Conservation agriculture as a tool against soil degradation and for improving biodiversity

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Introduction

- The share of agricultural area in the world is 37.3% and in Europe it is 43.6%
- Conventional agriculture is based on tillage and it is highly mechanized
- Cultivation is performed by inverting the soil using the plough or similar tools
- Conventional agriculture causes severe land degradation problems including soil erosion and pollution as well as other environmental damages like biodiversity and wildlife reduction, low energy efficiency and a contribution to global warming (Boatman et al. 1999)

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- ***Conservation Tillage (CT)*** is understood as tillage practices specifically intended to reduce soil disturbance during seedbed preparation. Conservation tillage encompasses a range of tillage practices up to and including „Zero (no) Tillage”

- ***Conservation Agriculture (CA)*** is a holistic approach to crop production, which encompasses „Conservation Tillage”, and also seeks to preserve biodiversity in terms of both flora and fauna. Activities such as Integrated Crop, Weed, and Pest Management form part of Conservation Agriculture. The concept of „As little as possible, as much as is needed”.

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Sustainable Land Management (SLM). This is one step beyond „Conservation Agriculture” and includes other „non-crop” activities used to promote biodiversity (landscape) historic character in the wider „farmed” landscape. CA is practised on 45 million ha worldwide.

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Conservation agriculture in Europe

- Slower development than in N and S America, S Africa, Australia, because:
  - Production costs are less important then elsewhere
  - Technology and technology transfer problems
  - Lack of institutional support
  - Soil degradation is only recently considered to be a major problem
  - In Europe water erosion endangers 12% of the total land area and wind erosion 4%, 16% of the cultivated land is prone to different kinds of soil degradation

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Estimation of surface under Conservation Agriculture and Direct Drilling in different European Countries (data obtained from ECAF National Associations)

	Surface under Conservation Agriculture	% Agrarian Surface	Surface under No-Till	% Agrarian Surface
Belgium	140.000	10%		
Ireland	10.000	4%	100	0,3%
Slovakia	140.000	10%	10.000	1%
Switzerland	120.000	40%	9.000	3%
France	3.000.000	17%	150.000	0,3%
Germany	2.375.000	20%	354.150	3%
Portugal	39.000	1,3%	25.000	0,8%
Denmark	230.000	8%		
United Kingdom	1.440.000	30%	24.000	1%
Spain	2.000.000	14%	300.000	2%
Hungary	500.000	10%	8.000	0%
Italy	560.000	6%	80.000	1%
TOTAL	**10.054.000**		**960.250**	

Arguments against CT

- Without ploughing no good job
- Weed problems
- Straw and stubble have to be removed
- Increased risk of fusarium
- Not good for the soil
- Poor germination
- Machinery not available

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Benefits for the soil

- The main benefit of CT is that the soil will be preserved more or less in semi-natural conditions as soil disturbance by cultivation is minimized and physical and chemical depletion are reduced.

- Soil structure remains very good with drainage, porosity, adsorption capacity and structural stability (Lavier et al. 1997).

- Compaction and loss of soil structure can be stopped or reduced by applying CT as well, since there is less traffic on the field and crop residues will not be buried in the soil.

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- OM remains in the soil. Organic matter influences soil structure, soil stability, buffering capacity, water retention, biological activity and nutrient balance, all of these determining erosion risk as well (Holland 2004).
- Under conventional tillage 50% of soil C may be lost
- Under CT crop residues remain on the soil surface
- Not equally beneficial for every soil type

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Environmental benefits

- On-site and off-site effects, local, regional and global effects
- Global aspects
  - reduced energy consumption and CO_2 emission
  - promotes carbon sequestration in the soil
  - reduced mechanical activity – less SO_2 emissions, reduced acidification
  - biodiversity: better nesting sites and food supplies
  - reduced air pollution
- Nutrients under conventional agriculture → fertilizers → eutrophication
- after long-term CT phosphate can accumulate → different fertilizer application techniques are needed

Effect of tillage on soil erosion and diffuse pollution (source: Jordan et al., 2000)

Measurements	Plough	Non-inversion tillage	Benefit compared to ploughing
Runoff ($l\ ha^{-1}$)	213,328	110,275	48% reduction
Sediment loss ($kg\ ha^{-1}$)	2045	649	68% reduction
Total P loss ($kg\ P\ ha^{-1}$)	2.2	0.4	81% reduction
Available P loss	3×10^{-2}	8×10^{-3}	73% reduction
TON ($mg\ N\ s^{-1}$)	1.28	0.08	94% reduction
Soluble phosphate ($\mu g\ P\ s^{-1}$)	0.72	0.16	78% reduction
Isoproturon	$0.011\ \mu g\ s^{-1}$	Not detected	100% reduction

Comparison of herbicide and nutrient emissions from 1991 to 1993 on a silty clay loam soil. Plots 12 m wide were established and sown with winter oats in 1991 followed by winter wheat and winter beans.

