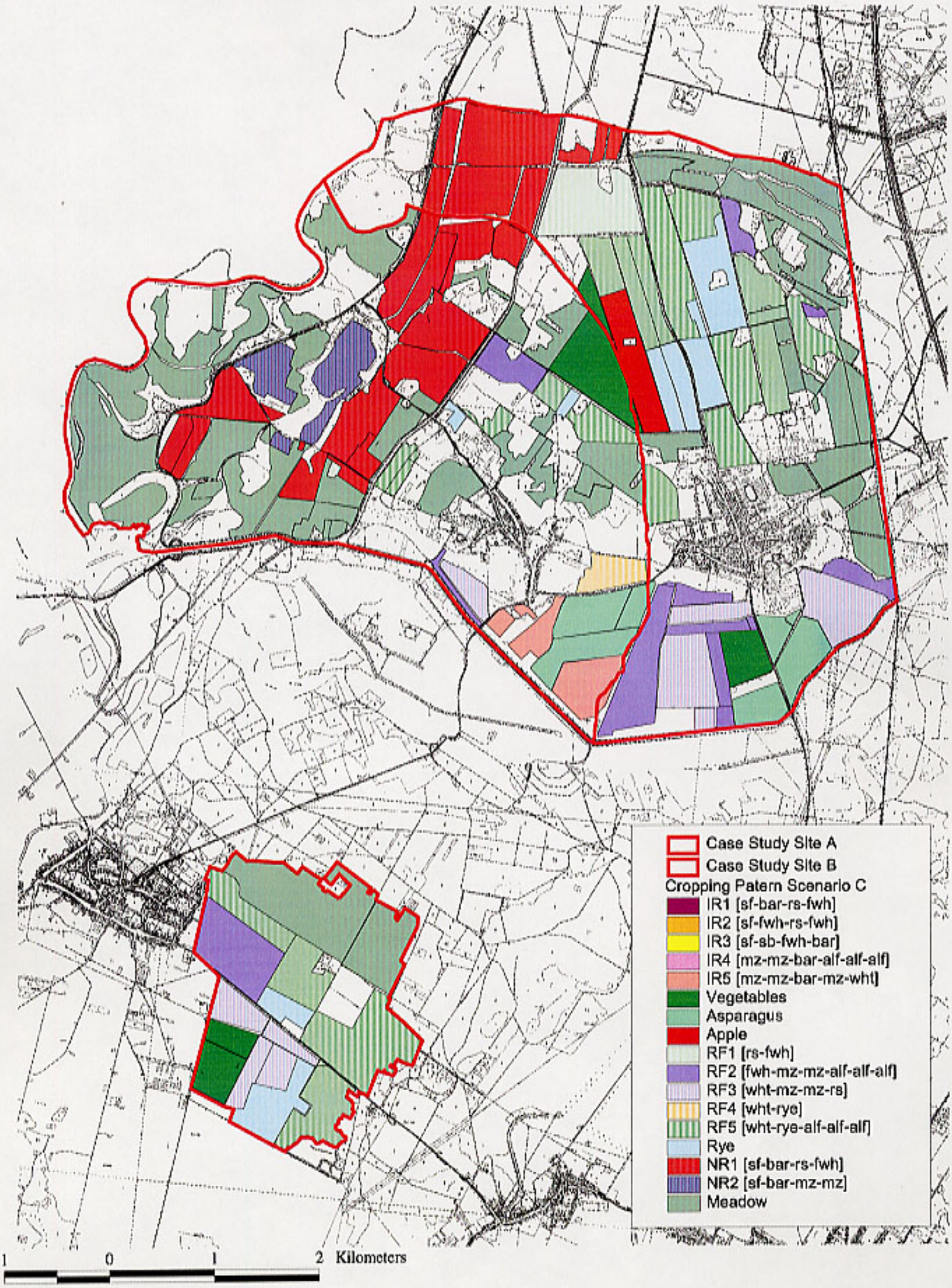



Scale 1:50,000

Figure 3.13 Expected Crop Rotation - Scenario C

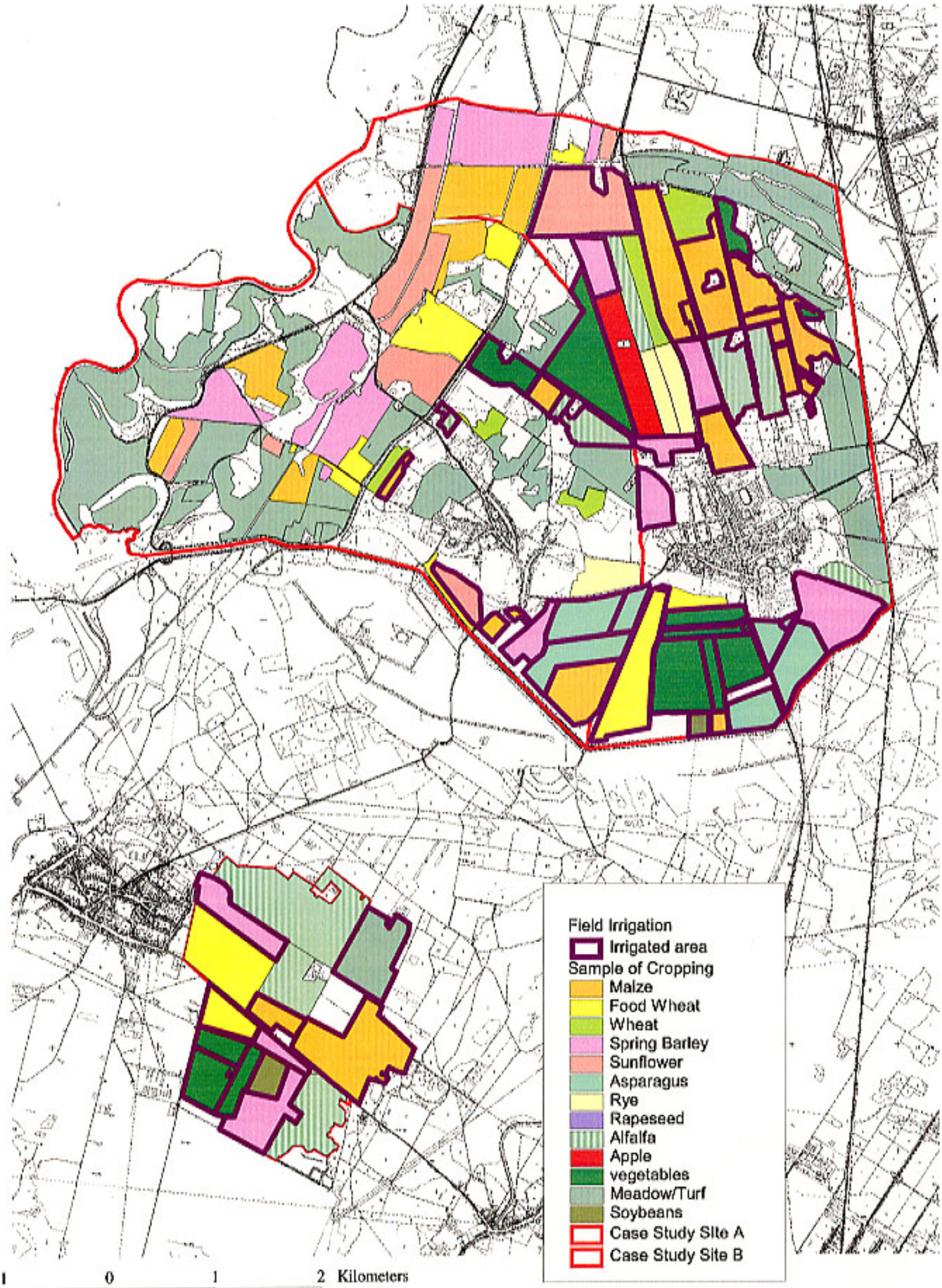



Figure 3.14 Croping Sample - Scenario A - 1st Year

Table 3.2 Area of Expected Cropping Pattern of Case Study Area

Scenario A (unit: ha)

| | Site-A | | | | Site-B | | |
|---|---|---|---|---|---|---|---|
| Cropping Pattern | Mare Levare-1 | Mare Levare-2 | Ground water Control | Rain-fed Area | Gajary | Total | Crop Sequence |
| IR1 | 51 | | | | | 51 | sunflower-s. barley-rapeseeds-food wheat |
| IR2 | | 62 | | | 44 | 106 | sunflower-food wheat-rapeseeds-food wheat |
| IR3 | | 45 | | | 34 | 79 | sunflower-soybean-food wheat-s. barley |
| IR4 | 172 | 14 | | | 155 | 341 | maize-maize-s. barley-alfalfa-alfalfa-alfalfa |
| IR5 | 137 | 10 | 46 | | 96 | 289 | maize-maize-s. barley-maize- w. wheat |
| RF1 | | | | 1 | | 1 | rapeseeds-food wheat/s. barley |
| RF4 | | | | 17 | | 17 | wheat-rye |
| RF5 | | | | 32 | | 32 | wheat-rye-maize-alfalfa-alfalfa-alfalfa |
| NR1 | | | | 338 | | 338 | sunflower-s. barley-maize-food wheat |
| NR2 | | | | 54 | | 54 | sunflower-s. barley-maize-maize |
| rye | | | | 27 | | 27 | rye |
| veg | 80 | 84 | | | 40 | 204 | vegetable |
| asp | | 49 | 56 | | | 105 | asparagus |
| apple | 34 | | | | | 34 | apple |
| meadow | 115 | 31 | | 451 | 35 | 632 | meadow / turf |

Scenario B (unit: ha)

| | Site-A | | | | Site-B | | |
|---|---|---|---|---|---|---|---|
| Cropping Pattern | Mare Levare-1 | Mare Levare-2 | Ground water Control | Rain-fed Area | Gajary | Total | Crop Sequence |
| IR1 | 51 | | | | | 51 | sunflower-s. barley-rapeseeds-food wheat |
| IR2 | 11 | 77 | | | 44 | 132 | sunflower-food wheat-rapeseeds-food wheat |
| IR3 | 18 | 64 | | | 44 | 126 | sunflower-soybean-food wheat-s. barley |
| IR4 | 63 | 6 | | | 47 | 116 | maize-maize-s. barley-alfalfa-alfalfa-alfalfa |
| IR5 | 107 | 4 | 46 | | 39 | 196 | maize-maize-s. barley-maize- w. wheat |
| RF1 | | | | 1 | | 1 | rapeseeds-food wheat/s. barley |
| RF4 | | | | 17 | | 17 | wheat-rye |
| RF5 | 109 | | | 32 | 90 | 231 | wheat-rye-maize-alfalfa-alfalfa-alfalfa |
| NR1 | | | | 338 | | 338 | sunflower-s. barley-maize-food wheat |
| NR2 | | | | 54 | | 54 | sunflower-s. barley-maize-maize |
| rye | | | | 27 | | 27 | rye |
| veg | 51 | 64 | | | 30 | 145 | vegetable |
| asp | | 49 | 56 | | | 105 | asparagus |
| apple | 34 | | | | | 34 | apple |
| meadow | 145 | 31 | | 451 | 110 | 737 | meadow / turf |

Scenario C (unit: ha)

| | Site-A | | | | Site-B | | |
|---|---|---|---|---|---|---|---|
| Cropping Pattern | Mare Levare-1 | Mare Levare-2 | Ground water Control | Rain-fed Area | Gajary | Total | Crop Sequence |
| IR5 | | | 46 | | | 46 | maize-maize-s. barley-maize- w. wheat |
| RF1 | 51 | | | 1 | | 52 | rapeseeds-food wheat/s. barley |
| RF2 | 29 | 84 | | | 44 | 157 | food wheat-maize-maize-alfalfa-alfalfa-alfalfa |
| RF3 | | 101 | | | 44 | 145 | wheat-maize-maize-rapeseeds |
| RF4 | | | | 17 | | 17 | wheat-rye |
| RF5 | 216 | 10 | | 32 | 137 | 395 | wheat-rye-maize-alfalfa-alfalfa-alfalfa |
| NR1 | | | | 338 | | 338 | sunflower-s. barley-maize-food wheat |
| NR2 | | | | 54 | | 54 | sunflower-s. barley-maize-maize |
| rye | 63 | | | 27 | 39 | 129 | rye |
| veg | 51 | 20 | | | 30 | 101 | vegetable |
| asp | | 49 | 56 | | | 105 | asparagus |
| apple | 34 | | | | | 34 | apple |
| meadow | 145 | 31 | | 451 | 110 | 737 | meadow / turf |

