.
2) Abundant water is available in early spring from snow melt without widespread flooding.
3) Solar radiation in summer is useful for crop cultivation and advantageous to ripening.
4) There is little damage by disease and pests in autumn and winter at an early stage of cropping. Damage to winter crops by weeds is also less because of early growth of winter crops that suppress the growth of weeds in spring.
5) Winter crops are resistant to wind erosion because winter crops reach a certain growth level which suppresses the erosion by wind.
6) There are many winter crops such as winter wheat, rye and triticale that are resistant to environmental stresses.

## ITEM-7.2 SELECTION OF APPROPRIATE CROPS

Agriculture is a manufacturing industry, and hence crop characteristics, consumption trends, natural environments and socio-economic requirements for the selection of appropriate crops need to be considered. Crops and livestock products need to be suited to natural conditions, meet increasing demands with the development of general economy, have high profitability and fulfill demands in health and preference.

### (1) Current Major Problem Areas

1) Although the privatization of farming units has been well developed in the Zahorska area, it is reported that market survey on the market needs and the renovation of management are not always well conducted for future development.

2) Promising crops need to be identified, and the demonstration of these crops to farmers should be organized in future extension work.

### (2) Aim of Countermeasures

It is necessary to identify promising crops and varieties through market survey on future consumption of commodities and opinions of scientists and administrators. The following categories of crops will be identified:

1) The production areas have already been well evaluated in markets in Slovakia, and future development is expected to continue due to the advantages in production and marketing in the Zahorska area.

   Examples: Asparagus, carrots, cabbage, kohlrabi, etc.

2) Stable production is established by utilizing the advantages of production conditions and coping with the unfavorable conditions of the Zahorska area.

   Examples:

   - Utilizing advantages of sandy soil: root crops, asparagus.

- Resistant to cold and dry conditions: rye, triticales.
- Bearing fruits in summer under the strong solar radiation:
  - Small fruits such as black berry, cherry, straw berry and black currant, etc.
  - Short growth period and wide leaves to suppress increase of soil temperature – water melon, melon and cucumber.
- Utilizing high soil water conditions: red clovers, maize and soybeans.

3) Efficient and high value-added crop production can be expected by high inputs

Examples:

- Irrigation: vegetables, sunflowers, soybeans, alfalfa, fruits, etc.

4) Crops have to meet increasing market demands

Examples:

- High marketability: food wheat, sunflowers, vegetables and fruits.
- Increasing demands with economic development: oil crops, high quality of vegetables and fruits,
- Materials for processed foods: fruits, asparagus, vegetables, sweet corn, potatoes, etc.
- Materials for high productivity: high quality feeds, materials for food processing.

5) Crops must meet the public demand for health

Examples:

- Human health: soybeans, winter vegetables, and crops with high polyphenols.

6) For the selection and extension of promising crops, demonstration farms need to be conducted to show the adaptability of crops and develop the understanding of the usefulness of new crops. Similar activities to the Field Day of SWME-ID will be applicable to the demonstration farms.

## ITEM-7.3 IMPROVEMENT OF CROPPING SYSTEM BY FARMING TYPE

Actual cropping pattern is established based on various natural and socio-economic factors. The following are the factors to be considered for the formation of appropriate cropping pattern in the Zahorska areas. The priority of factors will be different for the requirements of each cropping pattern. Major items will be examined for the cropping pattern in the following sections.

1) Crop characteristics such as consumer's needs and marketability.
2) Requirements of feeds in the crop-animal mixed farming.
3) Adaptability to climatic conditions such as rainfall, temperature and solar radiation.
4) Soil properties and soil fertilities.
5) Resistance to soil born pests and diseases and weed damages.
6) Reduction of cost and improvement of quality of crops.
7) Preparedness for damages by weather changes.
8) Prevention of environmental hazards, due to leakage of nutrients from fertilizers into groundwater.
9) Fulfillment of quality demands in organic farming and requirements of food products (e.g. standard of food wheat)
10) Availability of farm labor.

<NOTES> For further details of the farming type, please refer to the *3.6 Cultivation Type, Farming Subjects and Technical Measures*.

## ITEM-7.3.1 CULTIVATION OF HIGHLY PROFITABLE CROPS USING IRRIGATION

### I: SOIL CONDITION: GOOD (A), IRRIGATION: AVAILABLE

Although high profits will be expected, soil-born diseases and pests and damage by weeds will happen due to high contents of soil moisture and organic substances and few occasions of being bare fields during hot and dry summer. Severe damage will be caused in oil crops and leguminous crops, if they are cultivated continuously. For these reasons crop rotation has to include wheat and gramineous crops. It is also important to introduce high profit crops and apply necessary fertilizers to achieve yields to the full extent.

(1) Current Major Problem Areas

1) Current crop rotation is generally established with a view to protecting crops from soil born diseases. Therefore, high profit crops and low profit crops will be mixed, and hence it causes low efficiency of irrigation facilities. Irrigation requires high profit in farming, and it is fundamentally important to establish crop rotation by high value-added cash crops.

2) Oil crops need enough intervals in the crop rotation due to the soil born disease

(2) Aim of Countermeasures

1) Select and organize high profit crops and highly responding crops to irrigation. Sunflower, spring barley, food wheat, etc. are recognized as high profitable crops.

2) Due to high susceptibility to soil born diseases, crops of sunflower, rapeseed, soybean, etc. need a crop rotation with an interval of 2 - 3 years including wheat crops.

3) A possible example of crop rotation is <spring barley - food wheat - food wheat - sunflower>.

II: SOIL CONDITION: MEDIUM (B) AND POOR(C), IRRIGATION: AVAILABLE

Crop rotation needs to be established from a viewpoint of crop profitability and crop protection by introduction of grasses as shown in the previous section. Due to low soil fertility it is important to increase the application of chemical fertilizers, add organic matter, introduce leguminous crops to the crop rotation and assess exact soil fertility.

For possible crop rotation, the following combination can be suggested: <spring barley - soybeans - food wheat - sunflowers>.

## ITEM-7.3.2 CULTIVATION OF HIGHLY PROFITABLE CROPS WITHOUT IRRIGATION

I. SOIL CONDITION: GOOD (A), SOIL MOISTURE CONDITION: ABUNDANT (2)

There is a shortage of water supply during summer without irrigation. Therefore, high profit crops have to be selected from winter crops in combination with spring barley and maize from the necessity of feed crops. Several types of hazards can be expected such as soil-born diseases, weed damage and flooding. Farming work may be disturbed due to high soil moisture; for example, delay of seeding. If these problems are solved, high productivity will be achieved in this type of farmland.

(1) Current Major Problem Areas

1) Due mainly to the shortage of soil water in summer, it is recommend selecting high value-added crops from winter crops.

2) High soil water and soil fertility cause soil-born diseases and pests and weed damage.

3) High soil moisture also causes damages by water logging and delays the agricultural work such as land preparation and sowing.

(2) Aim of Countermeasures

1) In the Zahorska area, food wheat, rapeseeds and spring barley, which can be cultivated early in the spring and harvested in summer, can be recommended for highly profitable crops.

2) Wheat, rapeseeds, etc. absorb a large amount of fertilizer, and hence application of fertilizer is also important.

3) For the protection of crops from water logging, introduction of resistant crops such as maize is useful as well as a civil engineering method like subsoil breakage.

3) The following is a recommended example of crop rotation: <rapeseeds - food wheat - spring barley - maize>.

## ITEM-7.3.3 CULTIVATION OF CROPS CONSIDERING MAINTENANCE OF SOIL FERTILITY

### I. SOIL CONDITION: MEDIUM (B) AND Low (C), SOIL MOISTURE CONDITION: ABUNDANT (2)

Although soil moisture is abundant, winter crops for feeds will be major crops due to low soil fertility. Soil fertility will be maintained by cultivation of leguminous crops (e.g. Alfalfa). For the laborsaving and low-cost production of roughages, perennial feed crops need to be grown, and leguminous annual winter crops can be used for supplementary feeds. According to necessity of feed supply, maize will be included. In the areas susceptible to flooding, subsoil breakage and introduction of water-logging resistant crops will be recommended.

(1) Current Major Problem Areas

1) The requirements of feeds are different by species of animals. Quality of roughages <e.g. Alfalfa> are lacking for milking-cow.

2) Concentrated feeds used for cow for meat, pigs and milking cow always have to be low-cost. It is important to make good use of winter crops and high soil moisture areas.

3) In the current cultivation trends soybeans are grown in limited areas, and alfalfa is cultivated in the crop rotation of 3-4 year in succession with wheat and rye of about 3 years cropping as soil resting crops. Leguminous crops and feeds are limited in terms of cropping acreage, species and varieties in the actual cultivation.

(2) Aim of Countermeasures

1) For the needs of feed supply winter crops, wheat, rye and triticale will be major crops. Maize will be also cultivated.

2) Alfalfa will be required for the maintenance of soil fertility, the N fixed in the alfalfa cultivation can be used for wheat and other crops.

3) A crop sequence of <spring barley - alfalfa - alfalfa - alfalfa - wheat> can be recommended as an example of crop rotation.

II. SOIL CONDITION: LOW (C), SOIL MOISTURE CONDITION: POOR (3)

| |
|---|
| Under the shortage of soil water soybeans cannot be cultivated as a soil-resting crop. Winter crops resistant to environmental stresses such as rye and triticale will be suitable for feed crops. Lands of this type are susceptible to wind erosion; therefore, winter crops are also advantageous to the soil conservation by covering soils in early spring. |

A possible crop rotation can be <wheat - rye - triticale>

ITEM-7.3.4 AGRICULTURAL LAND USE OF MARGINAL FARMLAND

SOIL CONDITION: LOW (C), SOIL MOISTURE CONDITION: POOR (3)

| |
|---|
| Due to extremely severe cultivation conditions, even rye, triticale or grasses may not be suitable to the areas of this type. The first option to decide in the cultivation is production cost in comparison with the price of purchased feeds. |

## ITEM-7.3.5 CULTIVATION OF CROPS CONSIDERING PROTECTION OF NATURAL ENVIRONMENT

The fact that the farm lands are in the nature reservation areas and that the Slovakia is now in the home stretch to the EU accession, high value-added farming with a view to protecting the natural conditions is required in this area. In the current situation use of fertilizers and herbicides is authorized; however, there are possibilities of strengthening the regulation against the use of agricultural chemicals in the future. The soil in the region has high clay contents and high ground water level due to the location. Therefore, the farmlands are fertile and highly productive. However, weed damage and pests and diseases are widely spread, and hence weeding by plowing and introduction of resistant varieties are important for the crop protection. There are some possibilities that recycling of agricultural wastes and cultivation of leguminous crops will contribute to soil fertility.

### (1) Current Major Problem Areas

1) Weed damage
2) Water logging damage and other natural hazards
3) Soil-born diseases and pests

### (2) Aim of Countermeasures

There are no specific agricultural techniques for the agriculture of environmental protection. Practice of existing cultivation methods and their combination are most important.

1) Selection of resistant crops and varieties to flooding and pests and diseases.
2) Plowing for weeding without herbicides
3) Recovery of flooding areas by subsoil breakage and improvement of soil properties
4) Maintenance of drainage canals with a view to developing crop protection
5) Environmental conservation and increase of soil fertility by recycling of agricultural wastes and green manure.

6) Target crops and examples of possible cropping pattern.

- High soil fertility lands:<Rape seeds / sunflower- spring barley - soybeans - food wheat - maize>
- Medium soil fertility lands: <Wheat - triticale - maize - soybeans>

## ITEM-7.3.6 ORGANIC FARMING

SOIL CONDITION: GOOD (A) AND MEDIUM (B), SOIL MOISTURE CONDITION: ABUNDANT (2)

Organic farming is conducted under severe restrictions on chemical fertilizers, agricultural chemicals and herbicides by contracts with traders or middlemen. Generally leguminous crops and manures are used instead of chemical fertilizers, and plowing is used for weeding instead of herbicides. In the current situation the fertile and high soil moisture areas along the Morava River are selected for organic farming. Although crop yield is low, profit is not lower than the regular cultivation. For future development, diversification of organic farming and stabilization of marketing are crucially important.

(1) Current Major Problem Areas

1) Weed damage is widespread due to good conditions of water and soil fertility in spite of plowing.

2) Although fertile farm lands are selected, soybeans are cultivated and manures are applied (30 t/ha on average), crop yields are low and protein contents are not high enough for high quality wheat, because of no fertilization.

3) N fixed by soybean cultivation, which is estimated as 100 kg N/ha by one cropping, can be used for cultivation just after the soybean due to its character of fast acting. In the second year after soybean cultivation, fixed N is not effective and the supply of N is an important subject.

4) For stable production in organic farming, an alignment with traders or processors is essential. One case of contract farming is observed in the Study Area but it is necessary to enlarge varieties and standards and to diversify the partners

(2) Aim of Countermeasures

1) Various types of organic farming such as a type of low chemical fertilizers and no herbicides are proposed by farmers. It is important to diversify the mode of organic farming.

2) In accordance with the survey results, crop yields as high as 2 t/ha in wheat production and 0.5 t/ha in soybean production without chemical fertilizers were observed and it is expected to bring profit as same as normal farming.

3) Plowing for weeding.

4) Use of manure on farm lands.

<Reference>

Example of standards of grain quality and buying price of wheat in organic farming.

（Interview in the Farming unit survey, JICA 2001）

| Buying price | Protein content | FN | Volume weight | Foreign material |
|---|---|---|---|---|
| (SKK/ton) | (%) | | (g/L) | (%) |
| 7,200 | 13.31< | 250 | 780 | 1.5 |
| 5,800 | 11.51-13.30 | 230 | 760 | 1.5 |
| 5,000 | 11.00-11.50 | 230 | 750 | 1.5 |
| 4,600 | 11.0> | | | |
| 4,500 | (Feeds) | | | |

ITEM-7.4 IMPROVEMENT OF FERTILIZATION

Due to low holding capacity of water and nutrients, application of both macronutrients and micronutrients such as Cu, Mg, Zn and B are required. Nutrients at the later stage of growth affect the ripening and improvement of quality; therefore, it is important to supply N at this boot stage. Recycling of manure, urine and wastes of animal houses is important for the environmental protection and reduction of fertilizer cost. Manures and liquid manures are heavy, and special techniques are required to spread these matters. For the top dressing of fertilizers at the middle stage of growth, irrigation with fertilization is a promising method.

(1) Current Major Problem Areas

1) Low crop yield in the Zahorska area.

a. The low soil fertility causes reduction of crop yield as low as about 80% of the Slovakia average. In addition, since 1990, low fertilizer application has been another reason for the decrease of crop yield.

b. Traditionally, manures and fertilizers are applied as a basal dose, and chemical fertilizers are applied by top-dressing in early spring but effective fertilizer does in the mid stage of growing does not applied. For better ripening and high protein content in wheat grains, N application at mid-term growth is important.

c. Micro nutrients such as Magnesium, Zinc and Cupper are also deficient in sandy soil.

2) Increase of fertilizer price with the leveling off of selling prices for agricultural products has caused a reduction of fertilizer use. The reduction is most marked in N, P and K applications.

3) Manure is a dirty, wet and heavy product. There are a lot of difficulties in spreading the manure in fields. The difficult techniques of spreading are a barrier in the use of manure.

(2) Aim of Countermeasures

1) An increase of appropriate amount of chemical fertilizers is required for the increase of production and agricultural profits; however, it is necessary to decrease the dependence on the chemical fertilizers by using manures

2) The target of manure application is 30-35 t/ha as a basal dose. However, there is a limitation in production of manure by animals, and hence the area applied with manure is limited (as low as under 10% of the total arable land: Farming unit survey). Spreading of manure is costly; therefore, it is suggested to apply manure to vegetables and oil crops intensively.