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Environmental benefits 2

- CT may reduce runoff 15-89% and the pollutants in runoff, it has a positive influence on leaching as well
- there is an indirect positive affect on acquatic ecosystems
- soil biodiversity
- higher bird, small mammal and game population

The SOWAP project

- A demonstration project started in 2003, supported by the EU LIFE Programme
- 3 years, 4 million €, co-funded by EU LIFE & Syngenta
- **SOWAP (SOil and WAter Protection)** aims to assess the viability of a more “conservation-oriented” agriculture, where fewer tillage practices replace the numerous cultivations carried out under more “conventional” arable farming systems. The use of appropriate chemicals is tested, and their potential for off-site contamination assessed, to ensure that any suggested approaches are environmentally sound.

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- The main study topics of the project are as follows:

(1) **Soil erosion** studies are based on erosion plots, which are used to compare conventional, farmer and SOWAP practice and to measure sediment, pesticide and nutrient loss and runoff from these systems.

(2) **Aquatic Ecology** studies are an important part of the ecology – environment block of SOWAP. Soil disturbance produced by tillage creates high runoff rates and silty water that drains into streams, ditches and ponds. This results in reduced water clarity, enhanced levels of nutrients, organics, pesticides and silty bottom sediments. SOWAP will study the effects of „conservation" tillage on stream biodiversity (fish, invertebrates and plants) water chemistry and sediment loading.

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(3) **Biodiversity – Birds and Terrestrial Ecology**

Key biological indicators will assess the impacts of differing land management practices on ecosystem sustainability. Counts of foraging farmland birds in winter and in the breeding season will be undertaken. Of particular interest is the comparison of UK agriculture with the currently, lower intensity agriculture of Hungary. The abundance and availability of seed and invertebrate food resources will also be assessed. Earthworm numbers will be important indicators of soil „health”.

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(4) **Soil Microbiology**

The soil microbiology component of the project will complement the physical and chemical 33 measurements of soil undertaken in the erosion topic by monitoring biological indicators. The work will involve micro and macro biological survey recording indicator species and communities/populations thereby indicating levels of bio-diversity in the soil. Details on microbial biomass and community structure and function will add to the complex picture of biological activity in the soil under the different management regimes.

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(5) **Agronomy**

Changes in the way crops grow and are grown in response to different soil management regimes are important to understand and disseminate. To facilitate this understanding, various assessments e.g. crop cover, date of emergence, disease prevalence, weed incidence will be made during the season and over the three year duration of the project, thereby taking into account the farm's crop rotation.

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(6) **Economics**

The economic viability of the practices employed will be key to their successful uptake by farmers inside and outside the project. Project farmers will be encouraged to keep farming calendars throughout the project duration, noting economic inputs (costs of land preparation, treatment application, cultivations and management practice, harvesting costs, marketing costs, transport, variable and fixed costs, gross margins) and outputs (yields).