Table 3.3 Summary of Expected Cultivated Area by Proposed Cropping Pattern

Scenario A (unit : ha)

| | Site-A | | | | | | | Site-B | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Zone II | | | | | | Zone III | | | |
| | Male Levare-1 Irrigation Sytem | | Male Levare-2 Irrigation System | | Groundwater control | Rain-fed area | | Gajary Irrigation System | | |
| | Non irrigated | Irrigated | Non irrigated | Irrigated | Irrigated | Non irrigated | Non irrigated | Non irrigated | Irrigated | |
| Wheat | 28 | 9 | 7 | 36 | 0 | 14 | 79 | 44 | 2 | 226 |
| Spring Barley | 0 | 73 | 0 | 18 | 10 | 0 | 105 | 10 | 44 | 259 |
| Maize | 0 | 139 | 4 | 7 | 29 | 5 | 115 | 49 | 62 | 410 |
| Vegetable | 0 | 80 | 0 | 84 | 0 | 0 | 0 | 0 | 40 | 204 |
| Sunflower | 0 | 17 | 0 | 33 | 0 | 0 | 93 | 0 | 24 | 167 |
| Alfalfa | 0 | 86 | 6 | 1 | 0 | 16 | 0 | 78 | 0 | 187 |
| Rape Seed | 9 | 0 | 12 | 0 | 0 | 0 | 0 | 7 | 0 | 28 |
| Rye | 0 | 0 | 0 | 0 | 0 | 41 | 0 | 0 | 0 | 41 |
| Soybeans | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 10 | 18 |
| Apple | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| Meadow | 115 | 0 | 31 | 0 | 0 | 58 | 393 | 0 | 35 | 632 |
| Asparagus | 0 | 0 | 0 | 49 | 56 | 0 | 0 | 0 | 0 | 105 |
| Total | 186 | 403 | 59 | 236 | 94 | 135 | 785 | 187 | 217 | 2,310 |

Scenario B (unit : ha)

| | Site-A | | | | | | | Site-B | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Zone II | | | | | | Zone III | | | |
| | Male Levare-1 Irrigation Sytem | | Male Levare-2 Irrigation System | | Groundwater control | Rain-fed area | | Gajary Irrigation System | | |
| | Non irrigated | Irrigated | Non irrigated | Irrigated | Irrigated | Non irrigated | Non irrigated | Non irrigated | Irrigated | |
| Wheat | 64 | 0 | 53 | 0 | 0 | 14 | 79 | 57 | 0 | 277 |
| Spring Barley | 0 | 43 | 0 | 19 | 8 | 0 | 105 | 0 | 25 | 201 |
| Maize | 105 | 0 | 5 | 0 | 0 | 5 | 115 | 55 | 0 | 313 |
| Vegetable | 0 | 51 | 0 | 64 | 0 | 0 | 0 | 0 | 30 | 145 |
| Sunflower | 0 | 26 | 0 | 42 | 0 | 0 | 93 | 0 | 18 | 179 |
| Alfalfa | 86 | 0 | 3 | 0 | 0 | 16 | 0 | 69 | 0 | 174 |
| Rape Seed | 11 | 0 | 16 | 0 | 0 | 0 | 0 | 15 | 0 | 41 |
| Rye | 18 | 0 | 0 | 0 | 0 | 41 | 0 | 15 | 0 | 74 |
| Soybeans | 6 | 0 | 15 | 0 | 0 | 0 | 0 | 11 | 0 | 32 |
| Apple | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| Meadow | 145 | 0 | 31 | 0 | 0 | 58 | 393 | 75 | 35 | 737 |
| Asparagus | 0 | 0 | 0 | 49 | 56 | 0 | 0 | 0 | 0 | 105 |
| Total | 469 | 121 | 121 | 174 | 64 | 135 | 785 | 296 | 108 | 2,310 |

Scenario C (unit : ha)

| | Site-A | | | | | | | Site-B | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Zone II | | | | | | Zone III | | | |
| | Male Levare-1 Irrigation Sytem | | Male Levare-2 Irrigation System | | Groundwater control | Rain-fed area | | Gajary Irrigation System | | |
| | Non irrigated | Irrigated | Non irrigated | Irrigated | Irrigated | Non irrigated | Non irrigated | Non irrigated | Irrigated | |
| Wheat | 58 | 0 | 47 | 0 | 0 | 14 | 79 | 41 | 0 | 247 |
| Spring Barley | 17 | 0 | 0 | 0 | 0 | 0 | 105 | 0 | 0 | 130 |
| Maize | 46 | 0 | 70 | 0 | 0 | 5 | 115 | 60 | 0 | 326 |
| Vegetable | 0 | 51 | 0 | 20 | 0 | 0 | 0 | 0 | 30 | 101 |
| Sunflower | 0 | 0 | 0 | 0 | 0 | 0 | 93 | 0 | 0 | 93 |
| Alfalfa | 123 | 0 | 47 | 0 | 0 | 16 | 0 | 91 | 0 | 276 |
| Rape Seed | 17 | 0 | 30 | 0 | 0 | 0 | 0 | 11 | 0 | 58 |
| Rye | 99 | 0 | 2 | 0 | 0 | 41 | 0 | 62 | 0 | 203 |
| Soybeans | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Apple | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| Meadow | 145 | 0 | 31 | 0 | 0 | 58 | 393 | 75 | 35 | 737 |
| Asparagus | 0 | 0 | 0 | 49 | 56 | 0 | 0 | 0 | 0 | 105 |
| Total | 538 | 51 | 226 | 69 | 56 | 135 | 785 | 339 | 65 | 2,310 |

### 3.2.4 SOIL CONSERVATION

The land with low fertility soils in Site-B is considered as high risk land for wind damage and wind erosion as mentioned in Chapter 2. The technical measures of the windbreak forest and tree belt and plant cover are proposed in the Guidelines. Preservation and afforestation of windbreak forest and tree belt will prevent wind damage or wind erosion permanently however it will take a long time and a large amount of investment. Thus, the introduction of cropping patterns considering the crop cover in the spring season was set as a major countermeasure to wind damage and wind erosion in the Soil Management Plan of the Case Study Site. In order to avoid bare land in the risky season, perennial grasses such as alfalfa or turf, winter crops such as wheat, rye, and rapeseed, and some of the spring crops such as spring barley are promoted to be included in the cropping sequence in the possible crop rotation.

The ratio of cultivation area of crops possessing advantage against wind damage and erosion was 61% in the Scenario-A, 81% in the Scenario-B and 92% in the Scenario-C, as shown below beside the ratio of current cropping which is 78% on average in 2001 and 2002. In the Scenario-B and -C, the crop cover is improved by introduction of appropriate cropping pattern. The ratio of crop cover in spring is decreased in the Scenario-A because the promotion of irrigation was given precedence. It is important to introduce the combination of countermeasures such as adjustment of seeding period of summer crops and leaving stubble and residue of last crop in the field as long as possible without interfering with sowing so as to reduce the period of bare field in the Scenario-A.

Ratio of Grasses, Winter and Spring Crops (unit: ha)

| Crop | Current | Scenario A | Scenario B | Scenario C |
|---|---|---|---|---|
| meadow | 35 | 35 | 110 | 110 |
| alfalfa | 0 | 78 | 69 | 69 |
| wheat | 0 | 16 | 23 | 23 |
| rye | 179 | 0 | 15 | 62 |
| rapeseed | 0 | 0 | 0 | 0 |
| s.barley | 0 | 47 | 14 | 0 |
| maize | 61 | 111 | 55 | 23 |
| Total of winter & spring crops* | 214<br>78% | 175<br>61% | 231<br>81% | 263<br>92% |

*: Meadow/turf, alfalfa, wheat, rye, rapeseed and s. barley.
The ratio of coverage of winter and spring crop to total field are of B-2, B-3 and B-4 soil unit, of which total area is 286 ha, is shown.

### 3.2.5 WATER MANAGEMENT OF SOIL

In the case study site, expected areas of water logging and dry mounds were specified as permanent limitations to farmland in Chapter 2, and locations were shown in Figure 3.8. Because those limitations are considered impossible to solve in the short term, the farmland management plan is proposing to avoid decreases in production by reflecting the limitations in the proposed crop rotation.

- Drainage problem area in Zone II: even though the area is rated into A-1 soil unit which is the highest fertility, vegetables were excluded from crop rotation to avoid damage by water logging or drainage problems.
- Drainage problem area in Zone III: maize was proposed positively instead of rapeseed so as to avoid negative affect of high groundwater level in the early spring.
- Dry mound: this area was evaluated to be unsuitable land for cultivation and the land use conversion to grassland was proposed.

Farmland Having Permanent Limitation in Case Study Area

| Limitation | Zone II | Zone III |
|---|---|---|
| Drainage problem | 51ha | 90ha |
| Dry mound | 119ha | — |

### 3.2.6 SOIL FERTILITY MANAGEMENT

(1) Introduction of Soil Resting Crops

The introduction of appropriate cropping patterns is a fundamental of soil fertility management activity especially in the low fertile soils. In the low and very low fertile soils categorized to A-3, A-4, B-2 and B-3 soil unit, alfalfa is promoted in the crop rotation. In the possible crop rotation proposed for the Case Study Area, 53%~60% of farmland is expected to introduce the cropping pattern including alfalfa in each scenario and the cultivation area of alfalfa is expected to reach to 27%~30% while the present cultivation area occupies 3% of arable land.

Introduction of Soil Resting Crop in the Low Fertile Soils (Unit: ha,%)

| Items | Year 2001-2002 | Scenario A | Scenario B | Scenario C |
|---|---|---|---|---|
| Total area of low fertile soils (Soil unit: A3, A4, B2, B3) | 690 | 690 | 690 | 690 |
| Area of field introducing cropping system including soil resting crops | - | 381 | 369 | 417 |
| Ratio to low fertile soils | - | 55% | 53% | 60% |
| Average area of field cropping soil resting crops | 19 | 191 | 185 | 209 |
| Ratio to low fertile soils | 3% | 28% | 27% | 30% |

(2) Manure Application

In the Guidelines, an effective use of recycling the organic matter produced in both field cultivation and animal waste is promoted. The manure produced by animal waste is promoted to be mainly applied to improve low fertility sandy soils in Zone II in the case of the Study Sites. Because of the high cost of transportation and spreading of manures, the manure application is a priority for vegetables, asparagus, cash crops such as sunflower and alfalfa in the Case Study.

The balance of demand and supply of animal waste and produced manure is not completed within a small-scale area such as the Case Study Sites due to the scale of farm management of the area. However, it is helpful to confirm the capability of application of manures based on the balance of the Malacky district. The manure production of the Malacky district is estimated 185,616 ton per year as mentioned in Chapter 2, and the possible supplying capacity to the Case Study Area is expected to be approximately 18,000 ton in accordance to the ratio of scale of the area. On the other hand, 15,440 ton of manures are expected to be applied to the fields in the Scenario A, 13,745 ton in the Scenario B and 11,900 ton in the Scenario C in the Case Study.

Amount of Manure Application in the Case Study Area

(Unit: ton)

| Site | Crops | Scenario A | Scenario B | Scenario C |
|---|---|---|---|---|
| A | Vegetable | 4,920 | 3,450 | 2,130 |
| | Asparagus | 3,150 | 3,120 | 3,120 |
| | Sunflower | 1,500 | 2,050 | 0 |
| | Alfalfa | 2,400 | 2,320 | 3,940 |
| Sub-total Site-A | | 11,970 | 10,940 | 9,190 |
| B | Vegetable | 1,200 | 900 | 900 |
| | Sunflower | 720 | 535 | 0 |
| | Alfalfa | 1,550 | 1,370 | 1,810 |
| Sub-total Site-B | | 3,470 | 2,805 | 2,710 |
| Total | | 15,440 | 13,745 | 11,900 |

## 3.3 IRRIGATION AND DRAINAGE MANAGEMENT

### 3.3.1 IRRIGATION PLAN

#### 3.3.1.1 WATER BALANCE BETWEEN CROP WATER REQUIREMENT AND SOIL MOISTURE

The crop water requirement is calculated by applying the data of evapotranspiration depending on climate conditions, cropping period, soil moisture characteristic, crop coefficient and effective rooting depth. This calculation follows the sequence to be explained hereinafter.

(1) Basic Data

The meteorological data observed at Malacky Meteorological Station will be used for the basis of calculation of Evapotranspiration (ET c). For the calculation and planning of amount of water requirement and sprinkling intensity, the data obtained from the survey on soil characteristic (soil gravity and soil moisture, relation between pF and moisture) test and intake rate test will be utilized.

(2) Reference Crop Evapotranspiration (ETo)

Of various formulas regarding calculation of the reference crop evapotranspiration

(ETo), the FAO Penman-Monteith Method (FAO Table 56) which is based on four meteorological data (air temperature, humidity, wind speed and radiation) is employed for this study. Where, the year of 1993 registered the ETo of an average year.

**Effective rainfall (ER) and The reference crop evapotranspiration (ETo)**

| Item | | Year | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| Average year of rainfall | E.R | 1993 | 15.2 | 24.9 | 25.1 | 9.0 | 36.8 | 54.5 | 80.1 | 71.2 | 23.1 | 35.9 | 21.0 | 32.4 | 429.3 |
| | ETo | 1993 | 10.8 | 16.9 | 37.0 | 75.8 | 121.4 | 121.1 | 123.2 | 109.6 | 70.2 | 41.8 | 17.7 | 9.6 | 755.1 |

(3) Water Balance between the Crop Evapotranspiration (ETc) and Soil Moisture

Water balance of crops during the year is calculated in consideration of data such as evapotranspiration (ETo), Effective rainfall, cropping period, Crop Coefficient (Kc), soil water depletion and effective rooting depth. The summary of calculation of the water balance is shown in the following table.