3) Application levels of chemical fertilizers vary with target crops such as vegetables, fruits, oil crops and feeds. Vegetables (and oil crops) are usually irrigated, and fertilizers are required to achieve the full extent of production. Fertilizer dose to other feed crops should be decided in consideration of

economic effects, farming funds and management conditions to meet the feed needs in the mixed farming.

4) Irrigation with liquid fertilizers will be useful for the application of fertilizers in the middle growth stage as multiple-function irrigation.

5) Application of micronutrients such as Zn, Mg, B and Cu is also important in sandy soil farming. The field experiments by Duslo n.p. Sala (1988) indicate that the application of Zn, Mg and Cu increased yield of maize by 30% in the Zahorska area. It is well-known that B is often deficit in rapeseeds on sandy soil.

6) Mobile elements in soil such as N, Ca and Mg need to be applied as top dressing, and immobile elements such as P and K can be applied as a basal dose.

<Reference: 1> Manure Application

Manures were applied to 1710 ha in total of rapeseed, wheat, maize, asparagus, etc. The average amount of application was about 30 t/ha, and the cost of spreading was 30-100 SKK/t. (Farming unit survey, JICA 2001). The area applied was as low as less than 10% of the total arable land.

<Reference: 2> Merits of Manure

- Contents of nutrients in 30 t/ha of manure are estimated as N: 100 kg, $P_2O_5$: 60 kg and $K_2O$: 200 kg per ha. < 360 kg/ha>.
- The total amount of the NPK above is estimated to be 5040 SKK/ha in value. It can compensate for the cost of application: 214 kg/ha. (1 kg of NPK = 14 SKK).
- N compounds in manure have rapid availability, and about a half of N applied as manure can be used in the first year. P and K also have rapid availability. The microelements of manures are effective on plant growth, and organic matters are useful for the development of soil fertility. Wastewater from animal houses has also the same function as manure. Recycling of manures, are also important for the protection of environments, indicating the usefulness of mixed farming.

<Reference: 3> Upper Limits of Application of Fertilizers and Manure

Germany and several other countries in EU restrict the application of fertilizers and

manures to protect ground water quality. The amount of animal wastes is regulated legally in Germany: 210 kg/ha for pastures and 170 kg/ha for arable lands. Survey and research in this fields have been developed in the Slovak Republic, and an idea of the upper limit of N from N fertilizers: [150-170] kg/ha is presented.

<Reference: 4> N Fixation and improvement of soil characteristics by Leguminous Plants

Leguminous crops such as soybeans fix about 100 kg of N per ha in one cropping season. The N is fast acting and the effects of N by leguminous crops are mainly limited to one year. Wheat and rapeseeds absorb a large amount of N, hence, these crops should follow leguminous crops. In addition, several crops such as alfalfa can improve soil characteristics by their long roots.

## ITEM-7.5 INTENSIVE IRRIGATION OF SUMMER CROPS AND LEAFY CROPS

Summer crops and leafy crops have a large respiration ratio, and hence irrigation is important for these crops. These crops are generally high in response to irrigation and profitable as cash crops. It is necessary for efficient irrigation to conduct intensive irrigation by selecting high value-added crops for crop rotation and appropriate lands with high soil fertility. The increase of biomass by irrigation is expected to improve soil fertility and crop productivity. On the other hand, weed damage and pests and diseases are crucial points in plant protection.

(1) Current Major Problem Areas

1) In the decision of cropping pattern in the current conditions, crop profitability and productivity are not always given importance. This causes idleness in facilities and water supply, resulting in low operation rate and inefficiency of irrigation.

2) A high input of irrigation is requires necessary amount of fertilizers to achieve the targets increase of crop yields.

(2) Aim of Countermeasures

1) Major target crops are sunflower, alfalfa, soybeans, maize, spring barley, etc.

2) Select summer crops and efficient cash crops, and formulate appropriate crop rotation with irrigation application. Gramineous crops have to be included in the crop rotation to protect crops from soil-born diseases

3) Select fertile lands having low flooding or other natural hazards. High inputs such as appropriate fertilization and weeding will enable highly productive farming to be established to compensate for the cost of irrigation.

4) In order to increase effect of irrigation, manuring practice and weed control are to be carried out carefully.

## ITEM-7.6 CULTIVATION TECHNIQUES OF VEGETABLES AND FRUITS

### ITEM-7.6.1 VEGETABLES

In Slovakia vegetables were traditionally cultivated by garden farming, and the products were sold in local markets. No large scale wholesale markets were established, and small farmers seek favorable consumers on their own information. Large-scale vegetable growers produce vegetables by contract with vegetable processing companies. The vegetable production in future will be developed by upgrading quality of marketing standards and contract production with traders and processors for stable marketing.

(1) Current Major Problem Areas

1) Major vegetables of the Zahorska area are root crops such as carrots and onions, cabbages, parsley, etc. Yields of several vegetables reach the national levels, maintaining a promising position in vegetable production. However, varieties of vegetables are not abundant, especially in early spring.

2) Current irrigation is not efficient because of the characteristics of large-scale irrigation systems that were produced for cereals in the past.

3) The plow layer of the Zahorska area is often shallow. Breakage of hard pan was tried to soften the subsoil for the asparagus fields.

4) Due to limited marketing and consumption of vegetables, production has stagnated at low and medium levels. Except for asparagus, export of vegetables from Zahorska is limited.

(2) Aim of Countermeasures

1) The gene bank of Slovakia enables the development and diversification of crop species and varieties. It is necessary to have an active breeding and extension program for new crops and varieties.

<Reference>

The number of registered varieties of vegetables is 1,114 in 2001, increased by 1.78 times from 627 in 1995. The registered varieties of fruits increased by 1.16 times from 287 to 333 in the same period.

2) Winter vegetables in green house cultivation and tunnel cultivation to meet the consumption in winter could be a promising high value-added crop.

3) Timely irrigation is important corresponding to the growth stage of vegetables. Labor saving and low-cost irrigation systems such as drip irrigation are required.

4) It is necessary to increase plow layer depth, soil fertility, water permeability and control of ground water for soil improvement for vegetable cultivation. To tackle these problems, breakage of hard pans was introduced. Its effects are sustainable, but the cost is as high as 6,000-6,500 SKK/ha.

5) To protect vegetables from the severe damage of continuous cropping, appropriate crop rotation is quite important. There are various combinations of crops and the following is an example <vegetable - winter wheat - summer furrow - vegetables>. Vegetables require fertile and low-gravel-containing soils; therefore, crop rotation by vegetables themselves is recommended.

6) The vegetable markets are easily saturated <especially with products from the South west of Slovakia>; therefore, it is recommended that small farmers specialize in production of fresh vegetables, and that large enterprises will engage in it with a view to diversifying and stabilizing management.

## ITEM-7.6.2 FRUITS

The cold climate of Zahorska is not suitable for fruit production such as grapes, as it causes low sugar content of fruits. However, the summer time, when small fruits such as cherries and berries ripen, has long day-length, large difference between the temperature of day and night and small rainfall. The climatic conditions, favorable to the growth of fruits, enables production of high quality fruits. It is necessary to produce market-competitive fruits by selecting suitable fruit species and conducting appropriate crop management.

### (1) Current Major Problem Areas

1) Vast abandoned orchards occur in the Zahorska area that is known to be an apple producing area. Since 1990 a large amount fruits have been imported from tropical and temperate zones, resulting in the loss of market-competitiveness of domestic fruits.

2) The results of the survey on sugar content of apples from the Zahorska (Verke Levare) indicate that the apples of the area had a lower sugar content by 1% than in other areas, and that the quality of fruits in the Zahorska can be inferior.

3) The processing of domestic fruits needs to improve because of the stagnation of food processing.

### (2) Aim of Countermeasures

1) Since fruits are perennial crops, it is necessary to select the right land carefully, considering the conditions of soil quality, irrigation and drainage and location. In addition, since the soil characteristics in the Zahorska areas have a large variation, it is important to provide services on selection and cultivation for appropriate farm lands as well as land classification

2) Conduct quality control, such as evaluation of sugar content, and the harvest of high quality fruits by selecting well-ripened fruits.

3) Produce fruits, taking advantage of location close to the large consuming areas.

4) Develop fruit processing, based on the advanced technologies that can be derived from large dairy-farming enterprises in the Zahorska area.

5) Strengthen R/D and extension system, because growing and marketing of fruits require a high level of skill.

## ITEM-7.7 MANAGEMENT OF MEADOWS

Highly profitable farming and high quality products are required, anticipating the accession to EU. Mixed farming will maintain the fundamental function of livestock farming in future developments. In dairy farming, the increase of animal productivity and quality improvement are both important, and for these purposes the improvement of feed quality and increase of high quality feed supply are crucially important. For efficient meat production, reduction of cost of feed supply is important. Introduction of new species and varieties of crops/feeds and the upgrade of cultivation techniques are necessary to achieve these targets.

### (1) Current Major Problem Areas

1) Although Holstein is introduced in the dairy farming in the Zahorska area, the milk production is as low as 4,500 l/head/year on average. The land use for cows is also not efficient: 0.7 ha/head in Zahorska, while 0.4 ha/head for 7,000 l/head/year in Austria.

2) For pig rising and cow fattening the share of feed cost is so high in the production cost that lowering the cost of feed production is indispensable.

3) Productive wet lands spread along the Morava River, and sandy areas of low productivity are widely observed. It is important to make good use of these areas for meadows.

4) Diversification of meadow grasses is not well developed: only two major species <silage maize and alfalfa>. Efficiency, quality improvement and diversification are required in the production of roughages.

5) In spite of the purchase of large amounts of soybeans and soybean meal by livestock farmers, the production of soybeans is not well developed.

* Soybean production is being increased by the implementation of the development plan of the government of Slovakia - aiming at 10,000 ha planted areas with the government subsidies: 1,500 SKK/ton.

(2) Aim of Countermeasures

1) Increase the production of better quality roughages (alfalfa) for dairy farming. There is a typical example in which milk production was remarkably increased by the improvement of quality and increase of the proportion of alfalfa in the roughage.

2) Reduction of production cost

- Concentrated feeds: Increase the production and lower the cost of winter crops for cereals and feeds.
- Roughage: Increase perennial meadow grasses.
- Recycling manure to lower costs and for environmental protection.

(3) Diversification and stabilization of meadow grasses.

a) Upgrade the land division and make good use of natural meadows for economic feed production.

b) Expand the use of improved varieties of alfalfa that are suitable to the Zahorska area.-- the major (only) meadow grass of Zahorska.

c) Use the perennial crops for meadow grasses because of their economic advantages.

d) Introduce high quality feed varieties and diversify feed species and varieties. In the current situation, promising methods are recommended, such as growth of red clovers in the high soil moisture areas, various leguminous crops for feeds, gramineous crops with drought resistance and hybrids of several crops.

<Reference 1> Promising new meadow grasses

<Gramineous crops >

a. Tall fescue (Growth period: 5 years), b. Perennial rye grass (5-6 years),
c. Orchard grass (4 years), d. Tall oat-grass (4 years),

<Leguminous crops>

a. Alfalfa (Growth period: 3-4 years), b. Bird’s foot clover (3 years),
c. Hybrids of alfalfa (3 years), d. Red clover (3 years)

<Others>

a. Hungary peas（High yield in sandy soil areas）

b. Sorghum (Resistant to dry conditions)

< Reference 2> Requirements for soybean cultivation

① Fertile soil
② Abundant (soil) water supply
③ Inoculation of root nodule bacteria.
④ Small amount of fertilizers for starter
⑤ Requiring P, K, Ca and micro-nutrients.
⑥ Crop protection from pests and diseases.
⑦ Crop rotation of 2-3 year intervals with wheat and barley.
⑧ Development of parietal improvement and cultivation techniques.

<Reference>

The number of registered varieties of soybeans was only 8 varieties in 2001, markedly decreased from 13 varieties in 1995. The current number of soybean varieties was also much smaller, as compared with 23 varieties of rapeseeds and 48 varieties of sunflowers

## ITEM-7.8 WEEDING AND PLANT PROTECTION

In the Zahorska area arable lands rich in soil water and fertility have severe weed damage, resulting in serious problems for crop protection. Especially in organic farming, weeding is a crucial problem because of the prohibition of agricultural chemicals. Turn-over plowing is a useful alternative to weeding. Flood damage happens in early spring, and crops in lower places are sometimes covered with water, although no field is flooded entirely. Breakage of hard pans is required to protect crops from flooding. Damage by pests and diseases are not serious problems, but soil-born diseases are widely spread in sunflower and rapeseeds; therefore, crop rotations with 3-4 year intervals are required. Recently, new crops and varieties resistant to pests and diseases, weeds and environmental stresses, have been developed. Introduction of these new crops is needed for the upgrading and stabilizing of production. Besides, plots of the Zahorska area are large; therefore, concentrated treatment to demanded spots in fields is recommended to be introduced as well as deep plowing.

## ITEM-7.8.1 WEEDING

### (1) Current Major Problem Areas

1) Four major weeds in the Zahorska areas.

- Cirsium arvense (L) scop. : Creeping thistle,
- Galium aparine L.: Cleavers,
- Echinochloa cris-galli (L) Beauv.
- Chenopodium album L.

2) Phenomenon of weed damage

- Decrease and instability of yield by inhibiting growth.
- Poor ripening because of competition with weeds.
- Lowering of crop quality.
- Lowering of nutritional value in the roughage.

3) Susceptible areas to weed damage

- Areas with high soil water and high fertility.
- Improperly plowed areas.
- Fields close to irrigation and drainage canals.

### (2) Aim of Countermeasures

1) There are several useful methods, and these methods should be combined for practical and efficient use.

- Grow crops earlier than weeds can spread and grow.
- Inter-tillage.
- Turn-over plowing before planting/seeding.
- Increase of planting density.
- Use of cover crops.
- Use of herbicides.

<Reference>

About 20 kinds of herbicides are used in the Zahorska area and the ratio of the weeding cost is about 30% of the entire cost, being the highest among them.

2) Turn-over plowing and inter-tillage will be used instead of herbicides.

<Reference>

Comparison of weeding cost : Farming unit survey (2001 <JICA>)

- Plowing: 1,200-1,400 SKK/ha
- Herbicides: 2,400 SKK/ha <Round-up, 600 SKK/litre, 4 litre/ha>

## ITEM-7.8.2 FLOOD DAMAGE ON FIELD SURFACE

### (1) Current Major Problem Areas

1) Flood damage is caused when: water increases at thaw in early spring causing flooding from rivers and canals, the increase of soil moisture brought about by rise of water levels in adjustment canals, poor water permeability of field surface soil, etc.

2) Phenomena of flood damage

- Crops in lower parts of fields are covered with water <No fields were flooded over all the surface.>
- Field work is delayed due to difficulties of machine work.
- The major reason is that water, which does not pass through the soil layers, flows to the lower parts of the field.
- The fields along the dyke of the Morava, the southern part of the Zohol area and the north-eastern part of Malacky are examples of areas where flooding occurs frequently.

(2) Aim of Countermeasures

1) Construction and maintenance of drainage canals.

2) Breakage of hard pans, which contributes to the drainage of water on the surface of fields and control of ground water level.

3) Introduction of resistant crops to wet damages (e.g. maize)

4) Avoidance of excess water injuries by adjustment of seeding time in early spring (e.g. spring barley)

5) Crop growth and yields are often remarkably affected by a small difference in elevation of field surface and depressions. It is necessary to measure the difference in elevation of the field surface and to establish appropriate counter measures.