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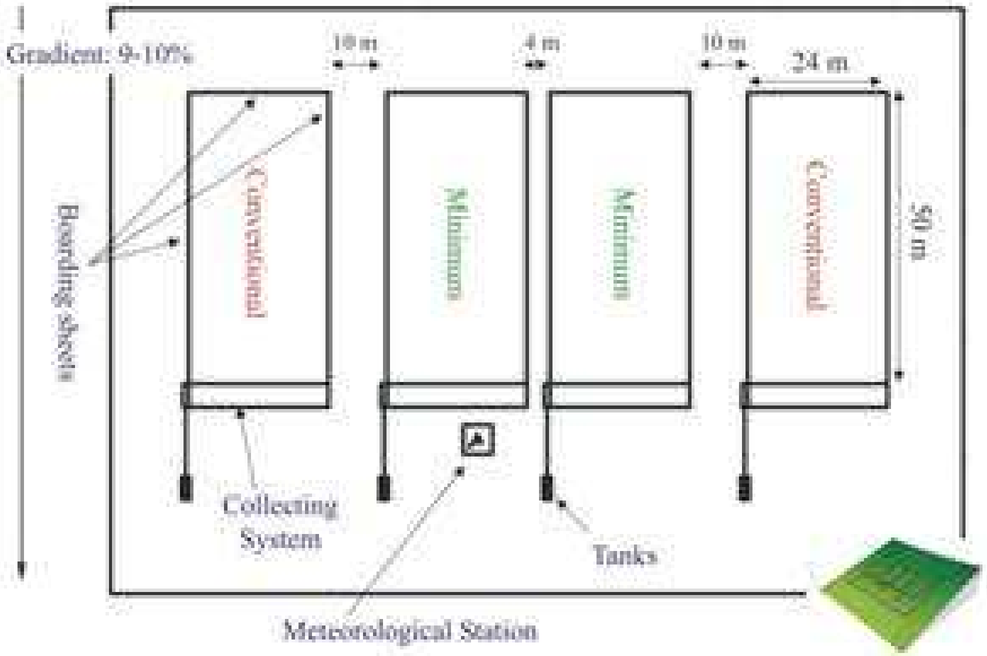
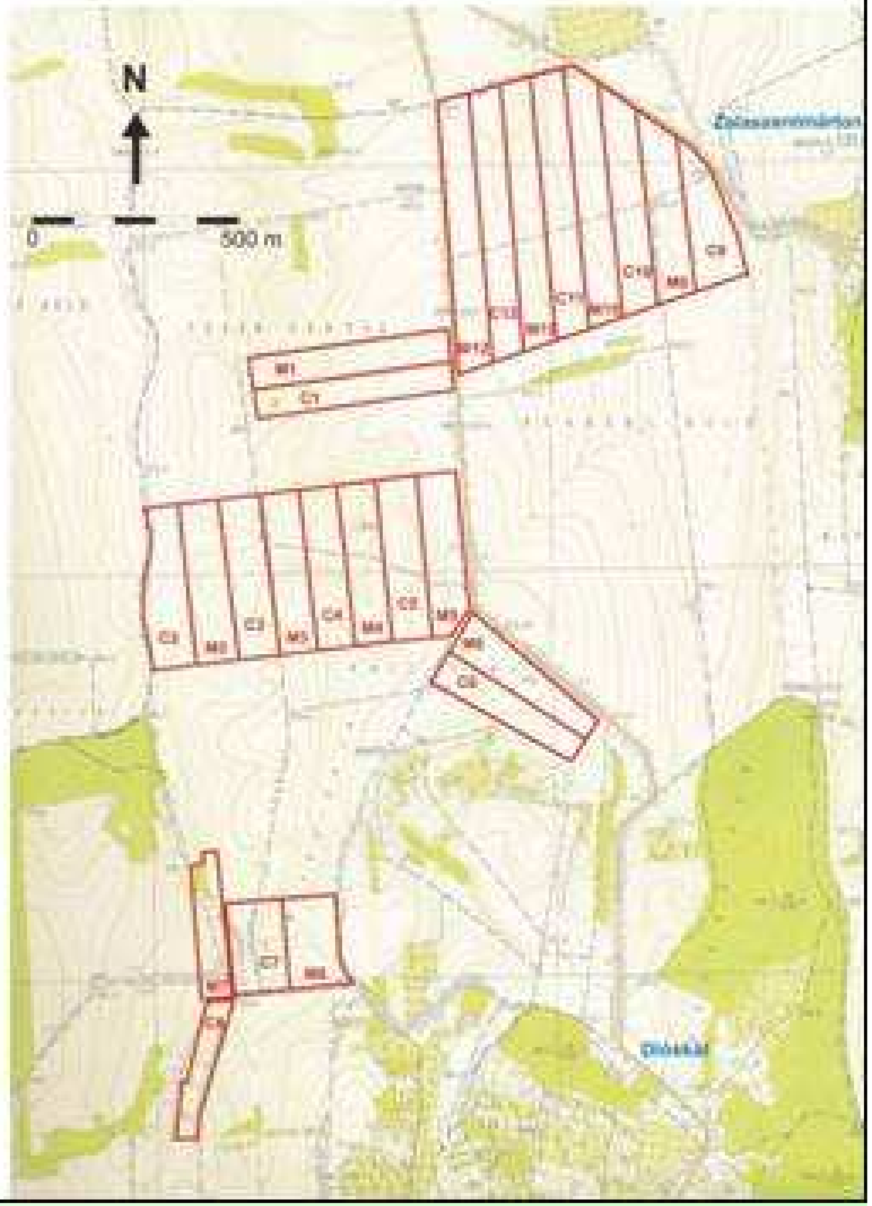
SLOVAKIA
UKRAINE
AUSTRIA
Danube
Miskolc
Nyíregyháza
Györ
BUDAPEST
Debrecen
Szombathely
Székesfehérvár
Szentgyörgyvár
Dunaújváros
ROMANIA
Kecskemét
Balaton
SLOVENIA
Dióskál
Danube
Szeged
0
40
80 km
0
40
80 mi
Pécs
CROATIA
Serbia