**Water Balance during Cutivation Priod**

| Item | Average year(1993) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT |
| | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm | mm |
| Winter Wheat | 92.5 | 112.2 | 134.3 | 127.0 | 132.2 | 113.8 | 44.0 | -58.8 | -64.2 | 30.9 | | | |
| Spring Barley | | | | | | 103.3 | 36.6 | -56.6 | -83.6 | 13.6 | | | |
| Grain maize | | | | | | | 30.4 | -39.6 | -78.8 | -66.5 | -52.7 | -27.4 | 19.2 |
| Carrot | | | | | | 65.6 | 3.5 | -70.2 | -72.7 | -49.2 | -2.3 | | |
| Potato | | | | | | | 25.8 | -9.1 | -70.3 | -61.6 | 1.4 | | |
| Asparagus | | | | | | 63.8 | 26.7 | -48.2 | -60.6 | -36.9 | -29.7 | -23.2 | 20.5 |
| Sunflower | | | | | | | 73.6 | 55.7 | -29.1 | -61.6 | -54.9 | 6.3 | |
| Soybeans | | | | | | | 70.5 | 28.4 | -56.4 | -52.9 | 31.5 | | |
| Alfalfa | | | | | | | 2.8 | -95.1 | -6.1 | -65.3 | 3.2 | -41.1 | 6.8 |
| Rapeseed | 113.8 | 138.5 | 144.0 | 131.2 | 138.6 | 131.5 | 81.9 | -16.0 | -18.2 | | | | |

The above calculation implies that, in the light of the water balance, most crops face deficiency in water requirement and need irrigation water accordingly.

3.3.1.2 IRRIGATION WATER REQUIREMENT

(1) Irrigation Efficiency

In calculating irrigation water requirement to supplement deficiency in crop water requirement, it is a precondition to take into account losses in water conveyance between intake point and receiving farmlands. Referring to the irrigation works (pipelines) and the irrigation method (sprinkling) of the case study area, the irrigation efficiency is estimated as Ea = 0.85 (Application efficiency; 0.90 and Rate of conveyance loss; 0.05).

(2) Gross Water Requirement

The unit water requirement per ha is multiplied by the irrigation efficiency (0.85) to obtain the crop water requirement. Monthly and yearly crop water requirement (unit: ha) for respective crop is estimated in the table below.

**Gross Irrigation Water Requirement**

E: Irrigation Efficiency: 0.85

| | Average year (1993,1998) | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| Item | APR | MAY | JUN | JUL | AUG | SEP | OCT | (mm) | (m3/ha) |
| Winter Wheat | 0 | 70.1 | 61.1 | 0.0 | 0.0 | 0.0 | 0 | 131.3 | 1,313 |
| Spring Barley | 0 | 77.8 | 83.1 | 5.0 | 0.0 | 0.0 | 0 | 165.9 | 1,659 |
| Grain maize | 0 | 44.6 | 77.6 | 89.8 | 85.0 | 16.1 | 0 | 313.2 | 3,132 |
| Carrot | 0 | 67.7 | 70.8 | 69.8 | 26.9 | 0.0 | 0 | 235.2 | 2,352 |
| Potato | 0 | 7.8 | 68.0 | 84.1 | 23.5 | 0.0 | 0 | 183.4 | 1,834 |
| Asparagus | 0 | 57.6 | 57.0 | 55.5 | 58.5 | 13.7 | 0 | 242.3 | 2,423 |
| Sunflower | 0 | 0.0 | 33.9 | 84.1 | 88.8 | 0.0 | 0 | 206.8 | 2,068 |
| Soybeans | 0 | 0.0 | 49.9 | 74.1 | 0.0 | 0.0 | 0 | 124.0 | 1,240 |
| Rapeseed | 0 | 9.4 | 10.7 | 0.0 | 0.0 | 0.0 | 0 | 20.1 | 201 |
| Alfalfa | 0 | 107.6 | 3.6 | 79.8 | 22.5 | 24.2 | 0 | 237.6 | 2,376 |

### 3.3.1.3 ON-FARM IRRIGATION SYSTEM

(1) Basic Intake Rate and Constraint on Irrigation Method

The basic intake rate within the case study area amounts to a considerable value ranging from 120 mm/hr. to 150 mm/hr. Due to the fact that soils in the area are represented by sandy loam, an appropriate irrigation method shall be by sprinkling or by drip. Referring to the value of the basic intake rate, it is supposed that the spray irrigation intensity should not constitute constraint on employment of irrigation equipment; the majority of irrigation equipment can be used for the case study area.

(2) Unit Water Requirement and Irrigation Interval

The unit water requirement, which varies according to available soil moisture and the effective depth of roots of crops, is in the range of 50 - 70 mm/application for cereals and 25 - 30 mm/application for vegetables, on the assumption that the irrigation interval is between 10 days to 15 days. Nevertheless, in view of making better utilization of effective rainfall, it is a prerequisite that irrigation water should be supplied giving some allowance in addition to the capacity of available soil moisture. It is thus suggested that the unit water requirement should be set as 30 mm for wheat, sunflower and maize and 20 mm for vegetables. An amount at each irrigation, irrigation interval and area of daily irrigation for the design water requirement are summarized in the following table.

**Irrigation Volume and Interval days**

| Item | Total Available Moisture | Max ETc | Requested Irrigation interval days from the soil moisture | Irrigation water volume of one time and Irrigation interval days | | Field Application | Gross irrigation requirement | Gross irrigation requirement | Capacity of hydrant | Irrigation hour/ha | Peak irrigation priod | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Hour | Area |
| Crop | (mm) | (mm/day) | Irrigation Interval day | (mm/day) | (days) | (Ea) | (mm/ha) | (m3/ha) | (l/sec) | (hr/ha) | hr | ha |
| Winter Wheat | 74.9 | 4.7 | 16.1 | 30 | 6.5 | 0.9 | 33 | 333 | 15 | 6.2 | 16 | 2.6 |
| Spring Barley | 75.6 | 4.6 | 16.4 | 30 | 6.5 | 0.9 | 33 | 333 | 15 | 6.2 | 16 | 2.6 |
| Grain maize | 102.7 | 4.9 | 21.0 | 30 | 6.1 | 0.9 | 33 | 333 | 15 | 6.2 | 16 | 2.6 |
| Carrot | 31.6 | 4.3 | 7.3 | 20 | 4.6 | 0.9 | 22 | 222 | 10 | 6.2 | 16 | 2.6 |
| Potato | 22.0 | 4.7 | 4.7 | 20 | 4.2 | 0.9 | 22 | 222 | 10 | 6.2 | 16 | 2.6 |
| Asparagus | 67.9 | 3.9 | 17.4 | 30 | 7.7 | 0.9 | 33 | 333 | 15 | 6.2 | 16 | 2.6 |
| Sunflower | 73.9 | 4.7 | 15.6 | 30 | 6.4 | 0.9 | 33 | 333 | 15 | 6.2 | 16 | 2.6 |
| Soybeans | 53.4 | 4.6 | 11.5 | 30 | 6.5 | 0.9 | 33 | 333 | 15 | 6.2 | 16 | 2.6 |
| Rapeseed | 77.1 | 4.5 | 17.2 | 30 | 6.7 | 0.9 | 33 | 333 | 15 | 6.2 | 16 | 2.6 |
| Alfalfa (1) | 107.3 | 4.9 | 22.1 | 30 | 6.2 | 0.9 | 33 | 333 | 15 | 6.2 | 16 | 2.6 |

(3) Rotation Irrigation and Irrigation Block

Irrigable area of each case study area (Male Levare, Kostoliste, Gajary) are ranging within 600 - 300 ha. Based on the quantity of water supply of hydrant (15 - 20 l/sec) and size of pipe and pipeline system, the irrigable area is divided into 7 blocks in Male Levare, 3 blocks in Kostoliste and 4 blocks in Gajary as irrigation blocks respectively. That is, each irrigation area is divided into irrigation blocks with a size of 50 to 80ha. Rotation irrigation systems of 7 days interval for cereal crops and 4 days for vegetables will be employed based upon the designed amount of irrigation water per application. In this case, 3 - 5 hydrants will cover 7 – 9 ha/day according to the rotation schedule to reach every part of the area. Number of rotation blocks and hydrant operation numbers are standardized as shown in the table below.

**Number of Irrigation Block and Operating Sprinkler**

| Sprinkler | No. of rotation block | Number of operating sprinkler/One rotation |
|---|---|---|
| Male levare-1 | 7 | 3 - 5 |
| Male levare-2 | 3 | 3 - 5 |
| Gajary | 4 | 3 - 5 |

### 3.3.1.4 ESTABLISHMENT OF IRRIGABLE AREA

(1) Available Water for Irrigation

Irrigation water to supply the case study area is taken from the Morava River, which has enough flow to satisfy the irrigation water requirement of the area in question. This fact suggests that the availability of irrigation water is not limited by source of water but by conveyance capacity and operation time of the pump. Assuming that existing pumps can be used and that the operation time of pumps in July (maximum water requirement throughout the year) should be set at 16 hours (one of three pumps shall remain out of operation to keep it for an emergency) for an average year and at 24 hours for a drought year, the available irrigation water to be conveyed to three pumping stations (Sekule Male Levare CV5, Kostoliste Cs and Dolecky Cs) is estimated as given in the table below.

**Irrigation Area and Amount of Water Resource**

| Item | Sekule Male Levare Cv5 | Kostoliste | Dolecky | Total |
|---|---|---|---|---|
| Irrigation area (ha) | 590 | 294 | 404 | 1,288 |
| Amount of water | $m^3$/sec | $m^3$/sec | $m^3$/sec | $m^3$/sec |
| Average year | 0.233 | 0.098 | 0.096 | 0.427 |
| Droughty area | 0.350 | 0.148 | 0.144 | 0.642 |

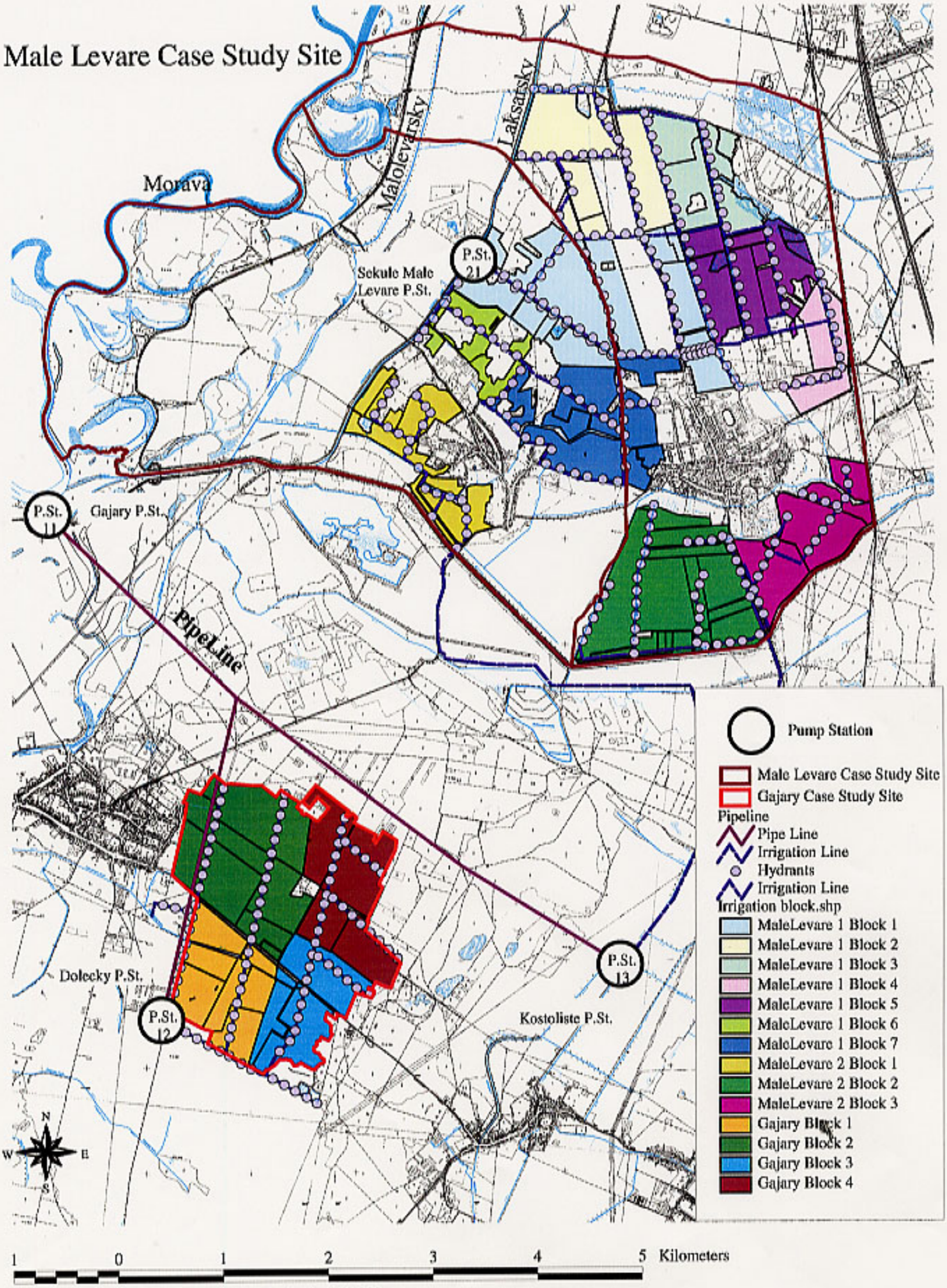



Figure 3.15 Setting of Irrigation Block in Case Study Site

(2) Irrigable Area According to Scenarios

Irrigation farming which aims to raise productivity of crops with a consistent supply of irrigation water entails investment in operation and maintenance of pumps and pipelines (including provision of spare parts), electric system, on-farm irrigation system (sprinkler), etc. With reference to the development of irrigation farming in the case study area, three scenarios with different irrigable area and investment level have been evaluated in relation to their impact on productivity of crops. An irrigable area for respective scenarios is established as explained below:

Scenario A (856 ha) : aims at maximum use of available water for irrigation

Scenario B (403 ha) : intends to focus irrigation water on crops which produce higher benefits with irrigation (like vegetables)

Scenario C (185 ha) : seeks to upgrade moderately prevailing irrigation to vegetables.