<Reference>

Examples of the breakage of hardpan in the case-study area

Since 1998 SWME-ID and private enterprises have been conducting the breakage of hard pans. STOMFA s.r.o. broke the flooded parts of the fields at 50-60 cm depth, and have so far finished about 80% of the surfaces of its own fields successfully. Asparagus s.r.o. also broke the hard pan of the entire area of asparagus fields at the same depth to maintain the ground water level below 1 m. From this field treatment, favorable soil conditions are produced; i.e., easier for rainwater to pass to the subsoil, better use of ground water, improvement of aeration at the lower part of the plowing layer and acceleration of root growth to the subsoil.

## ITEM-7.8.3 CROP PROTECTION FROM PESTS AND DISEASES

(1) Current Major Problem Areas

Pests and diseases are not major problems. However, pathological problems occur with continuous cropping of sunflowers and rapeseeds, causing the need for long intervals of crop rotation.

(2) Aim of Countermeasures

Damages by cysto-nematodes and root lesion nematodes are reported, and in oil crop cultivation, diseases such as Botrytis cinerea and Sclerotina scleotiorum are reported for sunflowers. Crop rotation with longer intervals has to be introduced to reduce density of nematodes.

## ITEM-7.8.4 CONCENTRATED TREATMENTS FOR DAMAGED PARTS OF FIELDS

(1) Current Major Problem Areas

Soil and water conditions vary in large scale fields by part even in a field in the Zahorska area. Several parts with heavy density of weeds, poor soil productivity, depressions, etc. are observed. These parts are not large in area, but affected in crop yields and crop quality. The weed damages are often enlarged year by year.

(2) Aim of Countermeasures

For these damages concentrated treatments for the heavily damaged parts are quite useful. As an example for weed damages, concentrated herbicide application should be made for the parts of the fields with high weed density. Plowing is also useful as additional management practices. The amount of herbicides to other relatively healthy areas can be reduced, resulting in the reduction of amount of herbicides for the overall application. This type of method is useful for countermeasures to damages in limited areas in a field.

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## SUBJECT-8 FARM MANAGEMENT

### ITEM-8.1 TECHNICAL GUIDELINES FOR MAJOR FARMING PATTERN

(1) Farming Patterns Observed in the Faming Unit Survey (JICA 2001)

It is necessary to consider the development aim from the farming pattern point of view as well as from the technical point of view, such as soil and irrigation, in order to increase agricultural productivity and profitability. Since the crop-livestock mixed farming is the fundamental pattern of farming in Slovakia, the following 3 patterns were categorized in relation to mixed farming:

A. Crop-livestock mixed farming <Reference: 5 units of 19 total units, 26% in the survey.>

B. Mixed farming + oil crops (sunflower, rapeseeds) + processing materials (food wheat, barley) + vegetables <Reference: 8 units of 19 total units, 42% in the survey>.

C. Combination of cereals, oil crops, processing materials <Reference: 6 units of 19 total units, 33% in the survey>.

* There was no single cereal producing farmers or animal husbandry farmers in the survey.

(2) Common Technical Factors in the Farming Patterns

1) Since the water supply and fertilization are 2 major limiting factors, technical factors will be considered for the water supply (irrigation + soil water) and soil fertility (level of clay contents, fertilizer dose)

2) Selection of appropriate crops

a. Winter crops: To make better use of rainwater and climatic conditions the winter crops will be selected as the major feed crops.

b. Summer crops: Small fruits such as cherries and blue berry are suited to the summer climatic conditions. Vegetables, sunflower, soybean and maize have a high response to irrigation.

c. Perennial crops: It is important to improve the quality of roughage and lower the production cost to develop mixed farming.

d. Leguminous crops: Leguminous feeds and soybeans as appropriate in the crop rotation to upgrade soil fertility.

3) Recycling of animal wastes to fields is required to protect the environment and increase soil fertility.

4) Selection and cultivation of highly profitable food crops (food wheat, sunflower, rapeseeds and spring barley) to make good use of favorable cultivation conditions (irrigation, soil water and soil fertilities).

5) Resistant crops to wet damages and drought: There are a lot of fields which have water logging and dry mounds depending on their topography. It is important to introduce resistant crops and adjust seeding times to avoid damages.

6) Irrigation to feed crops such as alfalfa, soybeans and other leguminous feed crops, when efficient irrigation is expected.

7) Small scale farmers and farming units using high land value fields in peri-urban areas have to concentrate on intensive production such as vegetables and fruits and dairy production.

### ITEM-8.1.1 CROP-LIVESTOCK MIXED FARMING

This is the fundamental farming pattern of the Zahorska area. Animal husbandry that has high profits uses low profit crops as self-supplied feeds, and so changes the feeds to profitable products. The direction of the future development of mixed farming should be to separate into the 2 different areas of feed production: dairy farming and meat production. Dairy farming, in which remarkable increase of productivity can be expected from the improvement of feed quality, requires high protein and high quality roughage containing fewer weeds. For pig production, raising efficiency by lowering production costs of concentrated feeds is crucially important. Due to abundant fields, the Zahorska area has advantages in the mixed farming.

(1) Current Major Problem Area

1) Due to low profitability of crop (feed) production, it is inevitable to run mixed farming.

2) Since the increase of milk production is required, it is primarily important to improve the productivity of dairy farming due in the Zahorska area due to the low milk production in the area to increase the milk production. To cope with these problems the production of high quality roughage is targeted.

3) From the fact that the ratio of the feed cost is quite high in the pig raise, approaches to lowering costs are important.

(2) Aim of Countermeasures.

1) Increase the production of high quality roughage (alfalfa) which meet the nutrition demand of animals, contain high protein and have low contamination of weeds for the purpose of improving productivity of doing farming.

2) Lower production costs of cereals and grasses through

- Reduction of costs by production of winter crops (Ex. Winter wheat, rye, triticale, oat and winter barley),
- Diversification and improvement of quality by introducing new species of weeds, varieties and hybrids,
- Expansion of crop cultivation in high soil-moisture areas from the soil characteristics, for example, cultivation of maize and red clover in wet areas.
- Inoculation of nodule bacteria suitable to roughage,
- Recycle of animal wastes and residues from food processing.

3) Conversion of meat production from cow to pigs and poultry from the reasons of BSE and high feed efficiency.

4) Change of land use from cereal and weed cropping to pastures in low fertility agricultural lands,

5) Maintaining and extension of recycle of animal wastes for manure in the mixed farming from a view to improving of soil fertility, reducing of fertilizers and protection if environments.

<Reference>

Example of increase in milk production by improvement of alfalfa.

<Farming unit survey, JICA 2001>

An example in the interview survey indicates that improvement in the quality of alfalfa by removing weeds and an increased supply to animals, upgraded milk production markedly. In this example, the alfalfa was increased from 5 kg/day/head to 15 kg/day/head in the daily ration of 30 kg roughage for Holstein, resulting in an increase from 4,500 l/head/year to 5,500 l/head/year. The alfalfa has a high protein content and is suitable for milking cows. In addition, it also adapts well to the natural conditions of the Zahorska area: dry and cold weather, alkaline soil, well drained soil, low pests and diseases, etc.

* High quality fresh milk is highly market-competitive, and, hence, is able to benefit from the increase in fresh milk prices in spite of slight increase of roughages.

## ITEM-8.1.2 PRODUCTION OF OIL CROPS, PROCESSING MATERIALS AND VEGETABLES WITH MIXED FARMING

This pattern is composed of oil crops, processing materials and vegetables as additional parts of mixed farming. Mixed farming is a traditional and stable form of farming, but it requires diversification in management to obtain more profits and make good use of management resources. Oil crops and processing materials as cash crops are an additional factor in land use. Vegetables are cultivated by full time farmers, and also produced as an additional product in intensive cultivation, and they provide great profits in a limited area, although an increase of inputs such as irrigation, fertilizers and human labor is required. The farming patterns are different between these two categories of products. The appropriate pattern will be selected by the characteristics of management resources.

(1) Current Major Problem Areas

1) Although mixed farming has a stable management pattern based on long tradition, high profit cannot necessarily be achieved due to the large facilities and unfavorable market conditions such as BSE.

2) The additional factors are the production by market-oriented farming, and, hence, stable marketing channels are required.

(2) Aim of Countermeasures

1) Diversify and stabilize cash crop production with high market needs.

2) Select agricultural and livestock products for which demand will increase in future developments <Examples: edible oil, dairy products, pork and poultry, high quality fruits and vegetables and processed food>.

3) Explore contract production with food processors and strengthen own marketing channels.

4) Oil crops require crop rotations with 3-4 year intervals. For profitable crop rotation, these crops need to be combined with highly profitable gramineous crops such as food wheat and malt barley.

5) Input manure to intensive vegetable producing areas in order to increase soil fertility and efficiency of manure use.

6) Increase the inputs such as fertilizers and irrigation, and achieve high yielding, high quality and highly profitable production.

7) Improve soil characteristics by breaking hard pans and other methods to stabilize production and improve the quality of vegetables and fruits.

## ITEM-8.1.3 PRODUCTION OF CASH CROPS: OIL CROPS, PROCESSING MATERIALS AND VEGETABLES

This pattern is not popular because it does not include livestock farming. However, all these crops are high value-added crops, and high profits can be expected. The production of oil crops and processing materials can be low-cost due to relatively low inputs of management resources. Vegetable production has the potential to increase profits using specific products by taking advantage of soil conditions, crop characteristics and location. All these crops are products for human consumption; therefore, grading and quality control should be well established, and contracted production, collaborative work and marketing need to be organized properly.

(1) Current Major Problem Areas

1) The natural conditions of the Zahorska area are not generally suitable for the production of high value-added crops; therefore, it is necessary to identify appropriate fields in terms of soil fertility and water supply.

2) Although oil crops, processing materials and vegetables are all market-oriented products, marketing standards are not well established except for wheat.

3) Research and development relating to quality control is not developed, and production techniques and extension services need to be developed.

4) Contract farming and collaboration in farming are strongly requested due to the limited progress in the marketing systems.

(2) Aim of Countermeasures

1) Select the right place suitable for high value-added crops in terms of soil water and soil fertility.

2) Develop technical packages covering land preparation, fertilization practices, irrigation, harvesting, marketing and quality control to achieve production of high quality products.

3) Establish a market information supply system in relation to dissemination of price information, preparation of marketing standards and market information for the purpose of smoothing the transaction of agricultural products in markets.

4) Develop the contract farming and the collaboration in farming in line with the development of privatization. The contract farming has a great advantage for farmers in obtaining operation funds, selling products and collecting bills depending on conditions.

## ITEM-8.2 REDUCTION OF FARMING COSTS AND INCREASE OF PROFITS

Agriculture in the Slovak Republic is in potential surplus of products, and, hence, priority should be given to the improvement of profitability and environment conservation rather than increase of production, facing at the accession to EU. Therefore, the costs of inputs such as fertilizers, irrigation and agricultural chemicals should be clearly grasped. In addition, the Zahorska area is designated the less favored areas due to the low productivity in agriculture; therefore, the government support is indispensable now and in future. Farmers self-help efforts are required to increase the productivity and activate rural areas by the development of agricultural techniques. Exact estimation of costs of agricultural products is fundamental to lowering costs and improving of profitability. Production costs have been calculated in the past by parameters of inputs. However, from the point of view of the technical development, the estimation from the working steps is more effective than that from the inputs.

(1) Current Major Problem Areas

1) In the survey on the production costs and profits, it was clear that the subsidies for supporting the development of rural areas and the agricultural production are indispensable. Lowering of production cost and increase of profits are important for the future development of sustainable agriculture.

2) The market-oriented farming is strongly required in the Zahorska area due to the disproportion of prices between agricultural inputs and products. Large fluctuation of production and selling price causes serious problems to agricultural profits. At the same time the economic evaluation of the farming has increasing importance. These ideas were shared by farmers.

3) In the estimation of production cost the calculation by input parameters is not clearly related with the technical practices in the crop production. To improve the agricultural practices it is necessary to calculate production costs from step of work.

(2) Aim of Countermeasures

1) Production costs have been calculated so far by costs of materials, labor cost and interests/rental. However, for the economic evaluation of agricultural practices the analysis of production costs by the following agricultural practices are useful: 1. land rent, 2. plowing, 3. organic manure application, 4. fertilization, 5. seeding 6. weeding, 7. plant protection, 8. harvesting, 9. irrigation, 10. management (10% of the total costs from 1. to 9. in this survey).

2) There are strong possibilities of reducing the production costs and improving profitabilities by the development and combination of existing techniques such as items shown below:

   a. Increase of production by irrigation and increase of limited amounts of fertilizers and agricultural chemicals.
   b. Better utilization of natural / environmental conditions.
   c. Reduction of agricultural damages by control of soil and water conditions.
   d. Selection of appropriate and resistant crops.

   In addition, fluctuation of crop yields and selling price has serious effects on profits; therefore, the range of the fluctuation should be reduced within a range of about [20%].

3) The subsidiary systems to agricultural practices after the accession to EU have not yet been established, what is estimated are possible reduction of supports to agricultural production and increase of direct supports to farmers in the designated areas. It is important to establish a style of environment friendly and sustainable farming and secure the supports and cooperation from the governments, marketing and processing sectors and various fields in urban societies through the mutual understanding.

## SUBJECT 9 OTHER RECOMMENDED MEASURES

### ITEM.9.1 AGRICULTURE SUPPORTING SERVICES

(1) Enhancement of the Agricultural Information Service Corresponding to Local Conditions.

The main role of the agricultural information service is to make a contribution to effective, well planned and stable agricultural production, through the provision of timely and accurate information. Information delivered should consider the socio-economic and natural conditions of each recipient, such as farmer, cooperative farm, agricultural company or related industry.

The agricultural information system, extension service and education programs must consider local needs in the long and short term.

1) Publicity of the Agricultural Information Service

The agricultural extension is promoted by the agricultural information service at the moment. In this system, users voluntarily obtain information by themselves using the Internet, etc. The major part of extension is carried out by the Technical Guidance System, which consists of advice provided by private agricultural advisers. However, this new system has not yet worked well because it is not well known Publicity and PR by the MoA, extension office and public organization is therefore needed to promote its use. Also the private advisers or companies, who are registered as agricultural advisers, should advertise the service showing uses and charges clearly.

2) System of Information Service

The extension service had been carried out by the agricultural chamber, which is the only farmers' organization at present. However, the chamber stopped its extension activity and they limited their activity to education, such as the symposium at the beginning of the Technical Guidance System. Because of this, there is concern that the extension activities and technical guidance do not correspond well with local

needs. Because the Technical Guidance System covers the whole country, activities relating to local subjects are needed, such as preparing a list of local advisers who understand the unique problems in each location.

3) Required Agricultural Information and Technologies

Now the MoA only provides general information such as the annual report or general forecasts about production, consumption and international situation, etc. Such information is useful to farm management or to prepare the management plan. However, the particular information on agricultural technology and techniques suitable for the unique situation of the sandy soils of Zahorska lowland is also required by the farmers. Related research institutes and universities should tackle such subjects in the local area or production site.

The agricultural information and technologies can be divided into three categories according to their characteristics

a. Information which is required at farmer's level (new or improved technology which is never provided)
b. Information, that requires further study or experiments (trial measurements such as examination of adaptabilities among the crops, etc.)
c. Information, that requires continuous monitoring or updating (information suitable for database)

It is recommended that following information is provided in future in relation to the Guidelines.