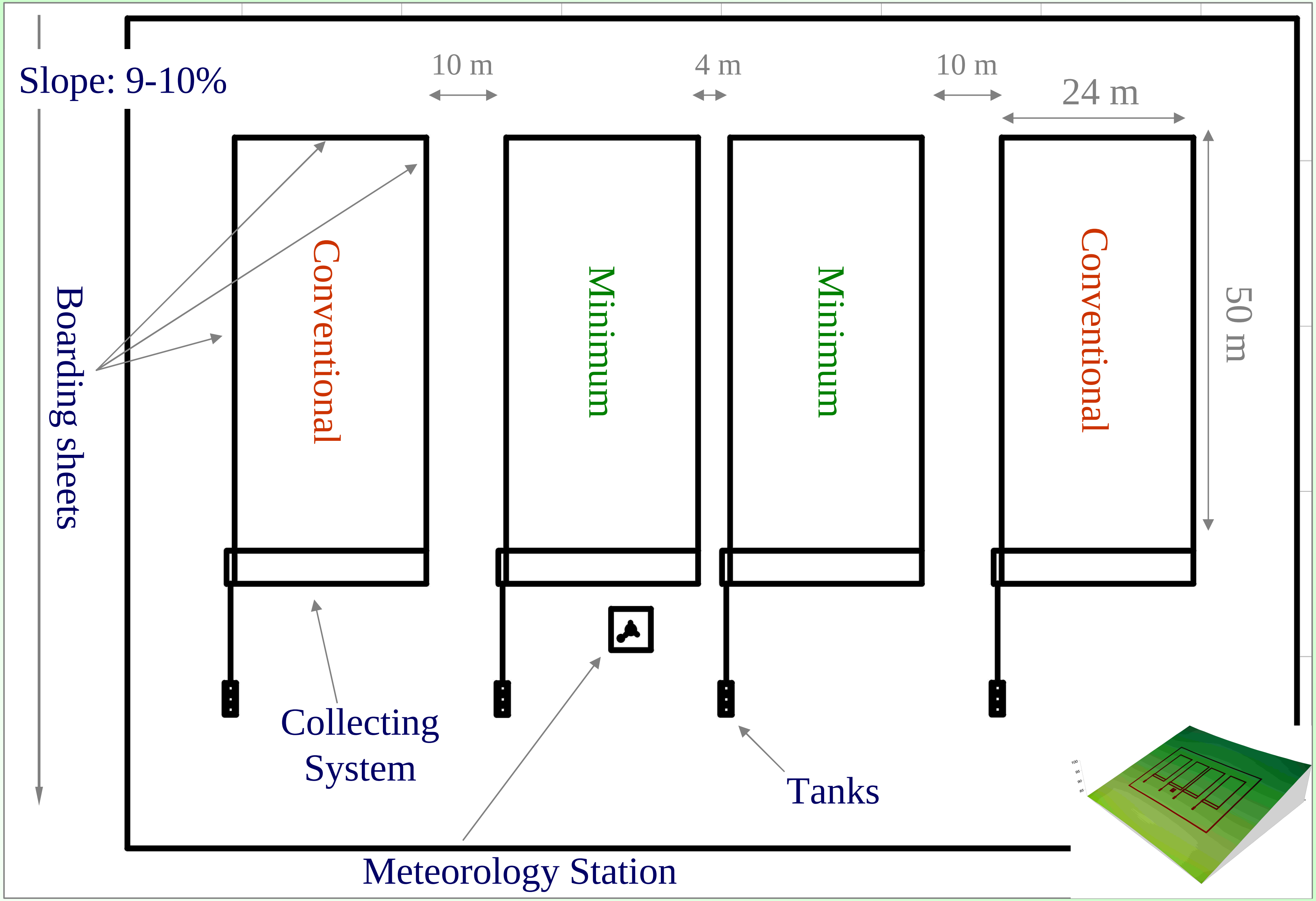
Sketch of the Szentgyorgyvar Site



Plots at Dioskal