The irrigable area and target crops for three scenarios mentioned above are as follows:

**Summary of Irrigation Area of Scenario A,B,C**

| Item | **Scenario A** | | | **Scenario B** | | | **Scenario C** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Irrigation area (ha) | No irrigation area (ha) | total (ha) | Irrigation area (ha) | No irrigation area (ha) | total (ha) | Irrigation area (ha) | No irrigation area (ha) | Total (ha) |
| Mala Levare (1) | 403 | 186 | 589 | 121 | 469 | 589 | 51 | 538 | 589 |
| Mala Levare (2) | 236 | 59 | 295 | 174 | 121 | 295 | 69 | 226 | 295 |
| Gajary | 217 | 187 | 404 | 108 | 296 | 404 | 65 | 339 | 404 |
| Total | 856 | 432 | 1,288 | 403 | 885 | 1,288 | 185 | 1,103 | 1,288 |
| Wheat | 46 | 79 | 125 | 0 | 173 | 173 | 0 | 145 | 145 |
| Spring barley | 135 | 10 | 144 | 88 | 0 | 88 | | 17 | 17 |
| Grain maize | 208 | 53 | 261 | 0 | 164 | 164 | 0 | 176 | 176 |
| Vegetable | 204 | 0 | 204 | 145 | 0 | 145 | 101 | 0 | 101 |
| Potato | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Asparagus | 49 | 0 | 49 | 49 | 0 | 49 | 49 | 0 | 49 |
| Sunflower | 74 | 0 | 74 | 86 | 0 | 86 | 0 | 0 | 0 |
| Soybeans | 18 | 0 | 18 | 0 | 32 | 32 | 0 | 0 | 0 |
| Alfalfa | 122 | 84 | 206 | 35 | 158 | 193 | 35 | 260 | 295 |
| Rapeseed | 0 | 28 | 28 | 0 | 41 | 41 | 0 | 58 | 58 |
| Rye | 0 | 0 | 0 | 0 | 33 | 33 | 0 | 163 | 163 |
| Apple | 0 | 34 | 34 | 0 | 34 | 34 | 0 | 34 | 34 |
| Meadow | 0 | 146 | 146 | 0 | 251 | 251 | 0 | 251 | 251 |
| Total | 856 | 432 | 1,288 | 403 | 885 | 1,288 | 185 | 1,103 | 1,288 |

Namely , the irrigable area of scenario A is 856 ha, 403 ha in scenario B and 185 ha in scenario C, respectively. The irrigation volume of water of each scenario is calculated as shown in the table below.

**Water Volume for Irrigation in Scenario A,B,C**

| Item | **Scenario A** | | | | **Scenario B** | | | | **Scenario C** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average Year (1993,1998) | | | | | | | | | | | |
| | Male Levare-1 | Male Levare-2 | Gajary | Total | Male Levare-1 | Male Levare-2 | Gajary | Total | Male Levare-1 | Male Levare-2 | Gajary | Total |
| | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year | m$^3$/year |
| Wheat | 11,157 | 47,033 | 0 | 58,190 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spring Barley | 120,566 | 30,418 | 72,727 | 223,711 | 71,621 | 31,801 | 42,032 | 145,454 | 0 | 0 | 0 | 0 |
| Grain maize | 435,839 | 21,400 | 193,126 | 650,365 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vegetable | 188,164 | 197,572 | 94,082 | 479,818 | 119,955 | 150,531 | 70,562 | 341,047 | 119,955 | 47,041 | 70,562 | 237,557 |
| Potato | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Asparagus | 0 | 118,716 | 0 | 118,716 | 0 | 118,716 | 0 | 118,716 | 0 | 118,716 | 0 | 118,716 |
| Sunflower | 35,157 | 68,247 | 49,634 | 153,038 | 54,460 | 86,170 | 36,881 | 177,511 | 0 | 0 | 0 | 0 |
| Soybeans | 0 | 10,124 | 12,397 | 22,521 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Alfalfa | 204,321 | 2,376 | 83,154 | 289,851 | 0 | 0 | 83,154 | 83,154 | 0 | 0 | 81,903 | 81,903 |
| Total | 995,204 | 495,887 | 505,120 | 1,999,211 | 246,035 | 387,218 | 232,629 | 865,882 | 119,955 | 165,757 | 152,464 | 438,176 |

### 3.3.1.5 IRRIGATION METHOD AND FACILITIES

The target crops under an irrigation system in the case study area are vegetables, cereals, oil crops, pasture, etc. At present, irrigation water is provided mainly to vegetables (asparagus, carrot) by means of rotary reel hose sprinkler.

(1) Irrigation to Cereals and Oil Crops

Due to the fact that cereals and oil crops are cultivated in large-scale lots and the farming system among these crops is similar, the same type of sprinkler can be applied. Generally speaking, sprinkler equipment available for irrigation systems are represented by: reel hose sprinkler, center pivot, lateral move and side-wheel sprinkler; in so far as the case study area (including Zahorska lowland) is concerned, the reel hose sprinkler is recommended, because water conveyance pipelines and hydrants are already installed within the area and the equipment is more economical than others from the viewpoint of the size of lands to benefit.

(2) Irrigation to Vegetables

It is desirable that the irrigation to vegetables should be provided not by the sprinkler with high pressure but by one with medium or low pressure, because the plant body of vegetables is smaller and more fragile than cereals. Irrigation to root crops like carrot and onion may be provided by replacing the sprinkler nozzle of reel hose from high pressure type to medium pressure type with the discharge in the range of 650 - 1,200 l/min. and the pressure in the range of 5 - 8 kg/cm$^2$. Due to the fragile plant body, the irrigation to leafy crops should be provided by a sprinkler with low pressure; it is advisable that the attachment of the sprinkler should be replaced by the arm spray sprinkler type.

(3) Preparation of Irrigation Facilities

The previous considerations lead to the suggestion that the most appropriate irrigation method to cereals, sunflower, asparagus and carrot should be reel hose type sprinkler, from the viewpoint of the location of existing hydrants and adaptability of the sprinkler. An estimated number of reel hose sprinklers for respective scenarios is given below:

**Number of Sprinkler of Each Case Study Area (Scenario A:Max-case)**

| Item | Male levare-1 | | Male levare-2 | | Gajary | | Total |
|---|---|---|---|---|---|---|---|
| | Vegetable | Cereal | Vegetable | Cereal | Vegetable | Cereal | |
| Irrigation area | 80 | 323 | 133 | 103 | 40 | 177 | 856 |
| Irrigation area 1 set/day | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | - |
| Hydrant discharge | Number of Sprinkler | | | | | | |
| 10 L/sec | 8 | - | 13 | - | 4 | - | 25 |
| 15 L/sec | - | 18 | - | 6 | - | 10 | 34 |

Vegetable : Irrigation Interval : 4days

## 3.3.1.6 IRRIGATION COST AND WATER PRICE

(1) Irrigation Cost

Irrigation cost consists of water charge, installation cost of sprinkler to receive water from hydrant, labor cost of operator during supply of irrigation water, depreciation cost and operation/maintenance cost of sprinkler, etc. Water charge is calculated in accordance with the volume of water to be supplied, and the water requirement varies with crop. The irrigation cost then is proportional to the volume of water to be supplied. Farmers benefit from the State subsidy of 70% of the sum of irrigation cost by sprinkler and water charge. The irrigation cost for each crop is summarized in the table below:

Irrigation Cost

| Item | Unit | Wheat | Spring Barley | Grain Maize | Sunflower | Soybeans | Alfalfa | Asparagus | Vegetable |
|---|---|---|---|---|---|---|---|---|---|
| | Average Year | | | | | | | | |
| Water Requirement | (m3/year) | 1,313 | 1,659 | 3,132 | 2,068 | 1,240 | 2,376 | 2,423 | 2,352 |
| Irrigation cost | SSK/ha | 2,744 | 3,056 | 4,382 | 3,424 | 2,679 | 3,701 | 3,743 | 5,216 |

(The irrigation cost contains the work expense, Equipment cost and water charge)

The services for repair and administration of main structures represented by pump and pipe are undertaken by SWME-PD (managed by SWME-ID after the organization revision) at their expense, with expansion of irrigable area in the case study area, it is proposed to strengthen related facilities.

(2) Water Price

The current price system of irrigation water is shown as follows;

(A) Farmer's Portion: 2.85
(B) State's Portion: 0.35 SKK/$m^3$ (Operation cost)
(C) State's Portion: 190.00 SKK/ha
(Administration cost of irrigation facilities)

The real administration cost (C) can be converted to the quantitative price of 0.25~0.40 SKK/$m^3$ and the current water price is estimated from this at 3.50 SKK/$m^3$. In addition, 70% of subsidy is paid to users for the farmer's portion (A) to support irrigation farming. The actual amount of the farmer's burden is calculated as 0.9 SKK/$m^3$. On the other hand, the water price in the case study area is estimated based on the amount of water use as shown in the Table below, of which Scenario A is 0.91 SKK/$m^3$, B is 1.64 SKK/$m^3$ and C is 2.90 SKK/$m^3$.

It is realized that the present subsidy or charge system in irrigation is maintained in the situations such as: 1) amount of water use per hectare is rather little and 2) ratio of irrigation is considerably low. With expansion of irrigation farming, water price will become cheaper sharply and the rate of a governmental subsidy will become lower simultaneously. It is presumed that the current charge system would be unsuitable and require to be reviewed in some stage in the future.

Water Price and Ratio of Water Charge in Case Study Site A

| | Scenario A | Scenario B | Scenario C |
|---|---|---|---|
| Water Volume (1,000 $m^3$) | 1,999 | 866 | 438 |
| Fixed Cost | 1,114,651 | 1,114,651 | 1,114,651 |
| 1) Maintenance Company | 215,851 | 215,851 | 215,851 |
| 2) Expenses of State | 898,800 | 898,800 | 898,800 |
| Electric cost (100%) | 699,650 | 303,100 | 153,300 |
| Total Cost | 1,814,301 | 1,417,751 | 1,267,951 |
| Water Price (SKK/$m^3$) | 0.91 | 1.64 | 2.89 |
| Water Charge (Paid by farmer) | 1,709,145 | 740,430 | 374,490 |
| Ratio of Water Charge | 94% | 52% | 30% |

#### 3.3.1.7 OPERATION AND MAINTENANCE PLAN

(1) Project Implementation

Irrigation Facilities are the property of SWME-PD, which are in charge of operation and maintenance of these works. In the light of this background, the recovery of the project shall be the responsibility of SWME-ID. On-farm irrigation facilities, like sprinklers, shall be prepared by farmers.

(2) Operation and Maintenance

A private company, which is entrusted by SWME-ID the task in question, shall remain the responsible body for operation and maintenance of pumps and pipelines, meanwhile farmers shall take charge of on-farm irrigation works. In case some farmers make use of the same pump, it is essential that a water users' council should be established to make decisions on the distribution of irrigation water, prioritization for use of irrigation works, introduction of rotation for irrigation, etc.

### 3.3.2 DRAINAGE

#### 3.3.2.1 IMPROVEMENT PLAN OF THE DRAINAGE SYSTEM

As a result of an assessment on functioning and operation and maintenance of the drainage system mentioned before in chapter 3.2.1, it is concluded that higher priority for improvement of the drainage system within the case study area should be given to five canals in Male Levare sector, a siphon installed at the lowest stream of the Laksarsky, outlet boxes of underdrains, etc.