- Adaptability of the variety of fruit to soil character, because the initial cost of the fruit production is high and its cropping period is long.
- Adaptability of existing crops to soil character, especially in sandy soil, and suitable cultivation methods and irrigation efficiency.
- Suitable new crops for sandy soil and the cultivation methods, especially soil resting crops.

- Information on varieties both of existing feed crops and new feed crops for rotation, and their applicability to livestock and their economy.
- The accessibility to high profit agriculture with less initial investment, such as organic farming.
- Counter measures to prevent wind erosion and wind damage in the cultivation method (Crop selection and crop rotation, etc.)
- Collection of actual data about existing irrigation and drainage systems conditions
- Assessment of the conditions and maintenance of drainage facilities and canals at field level.
- Improvement of field irrigation systems to cope with intensive farming, such as vegetables (examination of renewal method for existing system)
- Recommendation of crop rotation system corresponding to soil conditions

(2) Enhancement of the market information system

The wholesale market system is indispensable to the enhancement of intensive crop production such as vegetables and fruit, from the aspect of delivery management. However, the present market system has not been improved, so that dealings are directly between the producer and trader or produce is sold in retail markets by the farmers themselves. Because of this, the advantages such as the quality of products or stability of production is not reflected in the price. This restricts the farmer's incentive to improve the quality of production. To solve this, further construction of the market system is required.

ATIS provides information for the farmer about the market prices, but not about the vegetable wholesale market. This market information is prepared only biweekly, and this long interval greatly restricts the preparation of the delivery plan in which the current price should be considered. The market information system needs to be improved, especially in vegetables and fruit, to cope with real time price information and sending it to each local area, considering the affiliation to EU in the future.

## ITEM 9.2 SOIL POLLUTION

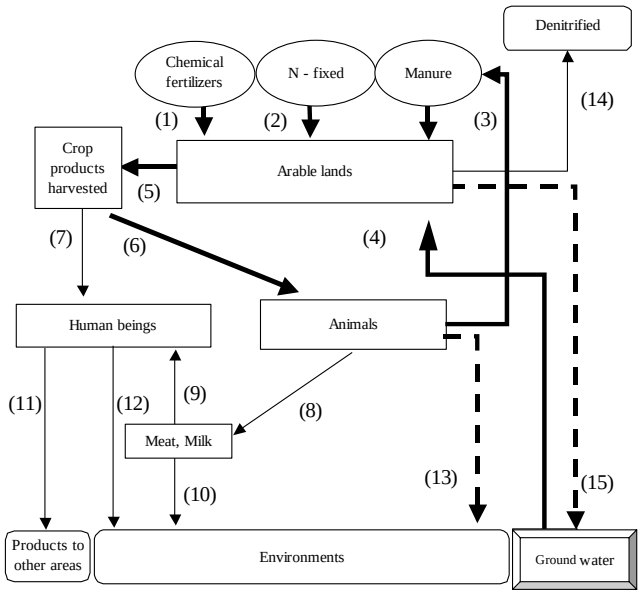
Traditional pollution sources derived from mining activity, such as a mine and a refinery, do not exist in this district. A low level of cadmium contamination is found in the farmland near a cement plant in Rohznik. The permissible cadmium concentration in wheat grain and flour has been set to 0.1 mg Cd/kg, and there remains a possibility of crops exceeding this standard cadmium concentration. It is desirable that tentative measures, such as conversion to non-edible agricultural products, should be recommended until the results of survey prove that levels are safe. In a cement plant, although the cadmium concentrations in the raw materials are generally low, there are many examples of pollution in surrounding farmland through the heat treatment process. The extent of the polluted area is extremely limited, and it may be a good chance to implement an ideal model of countermeasures against pollution.

## CHAPTER 5 TECHNICAL MEASURES AND ENVIRONMENTAL CONSERVATION FROM N-FLOW

It is convenient to use the scheme of N (nitrogen)-flow as a tool to get a bird's eye view of environment friendly agriculture. The proposed items of the guideline cover a wide range of agricultural development. It is important to understand the positioning and relations of the items for the appropriate use of the guidelines. The N-flow in the arable lands indicates the main route of agricultural products. N is one of the most widely related parameters in the scheme of the guidelines, and its flow is a visual and easy tool to grasp the entire view of the products and procedures. A brief explanation will be made of the related items following the number in the chart.

The numbers in brackets at the ends of sentences refer to the number of technical items in the guideline.

Many models have been proposed for the N-flow in global levels and regional levels. Due to the limited information and primary data, a simplified model cited in the Encyclopedia of plant nutrition and fertilizers, published in Japan was referred in this survey. The explanation was limited to the items relating to the agricultural production.




Distribution Ratio of Nitrogen Recycle in the Food Production and Consumption.
<Tentative Model>

### (1) N Application

The basic approach of the N flow is to increase the recycling of N compounds from animal wastes and ground water and to reduce the dependence on chemical fertilizers and the load to environments, although an appropriate amount of N fertilizer will actually be increased. This will result in the development of sustainable agriculture and environment-friendly farming.

The application level of the industrial fertilizers is as low as about 60-80 kg/ha for N, and it is often reported that the lower N application caused a yield decrease. The share of the fertilizer cost in the production cost is about 10%: not very high. The N level is at moderate level for the crop production; therefore, an increase of N application will bring about a higher yield efficiently. Therefore, it is recommended to

- increase N dose within appropriate use for the purpose of the activation of agricultural production and improvement of the farming profits,[ITEM-7.4]
- increase the N from the recycling of manure, absorption of N in the ground water and N- fixation to reduce the dependence on the chemical fertilizers, with a view to protecting the environment and developing sustainable agriculture, [ITEM-6.1], [ITEM-7.4]

(2) N-Fixation

The leguminous crop cultivation is mainly introduced by the necessity of livestock and dairy farming. N-fixation is induced by leguminous crops in agricultural fields: mainly by alfalfa in the Zahorska area. In the current situation chemical fertilizers make up most of the entire N supplied from outside of the system.

- It is quite important to increase the ratio of the N fixation by leguminous crops which are increased by strengthening the crop- livestock mixed farming. [ITEM-7.7]
- Alfalfa with large straight roots and other perennial crops has useful effects on the soil characteristics and the bio-diversity of the dry and sandy areas. [ITEM-6], [ITEM-7.3.3], [ITEM-7.7], [ITEM-8.1.1]

(3) Recycling of Manure

The N recycling from the manure is important both for the N resources for cropping and the environmental conservation. The application of N is not very large; therefore, the additional N is useful for the crop production.

- If the manure is applied as scheduled (about 30 t/ha), the N content will reach 100 kg/ha: not less than the chemical fertilizers. [ITEM-7.4]

- The manure has also other functions to improve soil fertility and soil characteristics and retention of crop nutrients. [ITEM-6.1]

This is the most important function of mixed farming in sustainable agriculture. A stable performance can be produced by recycling manure.

(4) Return of N from the soil and ground water

The N applied to fields easily leaks to the ground water in the sandy soil. The ratio is much higher than in the loamy soil. The absorption of nutrients from soil and ground water is estimated to be considerable. However, it is important to increase the retention of nutrients in the arable lands for the improvement of the efficiency of the nutrition uptake.

- Organic matters such as manure and green manure can improve the retention of crop nutrients in the soil. [ITEM-7.4]
- N in the soil and ground water can be absorbed and reused by plowing-in weeds and other crops after harvest as green manure. [ITEM-7.3.5]

(5) Amount of N absorbed by crops

The N applied to fields is used with a different rate of absorption by crop. In this survey it is estimated that about [60%] of the total N in the arable land will be absorbed by crops. The N absorption rate varies with cropping conditions such as plant growth, application time, split of application, application of organic matters, etc.

- The application of manure brings about the improvement of soil conditions and, hence, the rate of N absorption will be increased by the application of manure. [ITEM-7.3.1], [ITEM-7.3.2], [ITEM-7.4]
- Appropriate crop management is important from the fact that the vigorous growth enables crops to increase N absorption and produce high yields. [ITEM-7.2], [ITEM-7.3]

(15) Leakage of N to the environment

The sandy soil has high leakage of many kinds of plant nutrients. The rate is estimated to be about [30 %] of the total N in the soil. Although a large amount of N (Mainly $NO_3$-N) in the ground water is absorbed by crops, the leakage should be reduced, because the leakage of the N reduces the efficiency of the fertilizer use, and often causes pollution of the ground water.

- Split application of N fertilizers is important to increase the crop yields and to improve the efficiency of fertilizer use by reducing the loss of N from soil. [ITEM-7.4]
- The leakage is also influenced by irrigation and drainage. Excess irrigation water often causes high leakages; therefore, the irrigation should be well controlled. [ITEM-2.8]

(14) The N-denitrification

The N-denitrification usually happens in reductive conditions in the soil. The soil in the Zahorska area is sandy and dry, and containing low organic matters. Therefore, the soil conditions are oxidative, and the N-denitrification will be low. The exact mechanism remains to be reviewed and studied further.

(6) Use of agricultural products by animals

Major parts of the agricultural products are used for animals as self-supplied feeds. It is estimated that about [55%] of the cereals is used for the animals. Animal wastes are usually recycled to arable land as manure. The solid manure is piled on the fields up to the time of spreading before plowing for storage and fermentation. However, the liquid manure needs to be applied by applicators periodically after treatment due to the difficulty of storage. To improve and stabilize the treatment of animal wastes in the fields, the following techniques can be recommended:

- Application to crop fields and pastures for their better management:
  The liquid manure can be applied to alfalfa after its harvest and to fields of other crops before plowing or seeding. [ITEM-7.7], [ITEM-8.1.1]

- Agricultural lands in fallow for animal wastes especially for the liquid wastes:
  The liquid manure can be used on the fallow fields for the improvement of soil fertility. It is also necessary to prepare/set aside this type of field for environmental conservation as the primary purpose and keep them for agricultural production in their land use. [ITEM-7.3]

- Land use for grazing:
  Grazing of animals using the vast agricultural lands in the Zahorska area is also a useful way to reduce the load to the environments in animal husbandry. [ITEM-6.3], [ITEM-7.7]

The recycling of animal wastes as manure is crucially important to develop the cereal-animal mixed farming and strengthen the environment-friendly agriculture. Pig raising, which is efficient in feed consumption and recommended to increase for the EU, will put more importance on the recycling of animal wastes in the future. The land use in the Zahorska area is not limited; therefore, the area has an advantage for the development of environment friendly and sustainable agriculture.

# CHAPTER 6 OPERATION AND MAINTENANCE OF GUIDELINES

## 6.1 HOW TO USE GUIDELINES

Main users of the Guidelines are the agricultural entities of agricultural companies and SHR and the administrative bodies such as SWME-ID, SWME-PD, and Bratislava regional office of MOA. Information in the Guidelines shall be useful for both sides as shown below in a form of relationships between contents of the Guidelines and the users.

How to Use Guidelines

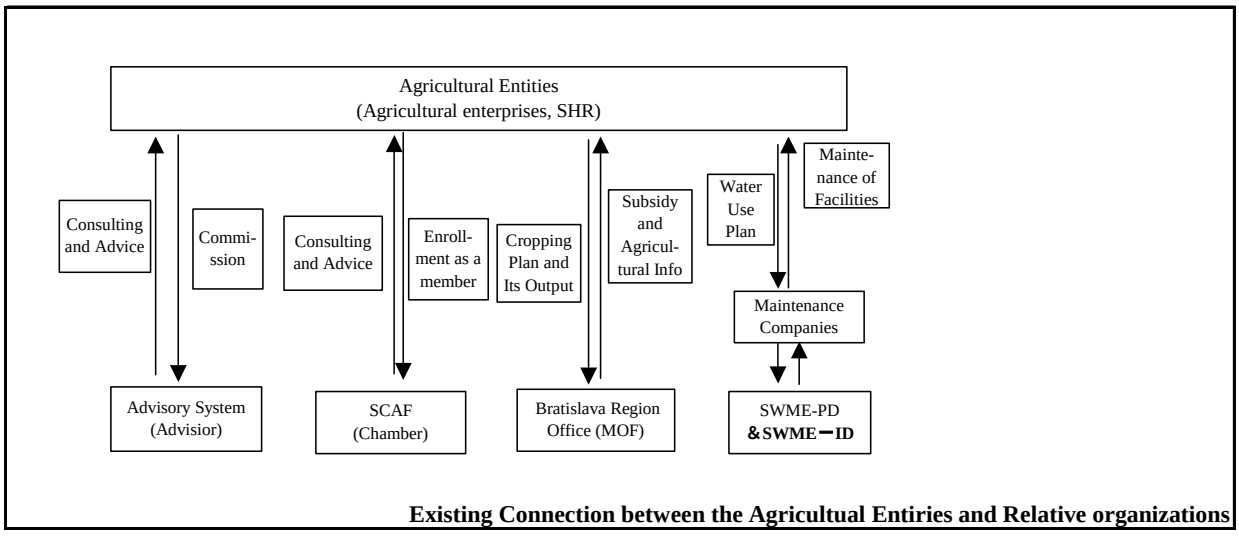
<table>
<tr><th></th><th>User</th><th>Agricultural Entities</th><th>Administrative Bodies</th></tr>
<tr><td rowspan="8">Content of Guidelines</td><td>GIS Information＊</td><td colspan="2">It provides useful information that both of Agricultural entities and Administrative bodies can understand easily situations in the Zahorska Lowland area.</td></tr>
<tr><td></td><td></td><td>Usable as a tool of planning irrigation and drainage.</td></tr>
<tr><td>Current Situation and Future of Regional Agriculture</td><td rowspan="3">It provides useful information for planning agricultural strategy in the future.</td><td rowspan="3">It provides a principal guide to formulate agriculture in the Zahorska Lowland..</td></tr>
<tr><td>Land Resources Evaluation and Expected Farming/Land use</td></tr>
<tr><td>Formulation of Water and soil Management Plan</td></tr>
<tr><td>Case Study</td><td></td><td></td></tr>
<tr><td>Technical Guidelines of "Crop Cultivation Techniques" and Farm Management"</td><td>It provides useful information that they can choose out of the Guidelines.</td><td>It provides useful information that they can choose out of the Guidelines.</td></tr>
<tr><td>Technical Guidelines of "Land Evaluation"</td><td>It presents the point that they should pay attention to appropriate and rational land use.</td><td rowspan="2">It provides a guide that the administrative bodies need to continue to survey and study hereafter.</td></tr>
<tr><td>Technical Guidelines of "Irrigation" and "Drainage"</td><td>It presents the point that they should pay attention to utilization of irrigation and drainage facilities.</td></tr>
</table>

＊: Conditions of Irrigation facilities and irrigable area, Drainage Facilities, Land evaluation, Land Ownership, Climatic Conditions, etc.