Sketch of St. George (Szentgyörgyvár) Site

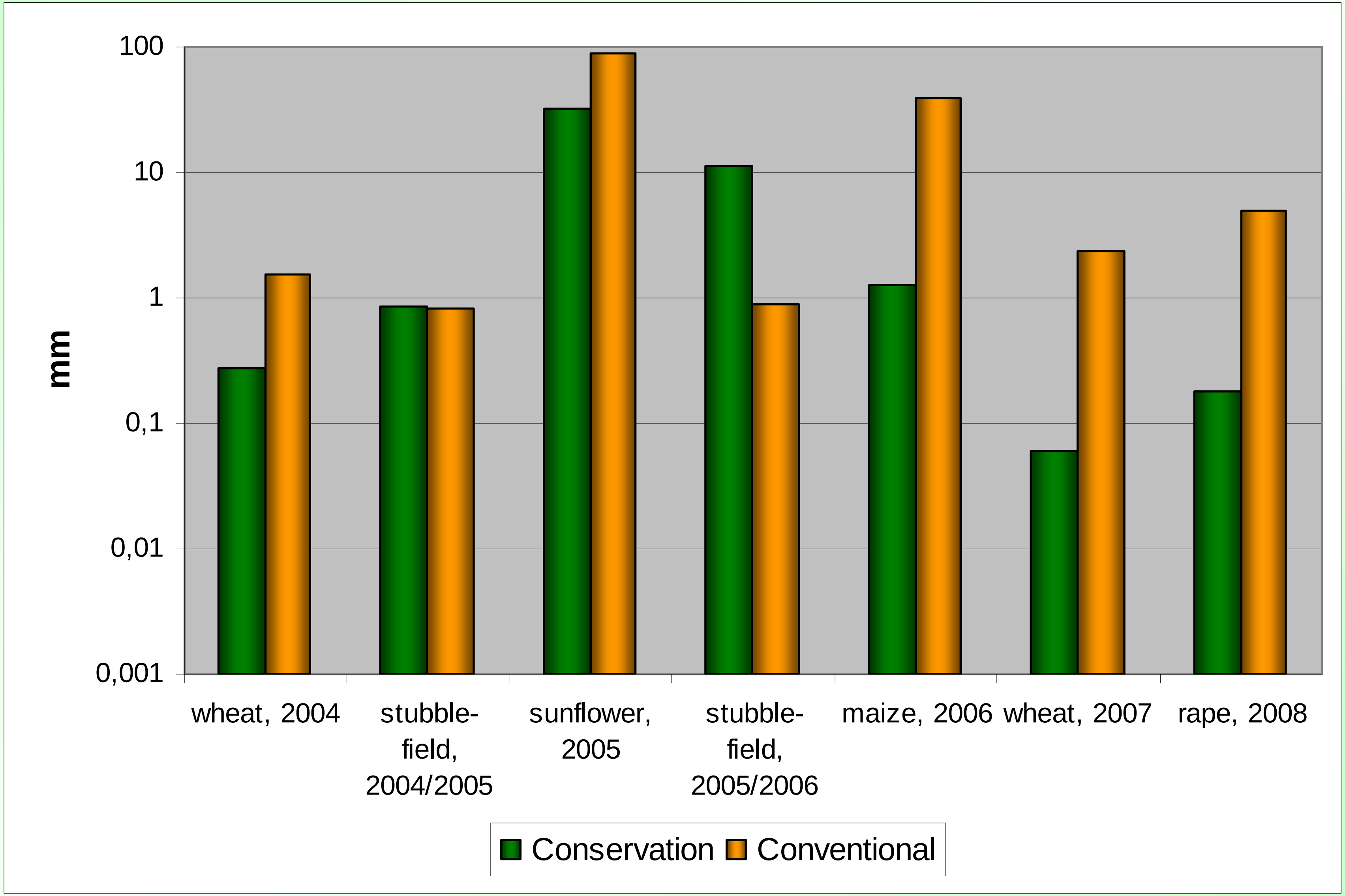