(1) Drainage Canals

An assessment of operation and maintenance of drainage canals has summarized the flowing capacity of the prevailing drainage canals. Although drainage canals have enough flowing capacity to permit conveyance of surface water, drainage through underdrains becomes jammed if the water depth of drainage canals exceeds 50 cm. The majority of drainage canals suffer from sedimentation thicker than 30 cm on average and, as a consequence, the said phenomenon takes place with water flow deeper than 20 cm. This situation suggests that 7 of 18 drainage canals in the area are vulnerable to difficulty in drainage at times of flooding; furthermore, it is reported that 5 drainage canals (in a partial section) have consistently poor drainage because of sedimentation thicker than 50 cm. Surface water within the area flows down into the drainage canal through pipe drains. Hence the sediment of drainage canals should be cleaned out when it becomes over 25~30 cm at the exit of the drainpipe.

(2) Siphon

Among four (4) siphons, the water conveyance capacity of siphon No.3 has declined as it crosses over the lowest reaches of Laksharsky river. Accordingly, the countermeasures (cleaning of earth and sand) should be taken to improve the function of the siphon. The siphon is made from concrete pipe with diameter of 1.0 m and 54 m long. The height of siphon at outlet and inlet is higher than the crossing part of the Laksarsky River. Due to this structure, earth and sand accumulated in the siphon cannot be drained by gravity drainage. The deposit should be removed by sending pressurised water from the pump.

(3) Underdrains

The situation for maintenance of the underdrains cannot be verified directly because they are laid underground, but it may be evaluated with observation of water discharge at the outlet box of drainage canals. Outlet boxes of underdrain are an important structure for the underdrainage system , but most of them in the area are filled with sediment. Therefore, all of them except for those installed within an underground control area (Male levare) need to be improved (removal of sediment, reinforcement of boxes).

### 3.3.2.2 OPERATION AND MAINTENANCE PLAN FOR DRAINAGE SYSTEM

(1) Preparation of Inventory for Drainage System

The drainage system consists of rivers, pumping stations, drainage canals (main, secondary and lateral), siphon/gate and underdrains. In view of improvements to the operation and maintenance tasks, it is essential to prepare an inventory of the characteristics of these works and to distribute it to those relevant to the drainage system.

(2) Periodic Monitoring of the Functioning of the System and Operation and Maintenance

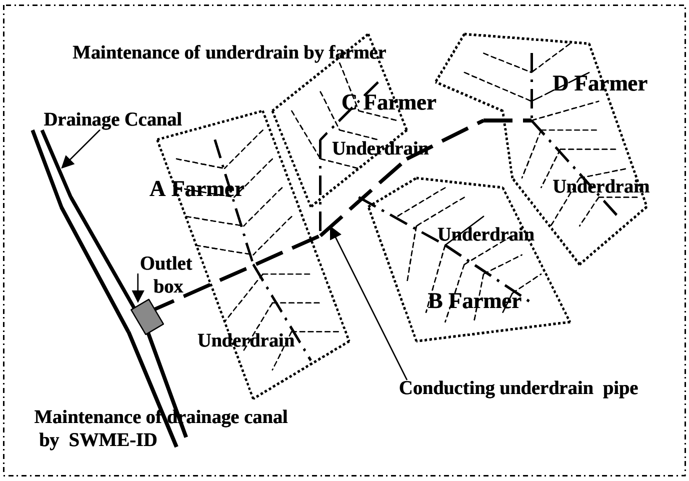
In order to maintain the drainage system without its performance being impaired, it is a prerequisite to make timely rehabilitation of damaged parts. In other words, the cost for the operation and maintenance of the system can be saved if necessary rehabilitation tasks are conducted prior to the system being damaged seriously. In conclusion, periodic monitoring of the functioning of the system is of importance.

(3) An Integrated Task for Operation and Maintenance

1) Affiliation of Water Users for Operation and Maintenance

Various farmers share one drainage network within the Male Levare sector and these farmers jointly benefit from the use of the collecting pipes of the underdrains. It is essential that these farmers should be affiliated so as to operate underdrains more effectively. In this context, SWME-ID is requested to provide farmers with an installation plan of underdrains and other relevant information.

2) Integrated Operation and Maintenance of Drainage Canals and Benefiting Farmlands



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

Outlet boxes of underdrains are connected with drainage canals and SWME-ID is responsible for their operation and maintenance. The drainage capacity of the outlet box of underdrains is closely related to the maintenance of drainage canals. When improvements to drainage canals are made, the opportunity to improve the outlet boxes of underdrains should be taken at the same time. Due to the fact that farmers directly benefit from underdrains, it is suggested that provision of information and routine maintenance tasks (weeding and removal of sediment) should be made by the farmers in the future, if timely and more effective operation and maintenance is desired.

(4) Periodic Monitoring

The drainage canals in the Case Study area are administrated by SWME-ID with the periodic task for their cleaning. On the other hand, drainage canals (including natural tributaries) are so extensively laid with a considerable total length that it is unpredictable how these canals are operated and maintained. In the light of this, it is advisable that monitoring of these canals to diagnose actual maintenance tasks needed (progress of sedimentation, growth of weeds over canals, inflow of driftwood and garbage, damage of canals, inflow of urban sewage) should be carried out with participation of farmers, with a view to prioritization of operation and maintenance tasks as well as improvement works.

**Monitoring Item and Monitor**

| Monitoring Item | Monitor |
|---|---|
| -Presence of obstacles in drainage canal (Settled sand, and driftwood, etc.)<br>-Growth of weeds<br>-Lining Condition of drainage canal<br>-Sedimentation of underdrain outlet Box<br>-Drainage condition of wasted water | -Farmer in the study area<br>-Town and Village Offices |

* The monitoring observation points are proposed to set at confluence of canals and drainage facilities such as siphon. Those monitoring points are shown in the Supporting Report.

## 3.4 CULTIVATION AND FARM MANAGEMENTS

Based on the results of the analysis in the previous sections, a recommended farming style will be proposed here with a view to strengthening environment-friendly agriculture and market-oriented farming. This type of farming is required not only from the needs in the development of the Zahorska area but also from the preparation for the accession to the EU. From a farmers point of view, every agricultural technique is required to be combined for the comprehensive production procedures at the level of agricultural area and individual field. The following are the necessary agricultural techniques to be shared by each type of field.

a. Develop the crop-animal mixed farming of high profitability as a major type of farming by strengthening the collaboration of crop production with animal husbandry,

b. Develop environment-friendly farming by improving practical existing techniques such as recycling of animal wastes as manures.

c. Accelerate the self-help efforts of farmers by increasing productivity and profitability through applying appropriate inputs such as fertilizers, irrigation and agricultural chemicals.

d. Strengthen the market-oriented farming by the development of business contracts with traders and food processing companies for the stabilization and diversification of agricultural production.

e. Make better use of the environmental factors to develop appropriate farming such as cultivation of winter crops and protect crops from damage such as water logging and dry mounds.

(1) Recommended Agricultural Style for Specific Type of Fields

In this section several types of fields having specific farming style (constraints) will be categorized, and appropriate techniques synthesized from the agricultural sub-region will be proposed.

The following are the 5 types of fields categorized by their agricultural conditions:

a. Fields in Zone-II
b. Fields with high moisture in Zone-II
c. Fields in the Zone-III
d. Fields with drainage problems in Zone-III
e. Vegetable growing fields

(2) Necessary Agricultural Techniques by Field Type

a. Fields in Zone-II

The area has sandy soil, and a majority of the area is installed with irrigation facilities. Therefore, various crops can be cultivated. However, appropriate crops and farming methods should be selected for efficient farming.

- Selection of appropriate crops: winter crops for non-irrigated fields and winter wheat for food, sunflower, vegetables and other cash crops for irrigated fields.
- Due to the low productivity of soil and for environmental conservation, the crop-livestock mixed farming is the most important, and it is necessary to develop as the fundamental farming type in the future.
- The low productivity also requires low-cost inputs such as plow-in of green manure, moderate amount of fertilizers, low application of agricultural chemicals.

b. Fields with High Moisture in Zone-II

Although the soil conditions are not suitable to crops due to sandy soil, water and plant nutrients gather at the low elevation areas, and hence, the growth of crops is usually quite good, and good harvest is obtained.

- Suitable crops will be sunflower, s. barley and maize, and their crop rotation will be profitable as cash crops.
- The water logging often happens in early spring; therefore, winter crops such as w. wheat and rapeseeds are not suitable.
- Major crops will not be crops for self-supplied feeds but cash crops for marketing.
- The lands are often water logged, but the areas are limited to small areas: about 0.1 - 0.3 ha. Therefore, these fields can be one of the high productivity areas in the Zahorska region. This is a good example of utilizing environmental factors for agricultural production well. It is recommended that this type of farming should be developed further.
- Contracts with traders and food processing companies will be recommended from various advantages such as preparation of farming funds, smooth marketing and collection of bills in the farmers side.
- An increase of inputs such as irrigation, fertilizers and agricultural chemicals is required to fulfill the demands such as quality control and stabilization/increase of commodities and lots in the contract farming.

c. Fields in Zone-III

This area has loamy soil, and it is good for crop cultivation with its potential soil conditions. High productivity is observed in various crops such as w. wheat, maize, s. barley, rye, sunflower and rapeseeds. These crops are recommended for this area as cash crops. W. wheat can be produced for food crop.

There are no serious depressions or low elevation areas; therefore, no specific damage such as water logging are observed in this area. Weed damage is the most serious problem. Most of the weeds are aquatic weeds. The following treatments can be recommended:

- Concentrated but limited application of herbicides to “ Weed islands”:
  “ Weed islands with high density of grasses” are often observed, and the crop growth is retarded seriously here. This area is designated as the natural reservation area, and, hence, the application of herbicides is requested to be as small as possible. Therefore, the total amount of herbicides should be suppressed to an appropriate level by decreasing herbicide use on normal growth areas and making concentrated application to high density areas.

- Repeated and Concentrated Plowing:
  The plowing after the crop harvest will be important: the cost of plowing-in of weeds is about 600 SKK/ha. Concentrated treatment will not be expensive for its effectiveness.

d. Fields with Drainage Problems in Zone-III

The soil type is fertile; however, water logging happens in many places, causing serious crop damages. The counter measures to the water logging can be recommended from several methods:

- Selection of resistant crops such as maize and sunflower,
- Seeding of summer crops such as spring barley at an appropriate time in early spring.
- Breakage of compact layers:
  <The treatment is practiced only for water logging. The cost, 6500SK/ha, will not be a seriously heavy burden because the treatment area is very limited.>
- Winter crops such as w. wheat, rapeseeds, triticale and rye, susceptible to the water logging, are not suitable for these areas.
- For fundamental countermeasures to the water logging, land leveling of the weed lands will be important.
- Crop production is often unstable, and grain quality can be also inferior to the normal area due to heavy weed damage.

e. Vegetable Growing Fields.

- Vegetables are suitable for flat and sandy areas installed with irrigation facilities.
- Vegetables require crop rotations, and they should be completed within the rotation of vegetables for the efficient use of fertilizers and increase of the soil fertility.
- Constant irrigation is required for the increase of production and the improvement of market competitiveness.
- Organic substances need to be applied by plow-in of green manure and manures.
- Sandy soils easily lose micronutrients; therefore, micronutrients such as Zn, B and Cu need to be applied periodically.
- The improvement of soil characteristics by breakage of hardpans is recommended. <The contract farming with vegetable processing company is advanced.>

For the market-oriented and environment friendly farming, there are many requirements from consumers, while, from a farmers point of view, practical countermeasures are limited due to economic conditions. What is important is to formulate stream-lined procedures in the agricultural development: to identify priority areas, select methods for target-cultivation and make preparations for the agricultural production.

# CHAPTER 4 EVALUATION AND CONCLUSION

## 4.1 IMPLEMENTATION PLAN

The activities proposed in the soil and water management plan are categorized to two levels, i.e., the regional level of which technical measures are to be conducted by the governmental agencies, public organization and private companies having contract with public organizations, and the field level at which technical measures are to be carried out by farming bodies, from the aspect of main actors to activities. The soil and water management plan is aiming to improve the efficiency of the regional agriculture through introducing appropriate farmland use and cultivation technologies and to realize value added agriculture through promoting irrigation farming. The major activities of the soil and water management plan are to be carried out by farming bodies by themselves through changing their cropping system and farming plan. Governmental agencies and public organizations are required to support farming bodies' activities directly through recovering and maintaining irrigation systems and to support and instruct through operating the subsidy system. The activities required for the levels and organizations in the soil and water management plan are summarized in the Table shown on the next page. Necessary investment will be required to implement the soil and water management plan. The amounts of investment of each level are estimated as below:

Necessary Investment and Subsidy for Soil and Water Management Plan

(Unit: 1,000SKK)

| Items | Current Situation* | Scenario A | Scenario B | Scenario C |
|---|---|---|---|---|
| 1. Governmental Subsidy | 4,236 | 10,433 | 6,706 | 5,143 |
| 1.1 Production subsidy and subsidy for disadvantaged area | 3,368 | 4,009 | 3,759 | 3,575 |
| 1.2 Subsidy for irrigation | 868 | 6,424 | 2,947 | 1,568 |
| 2. Recovery of Irrigation System | | | | |
| 2.1 Cost for recovery of irrigation | - | 6,721 | | |
| 3. Cost for field irrigation equipment | | | | |
| 3.1 Before receiving subsidy | - | 29,500 | 15,742 | 9,420 |
| 3.2 After receiving subsidy | - | 8,850 | 4,723 | 2,826 |
| 4. Farming cost | | | | |
| 4.1 Total amount of farming cost | 43,958 | 65,551 | 57,199 | 51,875 |
| 4.2 Farming cost per ha (SKK/ha) | 19,029 | 28,377 | 24,761 | 22,457 |

Remarks * : Estimated based on the cultivation in Year 2001 and 2002.