## 6.2 PLACES OF GUIDELINES USE AND FLOW OF INFORMATION

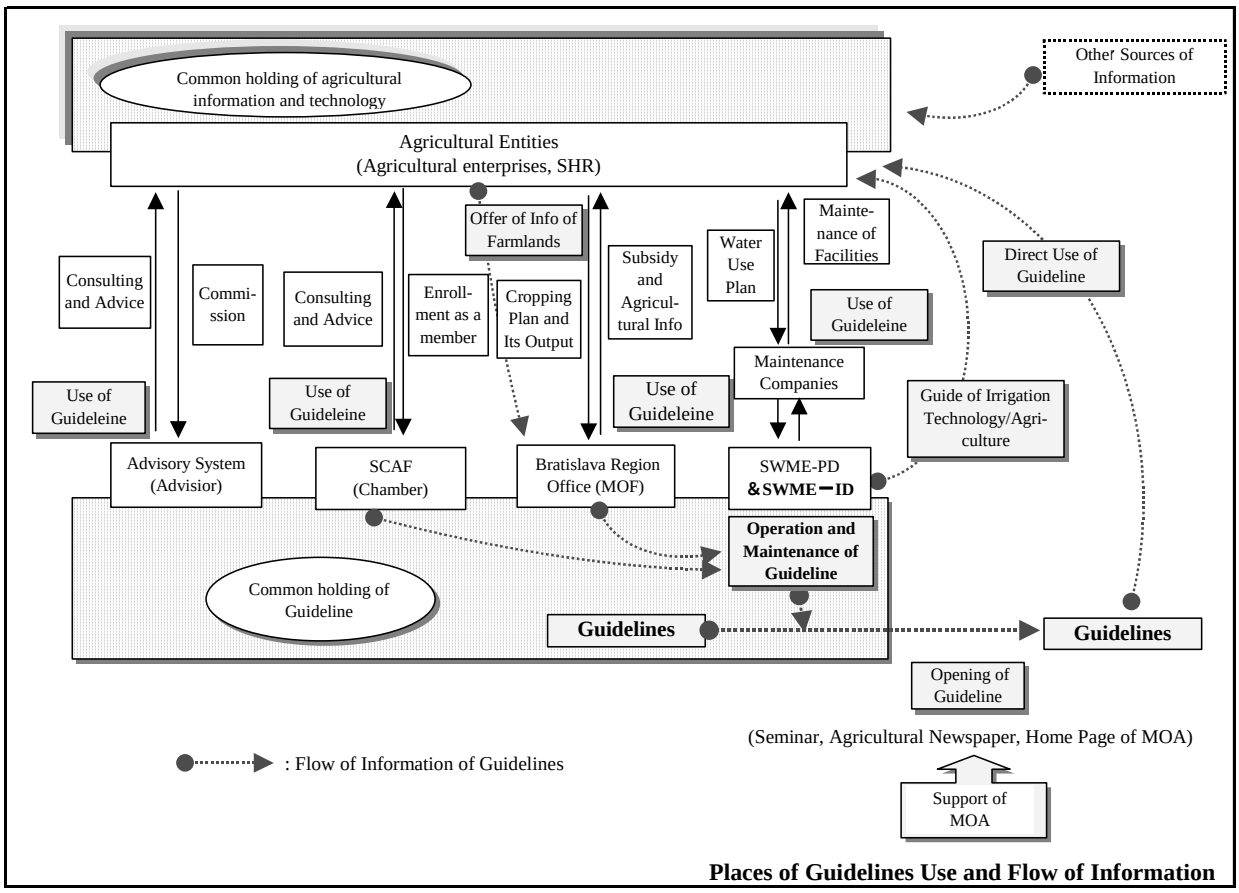
At present various kinds of information flow between the agricultural entities in the Study Area and the administrative bodies. For instance, the Bratislava regional office receives a yearly farming plan and its outputs from the agricultural entities, and the office gives them approval of subsidy and various kinds of agricultural information. Current information flow is connected individually between each agricultural entity and

administration body, and horizontal flow dose not work. By sharing the concept of the Guidelines and by using it, the information flow is expected to improve efficient. The figure below shows how they can use the Guidelines at each connection.




**Existing Connection between the Agricultual Entiries and Relative organizations**

**Use of Guidelines**




**Places of Guidelines Use and Flow of Information**

## 6.3 ROLE ALLOTMENT IN OPERATION AND MAINTENANCE OF GUIDELINES

The table shown in the following page indicates the role allotment of the related person and institutes in the operation and maintenance of the Guidelines. Names of the related bodies and institutes are placed at the top and left end of the table respectively and each role worked from the former to the latter are described in each column of the table. The upper row of the column shows the contents of the current information and lower rows show role allotments newly required in use of the Guidelines. As mentioned in detail in the next section, SWME-ID should be the responsible body for operation and maintenance of the Guidelines. Farmland's information such as planted/cultivated area, yields, inputs of fertilizer and industrial chemical, use of irrigation water, condition of hardpan, condition of poor drainage, and so on is indispensable to evaluate land productivity. Within all role allotments, one of the agricultural entities is very important for operation and maintenance of the Guidelines, because there is few data on the farmlands, land evaluation is impossible without these data, and only agricultural entities can provide them. They should submit this kind of data to the Bratislava Regional Office. All information shall be finally accumulated at SWME-ID, and shall be utilized as materials for successive studies of the Guidelines.

## 6.4 ORGANIZATION OF OPERATION AND MAINTENANCE OF GUIDELINES

It is important that the Guidelines can be effectively utilized as a tool to envisage and develop the agriculture in the region. In addition it is important that the detailed study area can be enlarged to extend the use of the Guidelines. Thus, when maintaining the Guidelines, experts in Irrigation, Drainage, Soil, Crop Cultivation, and GIS are required. By judging the fact that only SWME-ID holds all experts within the related institutes and SWME-ID has directly engaged in the Study of creating the Guidelines, it is suitable for SWME-ID to be the responsible organization of Operation and Maintenance of the Guidelines. SWME-ID had not stressed its work on collection of information in the field from farmers or technical guidance to farmers so that it had small chance to contact with farmers directly. In the operation of the Guidelines, it is necessary to strengthen such function to cope with such a situation.

# Role Allotment in Operation and Maintenance of Guidelines

| | Agricultural Entities (Agricultural enterprises, SHR) | Bratislava Region Office of Ministry of Agriculture | SCAF (Chamber of Agriculture and Food) | Maintenance Companies (INSERVIS & HMU) | SWME-PD: SWME Branch Office of Danube River Basin | SWME-ID: SWME Branch Office of Irrigation and Drainage |
|---|---|---|---|---|---|---|
| Agricultural Entities (Agricultural enterprises, SHR) | | - Judgment of Subsidy and Its Payment<br>- Offer of Agricultural Information | - Mediation of Consulting and Advice<br>- Opening Seminar on Agriculture | - Yearly acceptance of request of water use<br>- water supply<br>- Maintenance of facilities<br>- Demand for water charge | | |
| | - Exchange of agricultural information and technology<br>- Exchange of information in use of irrigation facilities and under drain | - Check of Farming Plan due to Guideline | - Seminar with Application of Guideline | - Check of Irrigation Plan due to Guideline | - Maintenance and Guidance of Under Drains<br>- Guidance How to Control, Operate and Maintain Irrigation Facilities | - Guidance of Farming<br>- Guidance of Irrigation Technology and Irrigation Agriculture<br>- Guidance How to Improve Soil<br>- Guidance How to Break Hardpan |
| Bratislava Region Office of MOA | - Report of Farming Plan<br>- Report of Agricultural Outputs | | | | | |
| | - Report of Information of Farmlands | | - Keeping common knowledge | - Keeping common knowledge | - Keeping common knowledge | - Report of Contents of Guidance to Agricultural Entities |
| SCAF (Chamber of Agriculture and Food) | - Entry as a member of SCAF<br>- Enrollment in Seminar | | | | | |
| | | - Keeping common knowledge | | - Keeping common knowledge | - Keeping common knowledge | - Keeping common knowledge |
| Maintenance Company (INSERVIS & HMU | - Report of Plan of Water Use<br>- Report of Current Conditions of Facilities | | | | - Approval of Plan of Water Use<br>- Check of Maintenance of Facilities<br>- Approval of Plan of Improvement of Facilities<br>- Payment of Repairing Cost | |
| | | - Keeping common knowledge | - Keeping common knowledge | | - Keeping common knowledge | - Keeping common knowledge |
| SWME-PD SWME Branch Office of Danube River Basin | - Report of Current Conditions of Facilities | | | - Report of Irrigation Plan (Area, Water Use)<br>- Report of Data of Repairing Facilities/Equipment<br>- Report of Adjustment of Water Use | | |
| | | - Keeping common knowledge | - Keeping common knowledge | - Keeping common knowledge | | - Cooperation in Field of Irrigation Planning |
| SWME-ID SWME Branch Office of Irrigation and Drainage | | | | | | |
| | - Consultation of Farming<br>- Consultation of Irrigation Technology and Irrigation Agriculture<br>- Consultation How to Improve Soil<br>- Consultation How to Break Hardpan | - Offer of Information of Farmlands Reported from Agricultural Entities | - Offer of Contents Inquired from Agricultural Entities | | - Cooperation in Field of Irrigation Planning | **- Operation and Maintenance of Guideline** |
| Ministry of Agriculture | | | | | | |
| | | | | | | - Submit of Plan of Operation and Maintenance of Guideline<br>- Report of Works |

*: Upper rows in the boxes show current flow of information and under ones show flow of information and roll after publishing the guideline.

A committee for operation and maintenance of the Guidelines should be set up inside of SWME-ID and members of the committee should be nominated by SWME-ID. Information from agricultural enterprises, SHR, SCAF, and the Bratislava regional office should be classified into technical categories, then brought together to each member, after that analyzed by them and the results finally presented in the future. As the topics upon which the committee deliberates are broad, such as technical countermeasures in the Guidelines, the future of regional agriculture, and the plan of implementation program of the project, not all members of the committee necessarily need to be present, depending on the theme at that time. The following organizations should be candidates for committee membership.

- ✓ Institutes holding various information through regular contact with farmers and institutes holding knowledge of irrigation and drainage:
  SCAF, Bratislava Region Office of Ministry of Agriculture, SWME-PD, SWME-ID

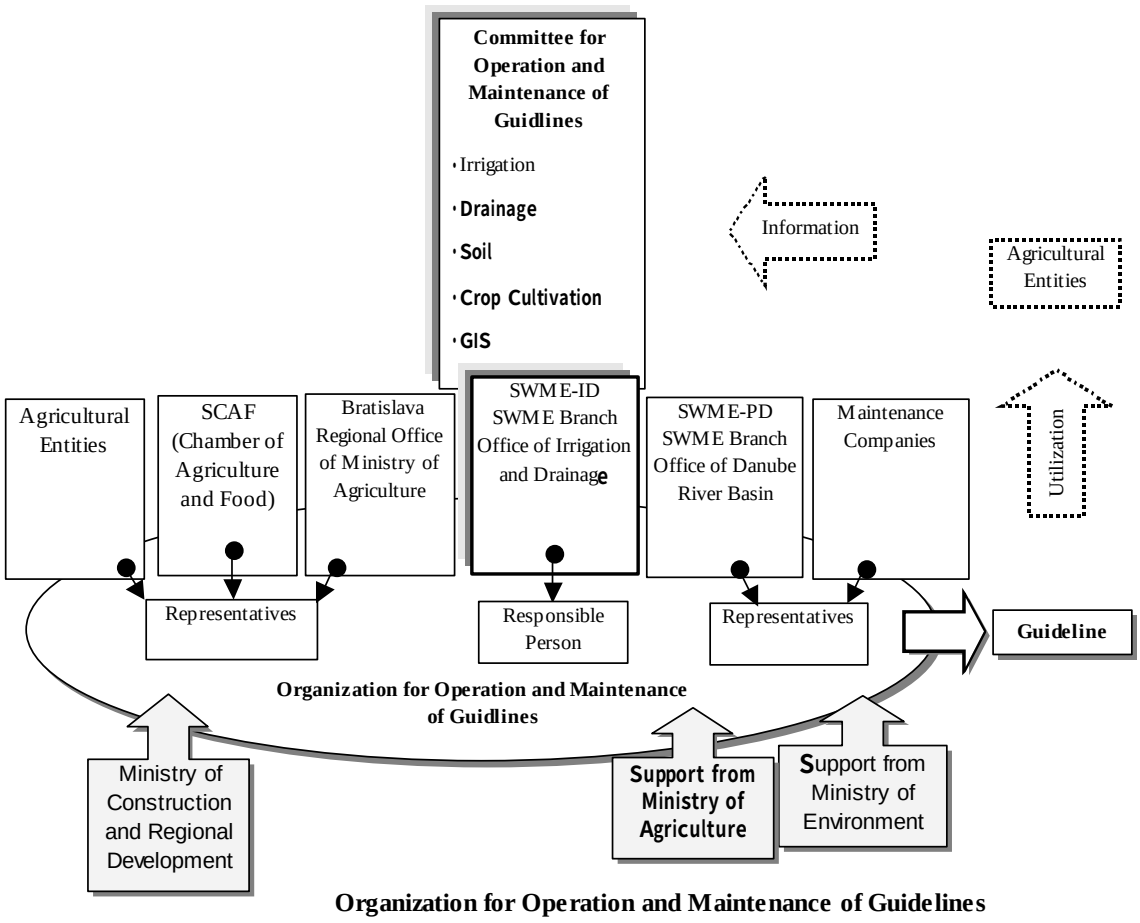
- ✓ National organization supporting Operation and Maintenance of the Guidelines:
  Ministry of Agriculture, Ministry of Environment

- ✓ National organization in charge of regional development:
  Ministry of Construction and Regional Development

- ✓ Body familiar with regional conditions through regular maintenance of the irrigation and drainage facilities:
  Maintenance companies

- ✓ Users of the Guidelines and farmers familiar with condition of farmlands:
  Representative of farmers

Consequently the organization for Operation and Maintenance of the Guidelines shall be proposed as shown in the following Figure.




**Organization for Operation and Maintenance of Guidelines**

The general meeting might be held about once a year according to the timing when SWME-ID shall announce results of the above-mentioned studies. Detailed works to be done in the future by SWME-ID are as follows;

(1) Works to be done by SWME-ID

- Function of the current irrigation facilities shall be periodically evaluated.
- Rehabilitation of the current irrigation facilities shall be planned.
- Manual for operation and maintenance of the current irrigation facilities shall be formulated and then the manual shall be presented to the related organizations and agricultural entities.
- If there is a request from agricultural entities, new irrigation system shall be designed.

- Method of water saving irrigation shall be studied.
- Method how to maintain the current drainage system shall be studied.
- Method how to monitor the current drainage canals shall be formulated.
- Method how to diagnose function of the current underdrain shall be planned.
- Effect of the underdrain shall be elucidated.
- Etc.

(2) Renewal of the Guidelines:

The following items should be regularly reviewed and the results should be officially announced about every two years.

- Condition of irrigation facilities,
- Result of the land evaluation,
- Newly introduced crops, and
- Required matters, if any

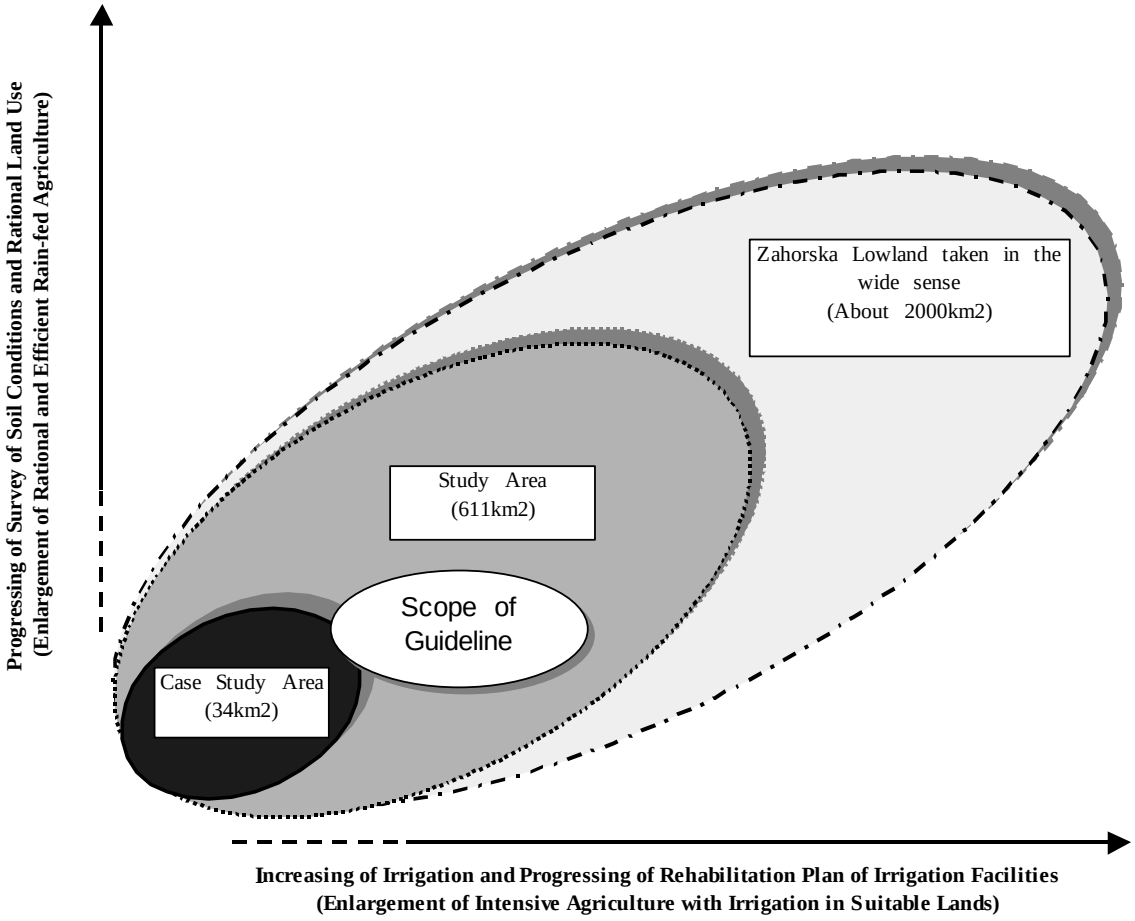
(3) Review of Conception of Regional Agriculture in the future

- When the regional agriculture will change drastically and/or drastic policy will have an effect on the regional agriculture, the concepts should be reviewed.

## 6.5 Enlargement of Scope of Guidelines

Description of the Guidelines is based on the study carried out from June 2001 to December 2002. The Study Area is focused on about 611km2 of lowland plain in and around the Malacky district. Comprehensive study of the whole area was carried out from June 2001 to April 2002, and then the Case Study of Male Levare and Veleke Levare Area (around 3,000 ha) and Gajary Area (around 400 ha) was carried out in detail continuing from the previous study after June 2002. Thus, contents of the Study change with areas. With enlargement of intensive irrigated agriculture and rational land

use, along with enlargement of the detailed study area, contents of the Guidelines should also be more substantial and some parts of the Guidelines should be adaptable to the northern parts of Senica and Myjava districts. Continuous work on the operation and maintenance of the Guidelines shall enlarge the scope of the Guidelines to other similar districts.




**Enlargement of Scope of Guidelines**

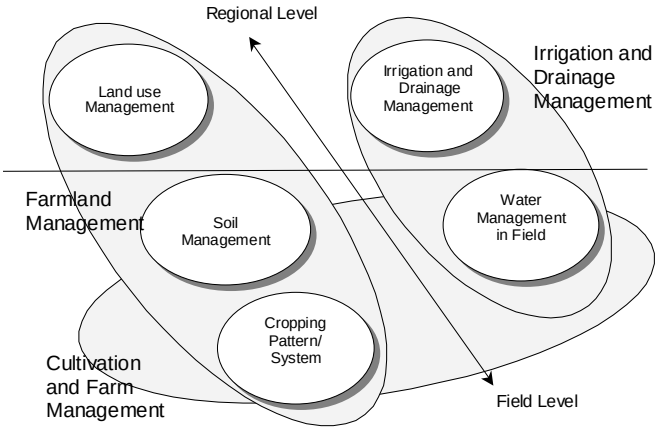
## CHAPTER 7 FORMULATION OF WATER AND SOIL MANAGEMENT PROGRAM

### 7.1 APPLICATION OF GUIDELINES ON SITE

The Guidelines will be applied on site by formulating a site-specific soil and water management program. The soil and water management program is defined as "a program, which presents the optimized combination of technical countermeasures according to priorities when each site tries to solve problems and improve agricultural productivity". This program is put into practice as a development plan or implementation program of public or semi-public organizations on the regional level. In addition, it is put into practice as a farm management plan for farmer or agricultural enterprise at field level.

The Guidelines recommend various technical measures which have various types of approach to implementation or application. They are categorized into two levels and five technical groups according to their type.

- **Technical measures at regional level**, which are expected to be carried out by public or semi-public organizations,
  - **Land management**, which consists of land resources evaluation and identifying potential areas of risk or damage. This is basic information for selection of appropriate technical measure for sites.
  - **Irrigation and drainage management**, which is mainly referring to the maintenance, restoration or improvement of irrigation and drainage facilities.
- Technical measures at field level, which are expected to be carried out by agricultural enterprises or individual farms in the fields,
  - **Soil management**, which aims to manage soil fertility at




**Components and Implementation Levels of Soil/Water Management Plan**

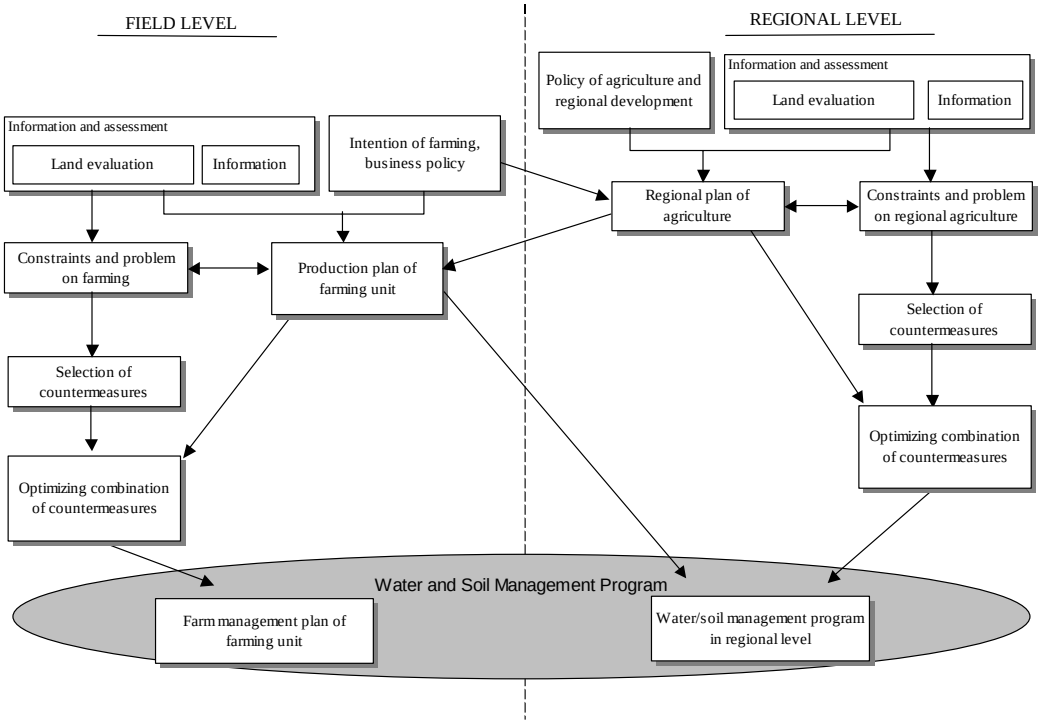
the chemical and physical level and improve soil moisture retention capacity.

- **Water management**, which is composed of field irrigation and drainage techniques to maintain soil moisture suitable for crops.
- **Cropping pattern/cropping system**, which consists of various technologies carried out in the fields and in farming practices including crop selection and cropping pattern.

The water and soil management program introduced in the Guidelines limits its target to crop cultivation even though the mixed farming of cereal production with animal husbandry is typical of the Zahorska Lowland. Generally, the major part of income of farming units is generated by the livestock-farming sector using mixed farming. In the management of mixed farming, crop cultivation aims to supply feed for animals principally and cash crop or other crops are secondary. The water and soil management programs should be formulated and implemented taking the combination of both sectors in the management of farming units fully into account.

## 7.2 FORMULATION OF WATER AND SOIL MANAGEMENT PROGRAMS

The components of water and soil management programs are divided into two levels, as mentioned above, the regional and field levels. The components belonging to each level are to be planned and implemented by different groups of people. The program at regional level is to be planned by administrative bodies or public organizations and to be implemented as public works. On the other hand, farmers or agronomist/engineers of enterprises are to include the program at field level in their farm management plans and to implement it in their farming activities, under the support of technical advisers. Although both programs are planned and implemented separately, a close coordination is important because the two components have a close mutual relationship. The flowchart for formulating water and soil management programs is shown below:




Flow of Formulating Water and Soil Management Program

(1) Formulation of Water and Soil Management Program at Regional Level

1) National Policy on Agricultural Sector and Regional Development Plan

The water and soil management program at the regional level, which is carried out by an administrative body or other public organization, is to be formulated following the national policy on the agricultural sector and regional development plan. The policies and plans shown below must be considered in formulating the program in the Zahorska Lowland.

- The New Concept of Agriculture and Food Policy in the Slovak Republic
- Report on Agriculture and Food Sector in the Slovak Republic (Green Report)
- Concept of Economic and Social Development in the Region of Bratislava
- Concept of Development of Agriculture in the Region of Bratislava

2) Collection and Assessment of Information

The water and soil management program is to be formulated based on information on agriculture and cultivation in the region possessed by various administrative or public organizations, and the land resources evaluation described in Chapter 3 of the Guidelines.

- Location, possibility of use and access to public information
- Results of land resources evaluation

3) Identifying Problems and Constraints of Regional Agriculture and Necessary Technical Measures

The character of agriculture in the region is to be assessed and the future of the agriculture there is to be examined and formulated in line with the national or regional development policy. The problems and constraints to achieving the targets are to be identified based on the assessment of current agriculture in the region. The technical countermeasures to the problems or constraints are introduced in Chapter 4. The problems are considered below:

- Conditions of farming activities such as soil conditions or irrigation possibilities
- Future of agriculture in the region
- Farming system, management or cultivation types of farm units

Among technical measures introduced in Chapter 4, problems at the regional level for the water and soil management program would be of the following types:

- Problems concerned with several farmers or enterprises
- Problems concerned with wide areas

In the Guidelines, the condition and character of agriculture are assessed in each zone and the problems and constraints to the future of agriculture of each zone are identified. Necessary technical measures to the above problems and constraints are to be selected from the technical measures introduced in Chapter 4.

4) Combination of Selected Technical Measures

Before establishing the soil and water management program, the priority of each countermeasure or technical item selected from the Guidelines and their combinations are examined. Some of the priority items are to be set based on technical judgement and some are to be set in consideration of the specific condition of the area. The Guideline shows technical measures at the regional level by the technical view point, however, they are necessary to be judged in consideration of the specific condition of the area in practice.

5) Formulation of Water and Soil Management Program

The water and soil management program at the regional level is recognized as one part of a regional agricultural development plan. The program is composed of several subject and categories of technical measures. The program is to be formulated by combining these subjects and technical measures based on the priority and order of implementation in the area. The program will be modified and finalized after consideration of financial and other related conditions.

(2) Formulation of Water and Soil Management Program at Field Level

1) Collection and Assessment of Information

The information necessary to formulate the water and soil management program is to be obtained from public information sources and the farmers' own data from their fields.

- Location, possibility of use and access to public information
- Information to be collected and accumulated by farmers (record of land use, record of farming activity and production, record of input and yield, etc.)
- Monitoring

The Guidelines show the land resources evaluation, however, it is prepared for the regional level. More detailed field information is needed for an evaluation at field level.

- Evaluation from the viewpoint of soil conditions, considering soil moisture conditions or fine particle contents of soils
- Consideration of the plan and progress of the rehabilitation program of irrigation facilities
- Consideration of farm lot size, farming activities in the fields, etc,
- Comparison of the evaluation and actual production in the fields

2) Identifying Problems and Constraints of Regional Agriculture and Necessary Technical Measures

Expected agriculture in each field is expressed, in the Guidelines, as an expected cultivation type and land use based on the comprehensive results of the land use evaluation. The production plan of each farmer or enterprise is to be formulated based on their intended farming activity or business policy referring to the comprehensive results. The following issues are to be considered in parallel with considerations of peculiar constraints and problems of the area.

- Farming type and income structure of farmer or enterprise
- Needs of feed production and other farming activity of crop production to support livestock farming
- Available resources of farm management such as fund, labor force, machine, land, etc.

- Proper land use based on the appropriate land resources evaluation
- Concept or development plan of regional agriculture

In the Guidelines, the expected cultivation types and problems are described by zone and land condition. Farmers or enterprises are required to examine the condition of their farmland and identify the problems and expected agriculture referred to in the Guidelines.

3) Combination of Selected Technical Measures

The technical measures concerning the expected problems in farming activity are to be taken from the Guidelines taking account of the peculiar condition of the farmland and all the related issues. Technical measures for each cultivation type in each zone are described in Chapter 3.

The relevant technical measures should be combined as a package applicable to the farmland and field. The combination is composed of items required in cropping systems and farm management in the field. It is necessary to decide the appropriate combination taking account of the available human, physical and financial resources, distribution of the resources in the farm management and needs of feed production for animal husbandry.

The optimization of the combinations of technical measures will be examined through establishing a typical farm management model in the Case Study. The results of the Case Study should be used as examples in applying the Guidelines.

4) Formulation of Water and Soil Management Program

The water and soil management program is composed of a combination of various technical measures concerning cropping and farming plans in the field. Farmers or enterprises are expected to decide their farming plan for their farmland utilizing the combined technical measures.

| | |
|---|---|
| *PART 3* | *CASE STUDY* |

# PART-3 CASE STUDY

The case study was conducted with the purpose of reinforcing the Guidelines through detailed investigation and examination in a limited area, and with the purpose of helping user's understanding by introducing ideal case of using the Guidelines. The case study examined farmland use in the case study area by field plot and the expected effect in the area of introducing agriculture in the Guidelines was analysed. The procedures of the case study were:

1) Selection of the case study site
2) Detail investigation by theme in the case study site
3) Establishing the soil and water management plan of the case study site
4) Evaluation and analysis of the soil and water management plan

The soil and water management plan of the case study site was established by two levels; by whole site as regional level and by actual field plot as field level. The analysis such as farming budget was also examined by two levels of site and filed plot.

## CHAPTER 1 CASE STUDY SITE

Two sites, i.e., Site-A in the Male Levare and Velke Levare villages and Site-B in the Gajary village as shown in Figure 3.1, were selected for the case study based on the following considerations:

Selection of Case Study Site

| Site | Constituent villages | Irrigation system | Related Subjects | Farm unit | Farming Type | Zone | Others |
|---|---|---|---|---|---|---|---|
| Site-A | Mare Levare, Velke Levare | V5 Male Levare (P21) Kostoliste (P13) | 1), 2), 4), 5), 6) | 2 enterprises and 2 SHRs | C+A+O C+A C+V | II+III | Various types of agriculture exist, partial drainage problem |
| Site-B | Gajary | Dolecky (P12) | 3), 6) | 2 enterprises | C+A+O+A C+V | II | Extremely high potential of wind erosion |

Notes: Major Subject

1) Restoration and functional improvement of irrigation system
2) Effective recycling of organic matters in the combination of crop production-livestock farming

3) Agriculture considering soil conservation (wind erosion)
4) Rain fed cultivation in sandy soil area and evaluation of effect of irrigation
5) Evaluation of land use in the marginal area for cultivation
6) Intensive and semi-intensive agriculture

Farming Type

C: Cereals
A: Livestock farming
O: Oil crops
V: Vegetables

## 1.1 NATURAL CONDITIONS

### (1) Location of Case Study Sites

#### 1) Site-A: Male Levare and Velke Levare Area

The main case study site (Site-A) is located in the Male Levare and Velke Levare Villages with the Malacky District. This site is defined as the area enclosed by the Rudava River in the south, the railway in the east, the village boundary in the north and the Morava River in the west. The total area of Site-A is around 3,000 ha of which agricultural land is around 2,500 ha.