In order to secure the progress of proposed agriculture, governmental agencies and public organizations have to secure the budget for agricultural subsidies and investment for the recovery and promotion of irrigation systems. The total amount of subsidy for the case study area including production subsidy, subsidy for disadvantaged land and irrigation subsidy is estimated as 4,236 thousand SKK, and it will increase to 10,433 thousand SKK in Scenario A, 6,706 thousand SKK in Scenario B and 5,143 thousand SKK in Scenario C. Most of the increment of subsidy is caused by increase of subsidy for irrigation water charge. In addition, the investment for recovering irrigation systems will take 6,721 thousand SKK.

On the other hand, farming bodies are also required to increase investment to improve their agriculture. The investment to field irrigation equipment such as sprinkler systems are necessary for introducing irrigation farming and they are to be prepared by farming bodies. The amount of investment in sprinklers is estimated at 29,500 thousand SKK, 15,742 thousand SKK and 9,420 thousand SKK in Scenario A, B and C. When the subsidy for purchasing this equipment, even the payment of subsidy is uncertain due to the limitation of governmental budget, the investment of farming bodies will be 8,850 thousand SKK, 4,723 thousand SKK and 2,826 thousand SKK respectively. In addition to the investment in equipment, farming bodies are required to prepare the increasing farming cost, which is caused by the change of farming practice through introducing irrigation farming and the improvement of cultivation including increase of agricultural input. The total farming cost is estimated 43,958 thousand SKK in the current situation and those of each scenario are estimated at 65,551 thousand SKK (149% of current situation), 57,199 thousand SKK (130%) and 51,875 thousand SKK (118%).

IMPLEMENTATION PLAN OF WATER AND SOIL MANAGEMENT PLAN (SHARING OF ACTIVITIES)

| | Regional Level | | Field Level |
|---|---|---|---|
| | Government | SWME-ID / Water company | Farming body |
| FARMLAND MANAGEMENT | | | |
| Land use conversion | • Preparation of subsidy budget | | • Changing farming plan<br>• Reflect to cropping system |
| Appropriate crop rotation | • Support for technical information | • Support for technical information | • Changing farming plan<br>• Reflect to cropping system |
| Soil conservation | | | • Reflect to cropping system |
| Soil moisture management | | | • Reflect to cropping system |
| Introduction of Soil resting crop | | | • Reflect to cropping system |
| Manure application | | | • Reflect to farming practice |
| IRRIGATION AND DRAINAGE | | | |
| Recovery of irrigation system | • Preparation of budget for recovery of irrigation system<br>• Preparation of subsidy budget for water charge<br>• Preparation of subsidy budget for supporting field irrigation equipment | • Rehabilitation/recovery work of system<br>• Ordinal maintenance work<br>• Organizing water users<br>• Support to farmers in irrigation techniques | • Preparing field irrigation equipment (Taking the fund for purchasing equipment)<br>• Changing farming plan<br>• Reflect to farming practice (Introduction of appropriate farming practice for irrigation farming)<br>• Developing the marketing route (Expanding farming contract of vegetables and cash crops) |
| Improvement of drainage management | | • Maintaining the drainage system<br>• Organizing integrated O/M of drainage system<br>• Periodic monitoring | |
| CULTIVATION AND FARMING PRACTICE | | | |
| Improvement of farming practice | • Preparing budget for increasing subsidy | | • Changing farming plan<br>• Reflect to farming practice in the fields<br>• Taking the fund for increasing farming cost |

## 4.2 FARMING BUDGET

### (1) Farming Budget of Case Study Area

The change of farming budget expected by the soil and water management plan was examined based on the total amount of the case study site. The amount of the gross income of crop farming in the case study area is estimated as 49,841 thousand SKK an average of year 2001 and 2002, and it will be increased in the farming plans proposed in scenarios as shown below. The increase is expected to be 28,954 thousand SKK in Scenario A, 17,751 thousand SKK in Scenario B and 10,933 thousand SKK in Scenario C.

Gross Income and Its Increment of Scenarios (in Financial Price)

| Items | Current Situation | | | Scenarios | | |
|---|---|---|---|---|---|---|
| | Year 2001 | Year 2002 | Average | A | B | C |
| Gross Income (1,000 SKK) | 49,367 | 50,315 | 49,841 | 78,795 | 67,592 | 60,774 |
| Increment (1,000 SKK) | - | - | - | 28,954 | 17,751 | 10,933 |
| Farming Cost (1,000 SKK) | 43,548 | 44,367 | 43,958 | 65,551 | 57,199 | 51,875 |
| Increment (%) | - | - | - | 149% | 130% | 118% |

The net return from the crop farming is estimated as below. The net return will increase by 7,361 thousand SKK in Scenario A, by 4,510 thousand SKK in Scenario B and 3,016 thousand SKK in Scenario C. The ratio of net return to total farming cost is 13% in the current situation and it will increase to 20% in Scenario A, 18% in Scenario B and 17% in Scenario C.

Net Return of Scenarios (in Financial Price)

| | Current Situation | | | Scenarios | | |
|---|---|---|---|---|---|---|
| | Year 2001 | Year 2002 | Average | A | B | C |
| Net return (1,000 SKK) | 5,819 | 5,948 | 5,883 | 13,245 | 10,393 | 8,899 |
| Increment (1,000 SKK) | - | - | - | 7,361 | 4,510 | 3,016 |
| Net return / Farming cost | 13% | 13% | 13% | 20% | 18% | 17% |
| Net return per hector (SKK/ha) | 2,519 | 2,575 | 2,547 | 5,734 | 4,499 | 3,852 |

As mentioned in 4.1, the total amount of subsidy will increase in scenarios because of expansion of irrigation farming of which dependence on subsidy is higher than rain-fed farming. The total subsidy amount will increase from 4,236 thousand SKK at present to 10,434 thousand SKK in Scenario A, 6,706 thousand SKK in Scenario

B and 5,143 thousand SKK in Scenario C. The ratio of subsidy to the gross income is at the same level with the current situation in Scenario B and C but it will increase to 13% in Scenario A. The ratio to the net return will increase 7 points in Scenario A while it decreases 7~14 points in Scenario B and C, as shown below.

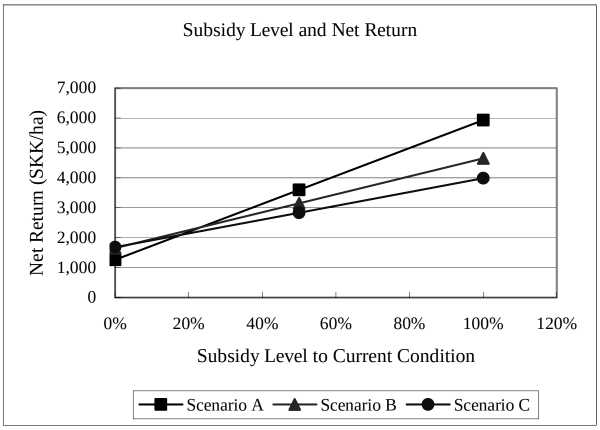
Ratio of Subsidy to Gross Income and Net Return of Scenarios

| Items | Current Situation | | | Scenarios | | |
|---|---|---|---|---|---|---|
| | Year 2001 | Year 2002 | Average | A | B | C |
| Amount of subsidy (1,000 SKK) | 4,230 | 4,241 | 4,236 | 10,434 | 6,706 | 5,143 |
| Ratio to gross income | 9% | 8% | 8% | 13% | 10% | 8% |
| Ratio to net return | 73% | 71% | 72% | 79% | 65% | 58% |

Because of uncertainty in the subsidy system in the future, which is expected to change drastically, the sensitive analysis of the farm budget on the change of income from the governmental subsidy was examined. The net return per hectare will decrease according to a decrease of subsidy level from 5,934 SKK/ha to 3,597 SKK/ha at 50% of subsidy level and 1,259SKK/ha without subsidy in Scenario A. The net return of Scenario A is higher than Scenario B and C when the subsidy level is 100% or 50% of the present situation, however it goes down and becomes lower than other scenarios without any subsidy. In the case that subsidy could receive 50% of the present condition, the profit ratio to the farming cost will be 12% in each scenario and it is equal to the present condition. With no subsidy income, the ratio will become 4~7% in each scenario and they mean the profit is mostly not expected.

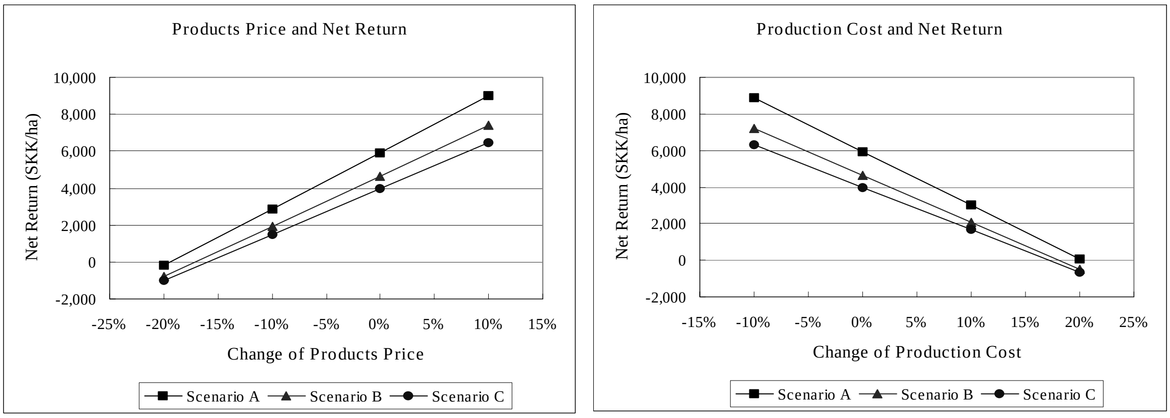
Sensitivity of Net Return by Subsidy Level

| Scenario A | | | |
|---|---|---|---|
| Subsidy level | 100% | 50% | 0% |
| Net return (1,000 SKK) | 13,245 | 8,028 | 2,811 |
| Ratio to cost | 20% | 12% | 4% |
| Net return per ha (SKK/ha) | 5,934 | 3,597 | 1,259 |
| **Scenario B** | | | |
| Subsidy level | 100% | 50% | 0% |
| Net return (1,000 SKK) | 10,393 | 7,040 | 3,687 |
| Ratio to cost | 18% | 12% | 6% |
| Net return per ha (SKK/ha) | 4,656 | 3,154 | 1,652 |
| **Scenario C** | | | |
| Subsidy level | 100% | 50% | 0% |
| Net return (1,000 SKK) | 8,899 | 6,328 | 3,756 |
| Ratio to cost | 17% | 12% | 7% |
| Net return per ha (SKK/ha) | 3,987 | 2,835 | 1,683 |



Due to the low profit ratio to the farming cost, the net return will be influenced sensitively by the change of market price of products and farming cost. Increase of production cost of 20%, 18% and 17% in Scenario A, B and C respectively is assessed to be a break-even point of net return. Decrease of market price of products of 19%, 17% and 16% in Scenario A, B and C respectively is assessed to be a break-even point of net return.

Sensitivity of Net Return by Change of Prodcuts Price and Production Cost




Sensitivity on Production Cost

| | Scenario A | | | | Scenario B | | | | Scenario C | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cost increase | -10% | 0% | 10% | 20% | -10% | 0% | 10% | 20% | -10% | 0% | 10% | 20% |
| Net return (1,000SKK) | 19,800 | 13,245 | 6,689 | 134 | 16,113 | 10,393 | 4,673 | -1,047 | 14,087 | 8,899 | 3,712 | -1,476 |
| Ratio | 34% | 20% | 9% | 0% | 31% | 18% | 7% | -2% | 30% | 17% | 7% | -2% |
| Net return per ha (SKK/ha) | 8,871 | 5,934 | 2,997 | 60 | 7,219 | 4,656 | 2,094 | -469 | 6,311 | 3,987 | 1,663 | -661 |

Sensitivity on Products Price

| | Scenario A | | | | Scenario B | | | | Scenario C | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Price increase | 10% | 0% | -10% | -20% | 10% | 0% | -10% | -20% | 10% | 0% | -10% | -20% |
| Net return (1,000SKK) | 20,081 | 13,245 | 6,408 | -428 | 16,482 | 10,393 | 4,305 | -1,784 | 14,462 | 8,899 | 3,336 | -2,227 |
| Ratio | 31% | 20% | 10% | -1% | 29% | 18% | 8% | -3% | 28% | 17% | 6% | -4% |
| Net return per ha (SKK/ha) | 8,997 | 5,934 | 2,871 | -192 | 7,384 | 4,656 | 1,929 | -799 | 6,480 | 3,987 | 1,495 | -998 |

(2) Cost of Self Supply Feed Production

The necessary cost to produce enough self supplied feed in the Case Study area is estimated based on the consumed amount in the existing condition and each scenario. The unit cost of each crop is decided according to the distribution of cultivated area in every scenario. The total cost is reduced about 10% from the existing condition to scenarios, so that it can be said that the feed production efficiency is also improved.

The reason for this improvement is the reduction of production costs created by improved farming techniques.

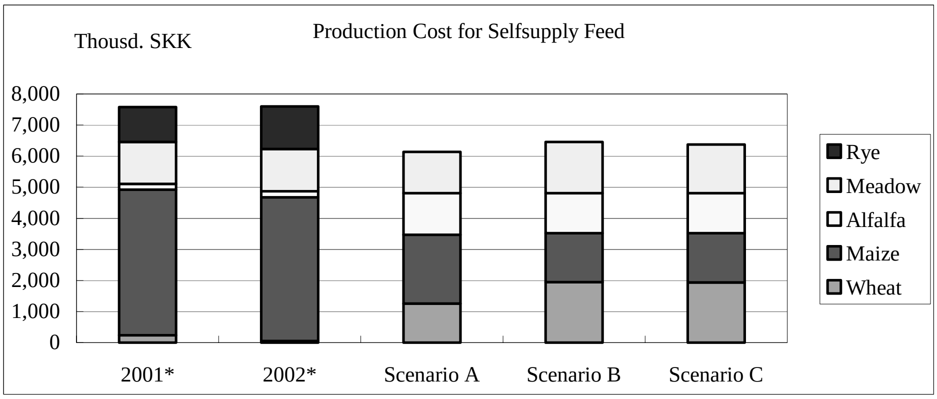
Among the scenarios, the highest cost is marked in scenario B and following are scenario C and A. In the scenario A, the reduction of total production cost is brought about by the fact that the irrigation area is expanded and the unit production cost of maize becomes low because the maize is sensitive to irrigation and its yield become very high when it is irrigated.

Average Unit Cost (SKK/ton)

| | 2001* | 2002* | Scenario A | Scenario B | Scenario C |
|---|---|---|---|---|---|
| Wheat | 3,821 | 3,821 | 3,574 | 3,574 | 3,574 |
| Maize | 3,811 | 3,833 | 3,366 | 3,639 | 3,645 |
| Alfalfa | 1,182 | 1,182 | 1,148 | 1,182 | 1,182 |
| Meadow | 744 | 744 | 703 | 709 | 709 |
| Rye | 4,458 | 4,435 | 4,130 | 4,130 | 4,130 |

Production Cost for selfsupply feed（Thoud. SKK）

| | 2001* | 2002* | Scenario A | Scenario B | Scenario C |
|---|---|---|---|---|---|
| Wheat | 233 | 50 | 1,258 | 1,944 | 1,940 |
| Maize | 4,684 | 4,626 | 2,208 | 1,579 | 1,582 |
| Alfalfa | 189 | 189 | 1,339 | 1,288 | 1,288 |
| Meadow | 1,347 | 1,367 | 1,333 | 1,642 | 1,568 |
| Rye | 1,127 | 1,364 | 0 | 0 | 0 |
| Total | 7,579 | 7,596 | 6,138 | 6,454 | 6,378 |



## 4.3 PLAN EVALUATION

### 4.3.1 PLAN BENEFITS

(1) Intangible Benefits

Unsuitable land use, improper tillage, insufficient building of wind breaks, improper crop rotations, unsuitable agricultural technique etc. among other factors are the major cause of soil erosion and are behind the decline of crop yields. The guidelines will provide a sound basis for the sustainable development of agriculture in the Case Study Site. Erosion control that brings about indirect and intangible benefits to the whole area with plan implementation does not have market prices that make traditional economic evaluation almost impossible in this plan.

(2) Tangible Benefits

The tangible or direct benefit to be expected in the Case Study Site is derived from the increased crop production attributed to a stable irrigation water supply and proper land management, proper fertilization etc. With irrigation water supply and proper land use, per hectare yield is expected to increase. The benefit will therefore be incremental to the existing benefit. The balance of net return obtained from crop production between future with and without plan conditions is the direct benefit and the benefits for each site and zone are summarized below.

### 4.3.2 BASIC ASSUMPTIONS FOR PLAN EVALUATION

Basic assumptions for plan evaluation are as follows;

(1) The life of the plan is 15 years, provided that proper maintenance is assured.

(2) All prices are expressed at Aug. 2002 constant prices. They are kept constant throughout the Project period.

(3) The exchange rate of US$ 1.00 = SKK45.0

(4) The main cause of low productivity in the Case Study Site is due to the lack of irrigation, unsuitable land use, inadequate farming practices etc. So the present

agricultural conditions are regarded as the without the plan case. To smooth the fluctuations, figures for 2001 and 2002 are averaged for the without the plan condition

(5) Only Benefits from irrigation development and land management are included in financial/economic evaluation.

(6) Rehabilitation will be completed in year 1 and full benefit will start from year 2.

### 4.3.3 FINANCIAL EVALUATION

The direct or tangible benefit to be expected in the plan area is derived from the increased crop production attributed to a stable irrigation water supply and proper land management, crop rotation, fertilizer application etc. The evaluation will be made through assessment of the project feasibility in view of financial and economic aspects. The financial viability of the project is found by estimating financial internal rate of returns (FIRR), benefit-cost ratio (B/C) and benefit minus cost (B-C) for the Case Study area. Sensitivity analysis is also made in order to elucidate the financial viability of the project against the changes in the rate of subsidy.

Financial viability of the project is evaluated in terms of Financial Internal Rate of Return (FIRR) and from the viewpoint of facility or service users. Costs and benefits are identified, valued and compared to see if the component of irrigation development and land management of the plan is viable.

(1) Direct Benefits from Rehabilitation of Irrigation Facilities and Land Management

Incremental net returns for each scenario are summarized below. The total incremental net return is 7,361 thousand SKK for Scenario-A, 4,509 thousand for Scenario-B and 3,015 for Scenario-C respectively.

Estimation of Incremental Net Returns (At Financial Prices)

(Unit:1,000 SKK)

| Site/Zone | Scenario-A | Scenario-B | Scenario-C |
|---|---|---|---|
| Site-A: Zone-II and III | 6,102 | 3,950 | 2,590 |
| Site-B: Zone-II | 1,259 | 559 | 425 |
| Total | 7,361 | 4,509 | 3,015 |

### (2) Costs

The plan broadly comprises repair cost and cost for sprinklers. As shown in the following Table, repair cost is estimated at, 6,721 thousand SKK for each scenario. The cost of sprinklers is estimated from 29,500 thousand SKK for Scenario A to 16,131 thousand SKK for Scenario C according to the level of irrigation development. In the evaluation, this cost was included in the irrigation cost of the crop budget by converting lease price.

Cost for Repair of Irrigation System

(Unit:1,000 SKK)

| Particulars | Scenario-A | Scenario-B | Scenario-C |
|---|---|---|---|
| Repair Cost | 6,721 | 6,721 | 6,721 |

Operation and maintenance costs of the irrigation system were counted in the water charge of the crop budget, and that of sprinkler equipment was counted in the irrigation cost of the crop budget.

### (3) Results of Financial Evaluation

Financial internal rate of return (FIRR) are calculated by the project cost and benefit valued at financial prices. The results of financial evaluation are shown in the following Table. As shown in the Table, FIRR for Scenarios-A, B and C is very high as 242%, 101% and 57.8% respectively. In the Case Study Site, the present irrigation facilities were completed before 1985 and the costs are estimated mainly for the rehabilitation of those facilities. For the plan evaluation, only future returns to future costs are considered and the sunk costs are ignored. So, the future returns to the costs are very high. In addition, the high subsidy to agricultural production, represented by support to irrigation water charge, also supports those high values of financial indexes.

Results of Financial Evaluation

| Particulars | Results | | |
|---|---|---|---|
| | Scenario-A | Scenario-B | Scenario-C |
| FIRR (%) | 242% | 101% | 57.8% |
| B/C Ratio | 8.62 | 5.28 | 3.53 |
| B-C (1000 SKK) | 46,534 | 26,143 | 15,459 |

(4) Sensitivity Analysis

In the Case Study Site, income from subsidy occupies 8% or 9% of gross income at present, and it will increase to 13% in Scenario A. A sensitivity analysis for the decrease of subsidy is made to evaluate the soundness of the plan. As shown in the following Tables, the elasticity of the plan feasibility even under 70% of current level of subsidy the incremental net return for Scenarios A, B and C and under 50% for Scenario A and B is more than 1,157 thousand SKK and FIRR is 16% and above. The analysis indicates that the plan is viable under the adverse case of decrease of subsidy.

Incremental Net Return with Different Subsidy Conditions

(Unit:1,000 SKK)

| Subsidy Level | Scenario-A | Scenario-B | Scenario-C |
|---|---|---|---|
| Current Condition | 7,361 | 4,510 | 3,016 |
| 70% of Current Level | 4,231 | 2,498 | 1,473 |
| 50% of Current Level | 2,144 | 1,157 | 444 |

FIRR under Different Subsidy Levels

| Particulars | 70% of Current Level | | | 50% of Current Level | | |
|---|---|---|---|---|---|---|
| | Scenario A | Scenario B | Scenario C | Scenario A | Scenario B | Scenario C |
| FIRR (%) | 91.9 | 45.4 | 23.3 | 37.5 | 16.7 | -0.6 |
| B/C Ratio | 4.95 | 2.92 | 1.72 | 2.51 | 1.35 | 0.52 |
| B-C (1,000 SKK) | 24,149 | 11,756 | 4,424 | 9,226 | 2,164 | -2,933 |

### 4.3.4 ECONOMIC EVALUATION

Economic analysis is conducted to examine the economic impact of the plan from the standpoint of a society's entire welfare. The economic viability of the plan is found by estimating economic internal rate of return (EIRR), benefit-cost ratio (B/C) and benefit minus cost (B-C) as described above in financial evaluation.

(1) Evaluation of Economic Factors

1) Conversion Factors for Agricultural Products and Inputs

Conversion Factors for fertilizers, chemicals, and seeds are estimated as 0.909 for fertilizer and chemicals and 0.907 for seeds. In order to evaluate project costs and benefits with respect to world market prices, a SCF of 0.985 is applied to the prices of non-traded goods and services. This figure is calculated on the basis of export and import statistics for the years 1996 to 2000. From the international economic point of view, the transfer payment such as value added taxes (VAT) and other taxes, subsidies, rents and interest are considered as domestic monetary movement without direct productivity. These transfer payments are excluded from the project costs and agricultural inputs/outputs in the economic evaluation.

2) Economic Farm-gate Prices of Agricultural Inputs and Outputs

Economic prices of farm inputs such as seeds, fertilizers and chemicals are calculated applying the above mentioned conversion factors. Financial prices of locally traded agricultural products such as carrot etc. are converted to economic prices using Standard Conversion Factor. Economic farm-gate prices of internationally traded agricultural products such as wheat, maize and barley, are estimated by the international prices.

(2) Economic Benefits

Economic benefits are calculated for the case Study Area according to soil quality and for irrigated and non-irrigated land respectively.

Estimation of Incremental Net Returns (At Economic Prices)

(Unit:1,000 SKK)

| Site/Zone | Scenario-A | Scenario-B | Scenario-C |
|---|---|---|---|
| Site-A: Zone-II and III | 1,832 | 744 | 573 |
| Site-B: Zone-II | 458 | 223 | 369 |
| Total | 2,290 | 967 | 942 |

### (3) Economic Costs

Economic cost for the plan is estimated at 5,627 thousand SKK. Tax amount (VAT 15%) is deducted from financial cost and a SCF of 0.985 is applied to convert financial cost to economic cost. The same figure is estimated for other scenarios also. Operation and maintenance costs are included in crop budget or in production costs and are not included in investment or capital costs.

### (4) Results of Economic Evaluation

Based on the project costs and benefits estimated above, the results of economic evaluation are summarized below. As the results show, the plan is economically feasible with EIRR, 50.9% for Scenario-A, 16.6% for Scenario-B and 16.0% for Scenario-C. For reference, the discount rate since April 2002 is fixed at 8.25% (National Bank of Slovakia).