40% of total land belongs to the natural protection area that spreads along the Morava River. Most of the natural protection area is also used for agricultural land except for the more strictly protected areas, which are the Ramsar Protection Area (451 ha) and the National Natural Reserves (91 ha).

#### 2) Site-B: Gajary Area

Site-B is a supplementary case study site for certain subjects such as wind erosion and vegetable cultivation. It is located at the northern part of the Gajary/Kostoliste farming area. The total area of Site-B is around 400 ha and some fields are selected as suitable for examination of every subject instead of defining the area. Seven (7) fields are selected for the subject of wind erosion and one (1) field is selected for intensive vegetable cultivation in Gajary Village.

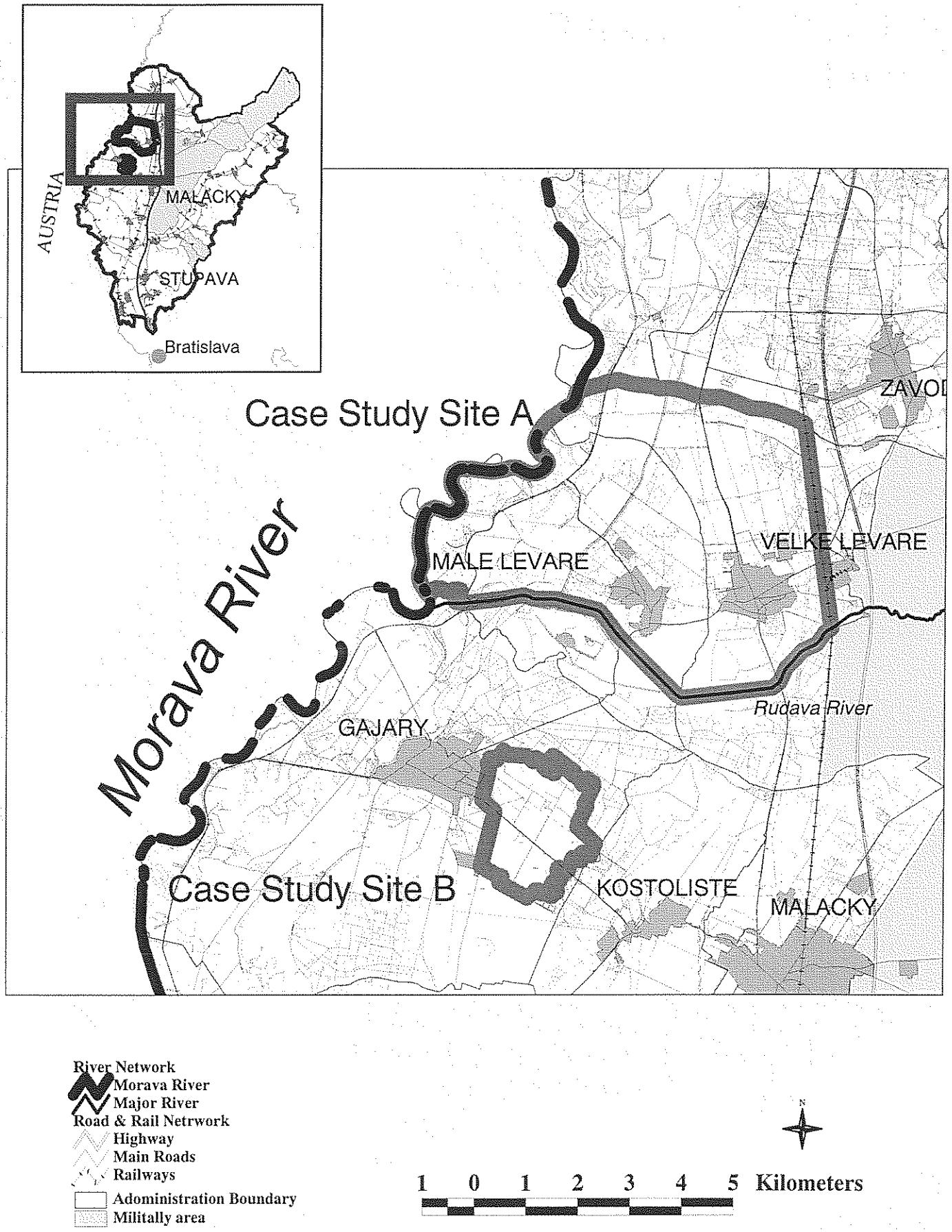



Figure 3.1 Location of Case Study Site

The area of the fields used for examination of wind erosion is around 280 ha. Sand and loamy sand is categorized as Eutric Regosol which represents the lightest and poorest soil and it covers mainly these fields. On the other hand, 80 ha of fields were selected to examine intensive vegetable cultivation where the major soil type is sand and loamy sand categorized as Fluvic Phaeozem.

(2) Geography, Geology in and around the Case Study Area

The principle feature of geography of the case study area, Male Levare and Velke Levare village, and of Gajary village, is characterized by river side terraces of the Morava. After the Vienen basin was filled up with the Tertiary deposit of the shallow sea shore, a series of denudation and deposition processes by running water, together with step by step regression of sea level in the Diluvial and Alluvial Ages, has brought about several steps of terraces along the Morava river. The area of Male and Velke Levare village consists of the Alluvial flood plain of the Morava with contour line of 147 ~ 148 m, low terrace in the Wurm with the line of 150 ~ 155 m, and middle terrace of the Riss with the line of 155 m and higher. In the Gajary village too, flood deposit plain with the line below 150 m, the low terrace and middle terrace could be identified.

Outcrops of the Tertiary deposit could be found only in the limited spot on the middle terrace of eastern rim of the area in the Velke Levare. Wind-blown sand deposits, characteristic and widely spread in the Zahorska lowland are exposed on the surface of land in several spots, and are composed of a selected particle size of quartz brought by wind from the Tertiary deposit. River deposits of the Rudava and the Porec developed Alluvial fans on gentle slopes in the opening after passing through the Central plateau. These fan deposits have a sandy texture with clay contents of around 5 – 8%. Both of the Diluvial deposits in the Wurm and Riss have a sandy texture with a small size of gravel. Only the Alluvial sediments of the Morava are abundant in clay particles with a texture of Loam and Clay.

(3) Soils in Case Study Area

The main soil types in the areas are Fluvisols, Fluvic Phaeozems, Eutric Regosols and Dystric Regosols. All of these soils found can be characterized as immature soils and the characteristics of each soil derive from different parent materials.

Fluvisol only occurs on the alluviums of the water flows and there is a significant effect of ground water in the profile formation. This soil has a light colored humus horizon. The soils on the fan deposits of the Rudava and Porec are classified as Fluvic Phaeozems. This type of soil is characterized by a dark humic horizon. Farmers in this area often call this soil “black sandy soil”. Eutric Regosols derive from Diluvial deposits rich in calcium and magnesium dissolved in the running water. Dystric Regosols are derived from Tertiary deposits and wind blown sand poor in bases.

Distribution of these soil types could be confirmed by spot survey in the fields, based on pre-survey on the maps of geography, geology and soil type. Drawing of the boundary requires more detailed survey in each spot, and classification of surface deposits plays a key role in all working processes of soil survey in the areas.

## 1.2 SOCIO-ECONOMIC CONDITIONS

(1) Summary of the Case Study Area

The Site-A is composed of two rural villages, i.e., Male Levare and Velke Levare. They are recognized as typical rural villages in the Zahorska Lowland. 66% of total village land is registered as agricultural land, including pastures in both of villages. Even though the share of agricultural land is at almost the same level, the proportion of agricultural land use is quite different. In Male Levare, 73% of agricultural land is categorized as arable land and the remainder as pasture. Whereas in Velke Levare, 54% of land is arable land while pasture, garden and orchard occupy a larger portion than in Male Levare. Brief descriptions of their rural society are given below.

Profiles of Villages

| Item | Sub-item | Unit | Site A | | Site B | Status and Sources |
|---|---|---|---|---|---|---|
| | | | Male Levare | Velke Levare | Gajary | |
| Area | | ha | 2,176 | 2,400 | 5,088 | IGC(GKU) |
| Population | | person | 1,002 | 3,358 | 2,577 | as of Dec 31 in 1999 |
| Population age structure by economic groups | Pre-productive age | % | 20.6 | 19.7 | 18.9 | as of Dec 31 in 1999, Statistic Office |
| | Productive age | % | 59.2 | 61.1 | 62.2 | |
| | Post-productive age | % | 20.3 | 19.2 | 18.9 | |
| Economically active poplation | Economically active poplation | person | 449 | 1,576 | 1,137 | Jul-99, Malacky Distrcit Office |
| | Registered unemployed person | person | 95 | 366 | 322 | |
| | % of Active Pop. | % | 21.2 | 23.2 | 28.3 | |
| Land Use | Agricultural Land | ha | 1,441 | 1,598 | 3,414 | Registered land use as of 1999, IGC(GKU) |
| | Arable land | ha | 1,055 | 862 | 2,761 | |
| | Pasture | ha | 366 | 569 | 524 | |
| | Garden | ha | 20 | 167 | 129 | |
| | Orchard | ha | 0 | 137 | 58 | |
| | Vineyard | ha | 0 | 2 | 7 | |
| | Non-agricltural land | ha | 735 | 802 | 1,674 | |
| | Forest land | ha | 326 | 452 | 1,162 | |
| | Water area | ha | 220 | 74 | 187 | |
| | Built up area | ha | 93 | 114 | 187 | |
| | Others | ha | 97 | 163 | 137 | |
| Land Use in Percentage | Agricultural Land | % of Total | 66.2 | 66.6 | 67.1 | |
| | Arable land | % of Agricultural Land | 73.2 | 54.0 | 80.9 | |
| | Pasture | | 25.4 | 35.6 | 15.3 | |
| | Garden | | 1.4 | 10.4 | 3.8 | |
| | Orchard | | 0.0 | 8.6 | 1.7 | |
| | Vineyard | | 0.0 | 0.1 | 0.2 | |
| | Non-agricltural land | % of Total | 33.8 | 33.4 | 32.9 | |
| | Forest land | % of Non-agricultural Land | 44.3 | 56.3 | 69.4 | |
| | Water area | | 29.9 | 9.2 | 11.2 | |
| | Built up area | | 12.6 | 14.2 | 11.2 | |
| | Others | | 13.2 | 20.3 | 8.2 | |

According to the last (2001) population census, there were 1,046 inhabitants living in the Male Levare Village (506 men and 540 women); 48.9% of inhabitants were of productive age. As far as ethnicity is concerned, 95.7% of inhabitants of the village consider themselves to be Slovak. With respect to religion, 94% of inhabitants declare themselves to be Catholic Church, 0.2% to be Evangelical Church, and 3.3% have no religious affiliation.

The village of Velke Levare covers 4,810 ha. According to the last (2001) population census, there were 3,430 inhabitants living in the village (1,679 men and 1,751 women). As far as ethnicity is concerned, 97.3% of inhabitants of the village consider themselves to be of Slovak nationality. As far as the religion is concerned, 81.1% of inhabitants declare themselves to be Catholic, 3.8% Evangelical, and 0.1% to be Greek Orthodox. The labour force constitutes 51% of the population, while 60.6% of the inhabitants are of productive age. These people

are employed in firms in the village, or they have to travel to work to other villages, towns, and cities (Bratislava, Kostolište, Malacky).

(2) Land Ownership Characteristics

During the case study, 87 agricultural fields were recognised for Male Levare and 82 fields for Velke Levare. In both villages the total area of agricultural land is about 1,000 ha. Out of registered owners in the cadaster, the numbers of those who have property in agricultural fields are about the same: 2,051 owners (54% of 3,818) in Male Levare and 2,230 owners (40% of 5,545) in Velke Levare. The ratio of owners who have agricultural land is higher in Male Levare.

For both Villages about half of the ownerships of agricultural fields are managed by the Slovak Land Found: 994 ownerships (49%) in Male Levare and 1,241 ownerships (56%) in Velke Levare.

In terms of parcels –an owner can have property rights in more parcels and thus in more fields – about 36% of ownerships of parcels are managed by Slovak Land Found in Male Levare and about 41% of ownerships in Velke Levare. It indicates about 15% less involvement of the Land Found in both villages.

On average a field has 212 owners in Male Levare and it has 157 owners in Velke Levare. The Slovak Land Found manages 89 ownerships in Male Levare and 69 in Velke Levare. Thus, in general the user has to contract 124 owners per fields in Male Levare, while it is 89 owners per fields in Velke Levare.

The ownership characteristics do not show any significant differences between the two villages.

However, comparing the average sizes of area managed by different owners in an agricultural field – that is how big an area owned by one owner – shows significant differences. In Velke Levare it is about 1 ha per person, while in Male Levare it is

only 0.3 ha per person. Thus in general a user has to contract 1 new owner to every 1 ha additional land he wants to use in Velke Levare and in the case of Male Levare he has to contract 3 owners for the same area. If we exclude fields where average land size of owners is above 5 ha/person (4 fields in Velke Levare and 2 fields in Male Levare), the land sizes of owners become half in Male Levare (0.17 ha/person) and less than half in Velke Levare (0.3 ha/person).

## 1.3 AGRICULTURAL PRODUCTION

### (1) Major Farming Types

Several major farming units occupy a large farmland in this area as in the other farming areas in the Zahorska region. The cereal-animal mixed farming is the fundamental farming style in this area. Milking and pig breeding are the major animal farming, supported by the self-supplied feeds from their fields except soybean meals and several mixtures for vitamins and minerals. Most of the feed production is consumed as self-supplied feed for livestock farming.

Cash crops such as winter wheat for food, spring barley, rye, etc. are cultivated mainly under contracts with traders and processing companies. The vegetables are also cultivated for processing companies under contracts. A large amount of the commodities produced by the large scale farming requires contracts for marketing for stability.

The area is designated as agricultural areas under unfavorable conditions by the government. The subsidies are one of the important sources of agricultural profits.

### (2) Cropping

#### 1) Site-A: Male Levare and Velke Levare Area

Due to the variety of agronomic conditions such as soil conditions and installation

of irrigation facilities, various crops are cultivated. Cash crops such as sunflowers, spring barley, rapeseeds and also rye are widely cultivated. A unique crop is asparagus under well-developed cultivation techniques with irrigation. It is also noted for being an export crop among the traditional crops for the crop-animal mixed farming.

There are four (4) major farming units in Site-A, of which two are agricultural enterprises and two are registered individual farms (SHR). The fields of these four farming units are set as the target fields in the Case Study.

The total area of target fields is 1,834 ha in Site-A., it is equivalent to 75% of the registered agricultural land in this site. In the target fields, 1,108ha are in Zone II where it is comparatively less fertile and most of them had installed irrigation systems. The other 711ha are located in Zone III which is in natural reservation areas and is fertile. The cultivated crops of farming plots of the year 2002 are shown in Figure 3.2. According to this, sunflower is cropped in the largest area of 341ha, equivalent to 19% of their fields. Most of them are cropped by Stomfa s.r.o. by contract farming with processing company. Rye occupies 299 ha and 16%, that is the 2nd largest crop in the area. Maize and wheat are cropped in 233 ha (13%) and 134 ha (7%) respectively. Asparagus is also cultivated in as large an area as 104 ha by Asparagus s.r.o.

On the other hand, 577 ha are used as meadow, about 226 ha of such meadow is not seeded and used as natural grassland where they collect the grass. Most of such natural grassland is located in riverside lands of the Morava river which are registered as Ramsar Areas and National Natural Reserves in Zone III, with the prohibition of positive agricultural land use in such areas. The other meadow is seeded so that it forms artificial meadows. Most of them are used by SHR Dunar for breeding horses for agro-tourism.

In each farming unit, Asparagus s.r.o. is using the 257 ha, Stomfa is 1,034 ha, Dunar 53 ha and Holly is 13 ha and the average size of the field expected for the orchard

and meadows is 16 ha, 15 ha, 16 ha and 3 ha, respectively. The land use of these farming units in the case study area is shown in the next page and the characteristics of those farming units are summarized below.

Character of Major Farming Units of Site-A

| Farming unit | Character of farming unit | Using field in site A (ha) |
|---|---|---|
| Asparagus s.r.o. | Mid-scale company specialized in cultivation of asparagus. 40% of their field is using the asparagus and rest is cereals and orchard. Asparagus is sold after processing in own factory and 100% irrigation is applied . | 257 |
| Stomfa s.r.o. | Conducting a large-scale and relatively extensive agriculture with mixed farming of crop and livestock. Major crops area cereals and oil crops. | 1,034 |
| SHR Dunar | Large-scale individual farm conducting a mixed farming of crop production and livestock. This SHR intends to do horse breeding and agro-tourism. | 531 |
| SHR Holly | Small-scale Individual farm conducting a mixed farming of crop production and livestock. Major income is generated by livestock sector. | 13 |

2) Site-B: Gajary Area

Due to dry and strong wind in early spring when large areas are not yet covered by crops, land is often exposed to wind erosion, although the damage does not seem to be very serious. The large and flat land is suitable for extensive crop farming. Therefore, cereals and maize are major crops. The area is windy and of low soil moisture content, so that winter crops are suitable under these conditions by making better use of the limited resources and unfavorable natural conditions.

The total area of the fields for examination of wind erosion belong to Jakos a.s. and is set on 283 ha of Case Study Site-B. Rye, maize, rapeseed and spring barley are cropped in 126 ha, 97 ha, 44 ha and 16 ha respectively in 2002. In this area, the average field size is 35 ha, it is larger than the average field size of companies in Site-A.

The field for examination of intensive vegetable cultivation belongs to Agro Gajary s.r.o. The company possesses 80 ha of arable land here of which around 20 ha are

used for cultivating vegetables such as carrot, onion, parsley, broccoli, etc with irrigation. The area with cultivation of vegetables is rotated on this land and cereal crops are cultivated in the remaining land, 39 ha of rye and 22 ha of spring barley this year.

Also in Site-B, 35 ha is used as turf products by a company from Holland. This field is located in poor fertility soil on the northeast part of Site-B along some forest.

Cultivation Area of Crops in Case Study Site in 2002 by Farming Unit

| | Farming Unit | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CROP | Asparagus s.r.o. | Stomfa s.r.o. | Dunar (SHR) | Holly (SHR) | JAKOS a.s. | Agro Gajary s.r.o. | Turf Copmpany | Total | |
| Wheat | | 130 | | 4 | | | | 134 | 6% |
| Spring Barley | | 27 | | 2 | 16 | 22 | | 67 | 3% |
| Maize | 27 | 206 | | | 97 | | | 330 | 15% |
| Rye | 57 | 183 | 57 | 2 | 126 | 39 | | 464 | 21% |
| Sunflower | | 257 | 84 | | | | | 341 | 15% |
| Rape Seed | | 26 | | | 44 | | | 70 | 3% |
| Alfalfa | | | 19 | | | | | 19 | 1% |
| Vegetable | | | | | | 19 | | 19 | 1% |
| Asparagus | 104 | | | | | | | 104 | 5% |
| Apple | 69 | 3 | | | | | | 72 | 3% |
| Artificial Meadow | | 45 | 305 | 1 | | | | 351 | 16% |
| Natural grassland | | 157 | 65 | 4 | | | | 226 | 10% |
| Turf | | | | | | | 35 | 35 | 2% |
| Total Field Area (ha) | 257 | 1,034 | 530 | 13 | 283 | 80 | 35 | 2,232 | 2% |
| Number of the Fields | 15 | 69 | 33 | 5 | 8 | 4 | 1 | 135 | |
| Average Field Area (ha) | 17 | 15 | 16 | 3 | 35 | 20 | 35 | 17 | |
| Filed Area except for Orchard ond Grassland | 188 | 829 | 160 | 8 | 283 | 80 | | 1,548 | |
| Field Number except for Orchard and Grass Land | 12 | 55 | 10 | 3 | 8 | 4 | | 92 | |
| Average Filed Size except for Orchard and Grassland(ha) | 16 | 15 | 16 | 3 | 35 | 20 | | 17 | |

Source:JICA STDY 2002

(3) Irrigation System

In Site-A, there are two irrigation systems developed in 1970's and 1980's. The ZP Sekule-Male Levare I CS V5 Male Levare System (P-21) covers 759 ha in the Male Levare Village and this system was evaluated as Category-I "Possible to use with small repair" in the guideline. However, only 50 ha which is 6.6% of the coverage, was actually operated in the year 2001. Among the target fields, 593 ha are covered by this system, of which Stomfa s.r.o. has 302 ha, Dunar has 206 ha and Asparagus.s.r.o has 67 ha.

A part of the ZP Velke Levare-Malacky II CS Kostoliste System (P13) is connected and supplies water to the southern part of Site-A. The system covers 4,407 ha, of which 293 ha is located in Site-A. In addition, a groundwater control system is set on the field of 102 ha, which is used by Asparagus, s.r.o.

The whole of the fields of Site-B are serviced by the ZP Velke Levare-Malacky I CS Gajary System (P12), which was evaluated as Category I. The record of actual irrigation use in the year 2001 was 40 ha in this Site-B while 535 ha were operated in all of the system.

Cultivation Area of Crops in Case Study Site in 2002 by Irrigation Category

| Site | Site A | | | | | | | | Site B | | | Grand Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Zone II | | | | | Zone III | Sub-Total | | Sub-Total | | | | |
| | Male Levare | | | | | | | | | | | | |
| Crop | Under-ground Irrigation | Rain fed Cultivation | Pump Irrigation | Of which Male Levare -1 | Male Levare -2 | Rain fed Cultivation | (ha) | (%) | Gajary | (ha) | (%) | (ha) | (%) |
| Wheat | | | 4 | | 4 | 130 | 134 | 7% | | 0 | 0% | 134 | 6% |
| Spring Barley | | | 0 | | | 29 | 29 | 2% | 38 | 38 | 10% | 67 | 3% |
| Maize | 31 | | 104 | 93 | 11 | 98 | 233 | 13% | 97 | 97 | 24% | 330 | 15% |
| Vegetable | | | 0 | | | | 0 | 0% | 19 | 19 | 5% | 19 | 1% |
| Sunflower | | | 212 | 119 | 93 | 129 | 341 | 19% | | 0 | 0% | 341 | 15% |
| Alfalfa | | | 19 | 19 | | | 19 | 1% | | 0 | 0% | 19 | 1% |
| Rape Seed | 0 | 0 | 18 | 18 | 0 | 8 | 26 | 1% | 44 | 44 | 11% | 70 | 3% |
| Rye | 15 | 69 | 169 | 122 | 47 | 46 | 299 | 16% | 165 | 165 | 41% | 464 | 21% |
| Apple | 0 | 17 | 55 | 55 | 0 | 0 | 72 | 4% | 0 | 0 | 0% | 72 | 3% |
| Meadow | 0 | 49 | 257 | 166 | 91 | 271 | 577 | 31% | 35 | 35 | 9% | 612 | 27% |
| Asparagus | 56 | | 48 | 1 | 47 | | 104 | 6% | | 0 | 0% | 104 | 5% |
| Total | 102 | 135 | 886 | 593 | 293 | 711 | 1,834 | 100% | 398 | 398 | 100% | 2,232 | 100% |
| | | | | | | | | | | | | | |
| Detail of Meadow | | | | | | | | | | | | | |
| Artificial Meadow | | 49 | 257 | 166 | 91 | 45 | 351 | | | | | 351 | |
| Natural grassland | | | 0 | | | 226 | 226 | | | 0 | | 226 | |
| Turf | | | 0 | | | | | | 35 | 35 | | 35 | |

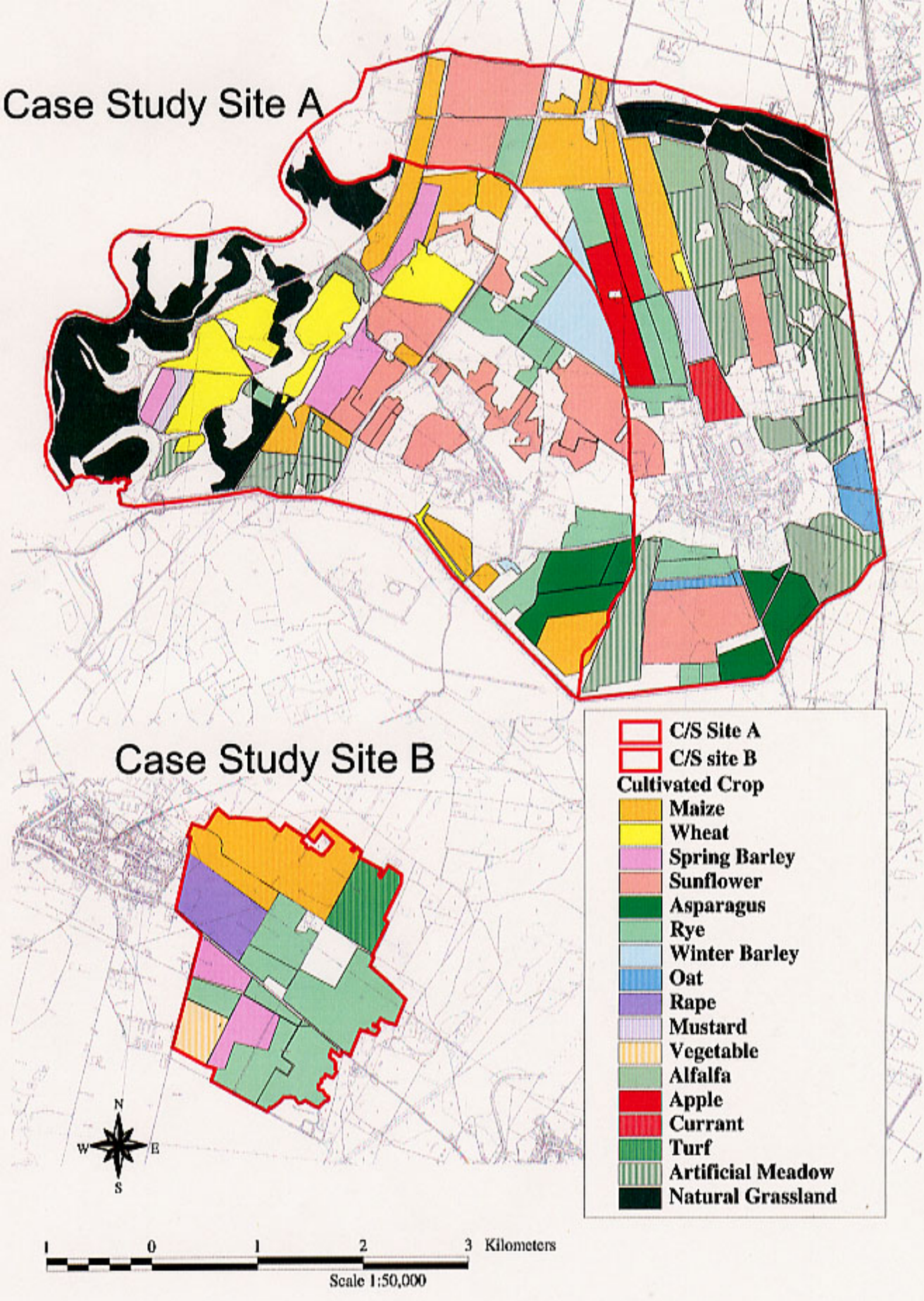



Figure 3.2 Cultivated Crop in Case Study Site - Year 2002

## 1.4 GARDENING ACTIVITY

The rural survey was carried out in the Case Study Site to clarify the condition of the rural society. In the rural survey, the gardening activity was considered as an important activity related to farmland and agriculture. The survey revealed that a wide range of 'gardening' activities take place in Male Levare and Vel'ke Levare. In particular, the survey indicated that there is considerable variation in both the nature and scale of these activities in terms of land used, the crops produced and animals reared, according to household circumstances. Furthermore, the interviews showed that the situation is 'dynamic' in the case of many households. There have been significant changes since the 1989 revolution and the time and effort that is now put into 'gardening' depends both on 'internal' factors (i.e. land available to the household, gardening experience and skills) and 'external' factors such as employment and other family circumstances. Some quantification of these 'gardening' activities has been possible and the results are presented where appropriate. However the complexities of the situation are often better explained by a qualitative description of some of the recorded/observed activities with reference to interviews carried out at representative households.

Data are presented below on the number of gardens/plots used for broad categories of 'crop'. A wide range of crops are grown in the gardens/household plots of both Male and Vel'ke Levare, while a smaller number are grown on the extra-vilan plots. Most respondents' households cultivate fruit (ML 85% and VL 86%), vegetables (ML 82% and VL 90%) and potatoes (ML 76% and 59% VL), especially on the plots close to their homes. Where 'other' plots are cultivated (most are extra-vilan), cereals are the main crop and are used in particular for domestic stock; potatoes are also cultivated, though it was said by several respondents that the latter are now grown less frequently on extra-vilan land because of the risk of theft. There are not great differences between the 'cropping patterns' of the two villages, though the percentage, 39%, growing cereals in ML is somewhat more than the 28% in VL. This probably reflects the higher percentage of respondents rearing animals, especially pigs and poultry, in ML and the greater size of ML household plots (larger plots being preferable where mechanised harvesting of cereals is to be undertaken).

Animal production (especially of poultry and small stock) is a feature of many respondents' households in Male Levare; 22 (67%) had domestic stock of one type or another, whereas only 14 (48%) of respondents' households in Vel'ke Levare had domestic stock. The most frequently reared animals are poultry, which were kept in 64% of ML respondents' households (mostly chickens for eggs, but also turkeys, ducks and geese) and 38% of VL respondents' households. Rabbits were kept in 33% of ML respondents' households, mostly for meat, but only 17% of VL households. Pigs are also of some significance, being owned in approximately 1 in 4 respondents' households in ML, though fewer (17%) in VL. Where such animals are kept it is usual for the household to grow some cereal crops, either on the plot near to their house and/or on extra-vilan land, as a source of feed. It is therefore apparent that the rearing of small numbers of domestic stock is a significant activity for many households in the Case Study area, and to a greater extent in the 'rural' Male Levare than in Vel'ke Levare with its smaller, more 'urban' gardens and a longer history of non-agricultural activities.