Results of Economic Evaluation (EIRR)

| Particulars | Results | | |
|---|---|---|---|
| | Scenario-A | Scenario-B | Scenario-C |
| EIRR (%) | 50.9% | 16.6% | 16.0% |
| B/C Ratio | 3.20 | 1.35 | 1.32 |
| B-C (1000 SKK) | 11,258 | 1,802 | 1,621 |

## 4.3.5 EVALUATION OF INVESTMENT FOR SPRINKLER EQUIPMENT

As discussed above, the rehabilitation of irrigation facilities and land management proposed in the Guidelines was evaluated to be economically and financially feasible from the viewpoint of the irrigation system. On the other hand, farmers or farming bodies are required to prepare the field irrigation equipment by purchasing or leasing in order to develop irrigation farming on their fields. The financial feasibility of investment of farmers in equipment was assessed from the viewpoint of their budget. In the evaluation, the field of which the proposed crop sequence consists of target crops for irrigation is assessed in each scenario. The life of sprinkler equipment was assumed as 12 years.

Summary of Direct Benefit and Investment Cost

(Unit:1,000 SKK)

| Site | Scenario-A | Scenario-B | Scenario-C |
|---|---|---|---|
| Assessed field area (ha) | 1,073 | 769 | 150 |
| Estimation of incremental net returns at financial price* | 7,675 | 4,346 | 2,114 |
| Investment for sprinkler equipment under the condition of 70% of subsidy | 8,850 | 4,723 | 2,826 |
| Investment for sprinkler equipment under the condition of no subsidy obtained | 29,500 | 15,742 | 9,420 |

*: Cost of field irrigation equipment such as sprinkler is excluded from the crop.

The results of financial evaluation of investment for field irrigation equipment are shown in the following Table. FIRR for Scenarios-A, B and C is very high as 152%, 168% and 117% respectively under the condition of 70% subsidy for purchasing field equipment were obtained. Even the subsidy for equipment was not obtained due to the limitation of governmental budget, FIRR would decrease but they are still at the level of 22% ~ 30%.

Results of Financial Evaluation

| Particulars | Results | | |
|---|---|---|---|
| | Scenario-A | Scenario-B | Scenario-C |
| In case 70% subsidy for equipment obtained | | | |
| FIRR (%) | 152% | 168% | 117% |
| B/C Ratio | 5.92 | 6.17 | 4.88 |
| B-C (1000 SKK) | 40,573 | 23,155 | 10,688 |
| In case no subsidy obtained for equipment | | | |
| FIRR (%) | 27.8% | 30.0% | 22.1% |
| B/C Ratio | 1.81 | 1.91 | 1.54 |
| B-C (1000 SKK) | 21,800 | 13,137 | 4,693 |

### 4.3.6 EXAMINATION OF IRRIGATION RECOVERY PLAN IN VARIOUS FACILITY CONDITIONS

The financial and economic viability of irrigation recovery was assessed in various assumed conditions of facilities. The following conditions were given to the irrigation system of the case study area in this assessment:

1) Current condition of the system in the case study area (the original case)
2) Assumption that the condition is on the average level of facilities categorized to Category-I
3) Assumption that the condition is on the average level of facilities categorized to Category-I to Category-II
4) Assumption that the condition is on the average level of facilities categorized to Category-I to Category-III
5) Assumption that the condition is on the average level of facilities categorized to Category-I to Category-IV

As a result of the financial evaluation, more than 17% of FIRR and more than 1.4 of B/C were given to facilities in Category-I to Category-IV in Scenario A and B and to facilities in Category-I to Category-III in Scenario C. On the contrary, the recovery of facilities in Category-I to Category-IV in Scenario C gave less than 1.0 of B/C. As a result of the economic evaluation, more than 15% of EIRR and 1.3 of B/C were given to facilities in Category-I to Category-III in Scenario A, and only facilities in Category-I gave more than 1.0 of B/C in Scenario B and C.

Under the assumption that the economic and financial viability of the irrigation recovery in the Study Area can be represented by those of the case study area, the following conclusion can be arrived at; The irrigation systems categorized in Category-I to III are economically and financially feasible to be recovered if the amount of water use reaches the level set in Scenario A. On the contrary, if the amount of water use reaches only to the level set in Scenario B or C, only facilities in Category-I will be feasible and other facilities would not be recovered from the aspect of economic effect.

Results of Financial and Economic Evaluation in Various Facility Conditions

Financial Evaluation

| Conditions of facilites | Recovery cost | Scenario A | | | Scenario B | | | Scenrio C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | FIRR | B/C | B-C | FIRR | B/C | B-C | FIRR | B/C | B-C |
| | (1,000S KK) | (%) | | (1,000S KK) | (%) | | (1,000S KK) | (%) | | (1,000S KK) |
| Original case | 6,721 | 242.1% | 8.62 | 46,533 | 101.0% | 5.28 | 26,142 | 57.8% | 3.53 | 15,458 |
| Category I | 7,728 | 181.9% | 7.49 | 45,618 | 82.4% | 4.59 | 25,227 | 48.3% | 3.07 | 14,542 |
| Category I-II | 12,743 | 81.2% | 4.54 | 41,059 | 42.7% | 2.78 | 20,668 | 25.8% | 1.86 | 9,983 |
| Category I-III | 17,033 | 55.0% | 3.40 | 37,159 | 29.7% | 2.08 | 16,768 | 17.4% | 1.39 | 6,083 |
| Category I-IV | 25,263 | 33.5% | 2.29 | 29,677 | 17.6% | 1.40 | 9,286 | 8.8% | 0.94 | -1,399 |

Economic Evaluation

| Conditions of facilites | Recovery cost | Scenario A | | | Scenario B | | | Scenrio C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | FIRR | B/C | B-C | FIRR | B/C | B-C | FIRR | B/C | B-C |
| | (万S KK) | (%) | | (1,000S KK) | (%) | | (1,000S KK) | (%) | | (1,000S KK) |
| Original case | 5,627 | 50.9% | 3.20 | 11,258 | 16.6% | 1.35 | 1,802 | 16.0% | 1.32 | 1,621 |
| Category I | 6,470 | 42.7% | 2.78 | 10,491 | 13.4% | 1.18 | 1,036 | 12.8% | 1.15 | 855 |
| Category I-II | 10,669 | 22.7% | 1.69 | 6,674 | 4.0% | 0.71 | -2,781 | 3.6% | 0.69 | -2,962 |
| Category I-III | 14,261 | 15.0% | 1.26 | 3,409 | -0.2% | 0.53 | -6,047 | -0.6% | 0.52 | -6,228 |
| Category I-IV | 21,152 | 7.0% | 0.85 | -2,856 | -5.2% | 0.36 | -12,311 | -5.5% | 0.35 | -12,492 |

## 4.4 CONCLUSION OF CASE STUDY

### (1) Land Use Conversion and Sustainability of Farmland Use

As a result of the land use evaluation, around 110 ha of currently cultivated land is recommended to convert to grassland. The area occupies 5% of agricultural land in the case study area and it is possible to realize the conversion without severe change of agricultural production in the area. The land use conversion of arable land to grassland does not have economic advantage to farming bodies but there is an advantage in the aspects of sustainability of land use and protection of natural resources. In accordance with the results of the case study, the crop budget of artificial grassland shows 566 SKK/year of loss without subsidy and it reaches to break-even point if subsidy for grassland promotion could be received. Thus, it is necessary to operate the subsidy system for the grassland appropriately in order to promote land use conversion and secure its sustainability.

### (2) Promotion of Irrigation Farming

<Importance of Contract Farming in Marketing>

The major target crops of irrigation farming in the proposed agriculture in the case study are vegetables, oil crops and raw material crops. Securing marketing channels is an indispensable factor for promoting the above crops. In the case study area, contract farming with a food processing factory or traders is popular in oil crops and raw material crops at the moment. Contract farming of vegetables is starting and is expected to expand. The expansion of contract farming is considered as a key factor to promote irrigation farming.

<Economic Viability of Irrigation Recovery in the Case Study Site>

The recovery of the irrigation system in the case study area has an advantage of cost effectiveness because it is possible to recover and maintain its function with relatively low cost owing to the good present condition. As a result of economic evaluation in the case study, the irrigation recovery plan of Scenario A marked 50.9% of EIRR, and more than 16% of that in Scenario B and C. The expected net return per hectare increases from 2,547 SKK/ha at present to 3,852 ~ 5,734 SKK/ha in the Scenarios. A large amount of economic effect is expected by implementing the irrigation recovery plan from both viewpoints of farmers/farming bodies and regional economy. Immediate implementation of irrigation recovery is recommended.

<Increase of Farming Cost and Problem of Financing>

For the farmers/farming body side, they have to prepare higher farming funds because farming cost will increase significantly in irrigation farming in addition to the necessary investment in the field irrigation equipment. The average farming costs are expected to increase to 1.5 times the current one in Scenario A according to the increase of irrigation farming, 1.3 times in Scenario B and 1.2 times in Scenario C, in accordance with the results of the case study. Farmers/farming bodies might meet some problems in financing and taking farming fund due to the increase of farming cost. From the viewpoint of financing, contract farming becomes more important by lightening the load of farmers/farming bodies through support of agricultural input, equipment and financing.

<Necessity of Reviewing System of Irrigation Water Charge in Future>

The expansion of irrigation farming causes an increase in amount of governmental subsidy and dependence of the farming budget on subsidy. The increase is mainly in the subsidy to water charge. The system of water charges for the high rate of irrigation usage, including the price system of water and the share of the user's burden, is to be examined.

<Irrigation Recovery Plan and Necessity of Rotation Irrigation>

The existing irrigation system in the case study area has a capacity of water supply for irrigation farming assumed in the scenarios if the system is recovered by minor rehabilitation. In the Scenario B and C, the capacity of the system is enough and the system is able to cope with small intensive irrigation, of which the irrigation area is 41% and 19% of the whole system respectively and the peak discharge is 89% and 37% of the capacity. However, the irrigation in Scenario A is planned to cover 87% of the area and the peak discharge will reach 100% of capacity. Thus, it is necessary to introduce rotation irrigation sequence, which requires adequate coordination of water users. SWME-ID and water companies, who are responsible for irrigation water management, are required to organize water users and enhance the capability of coordination between water users.

After irrigation farming is introduced widely and has become used constantly at the level of Scenario A, it is expected that the demand of water users for flexibility of field irrigation will rise with the next step in expansion of irrigation. Management of water facilities to allow for flexible water use in the field such as use of farm ponds will be expected to be introduced.

<Economic Viability of Irrigation Recovery in Study Area>

As a result of the case study, more than 15% of EIRR and 1.3 of B/C were given to the irrigation recovery of facilities in Category-I to Category-III in Scenario A, and only facilities in Category-I gave more than 1.0 of B/C in Scenario B and C. Under the assumption that the economic and financial viability of the irrigation recovery in the Study Area can be represented by those of the case study area, the following conclusion can be reached; The irrigation systems in Category-I to III are economically and financially feasible to recover if the amount of water use reached will be at the level set in Scenario A. On the contrary, if the amount of water use only reaches the level set in Scenario B or C, only facilities in Category-I are feasible and other facilities would not to be recovered from the aspect of economic effect.

(3) Dependence of Regional Agriculture on Governmental Subsidy

The high dependence of the farming budget on the governmental subsidy is pointed as a character of the regional agriculture. The income from subsidy occupies 8~9% of the gross income, which is equal to more than 70% of net return, in the case study area at present. The proposed soil and water management plan is aiming to improve the farm management through increasing and stabilizing the profit by expansion of irrigation farming. The expansion of irrigation farming, which requires high amounts of subsidy, increases the dependence of regional agriculture on the governmental subsidy. Thus, the ratio of subsidy to gross income and net return increases to 13% in Scenario A, which expects the maximum expansion of irrigation farming, the ratio remains at the present level in Scenarios B and C. The amount of subsidy increases in all scenarios.

The area is distinguished as a disadvantaged agricultural area in which soil is dominated by low fertility sandy soil. The support by governmental subsidy is indispensable to the promotion of agriculture and sustainable land use and the protection of natural resources. Even though a drastic change is expected in the subsidy system owing to joining the EU in 2004, it is expected that the subsidy for the disadvantaged agricultural land will be held fast and the amount of agricultural subsidy will increase even after joining the EU. Based on this understanding, it is considered that the agricultural promotion premising the dependence on the subsidy at the present level is realistic.

### (4) Consideration of Gardening Activity

Another important activity of agriculture other than enterprise farming is gardening activity. As a result of the rural survey, the gardening activity of inhabitants provides not only a supplementary income to the family budget but also forms a valuable aspect of their lives. In addition, it is indispensable for the sustainable development of rural society which is full of vitality because the villages include gardening activity as an important component of rural life. The Guidelines aim to contribute to the regional economy and the rural community and livelihood through improving and promoting enterprise farming. In order to maintain rural community and livelihood, it is necessary to consider the promotion of gardening activity in agricultural and rural development in addition to the promotion of enterprise farming.