XTRA-VATOR
FORD

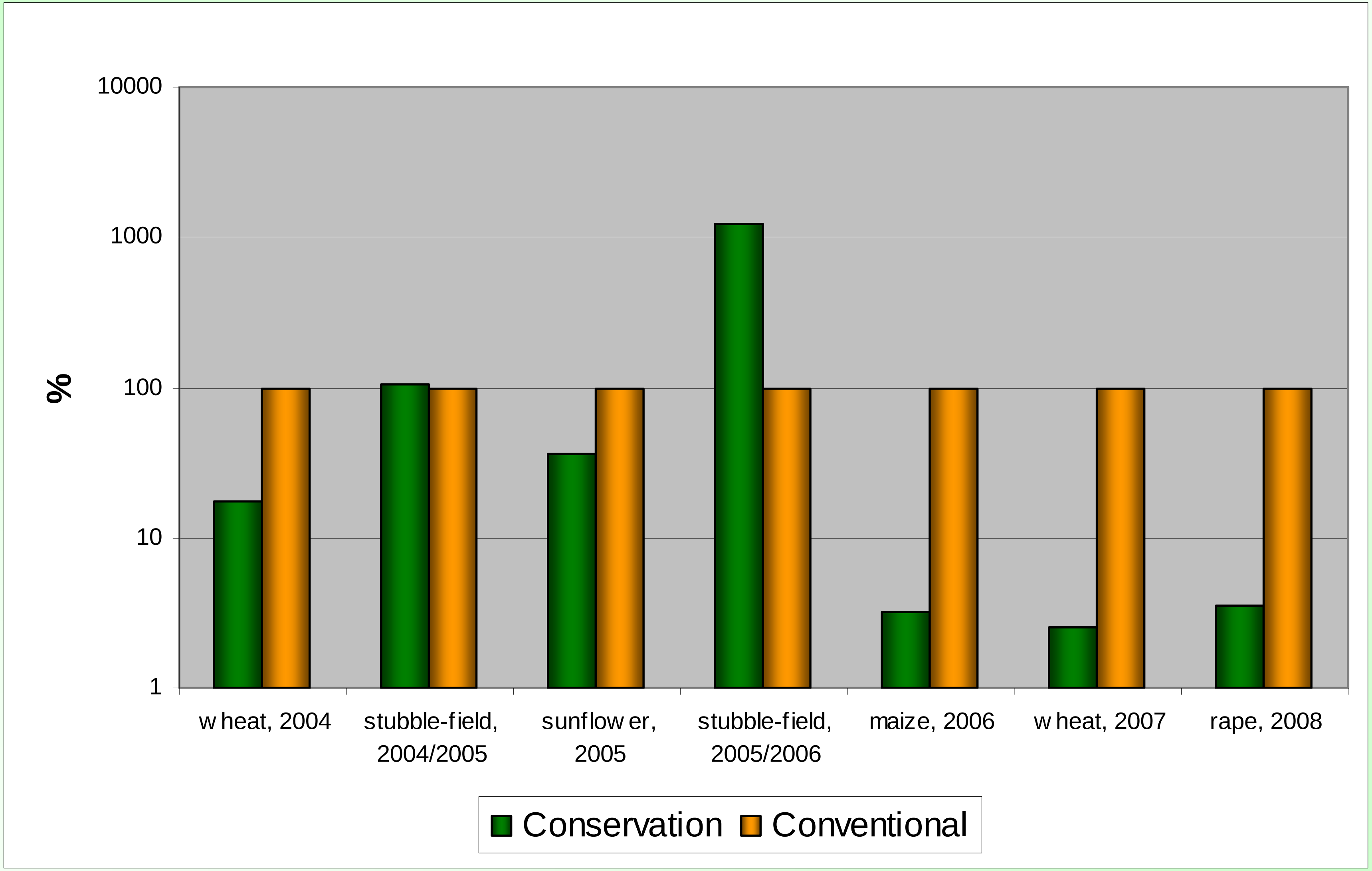
Conventional

Minimum

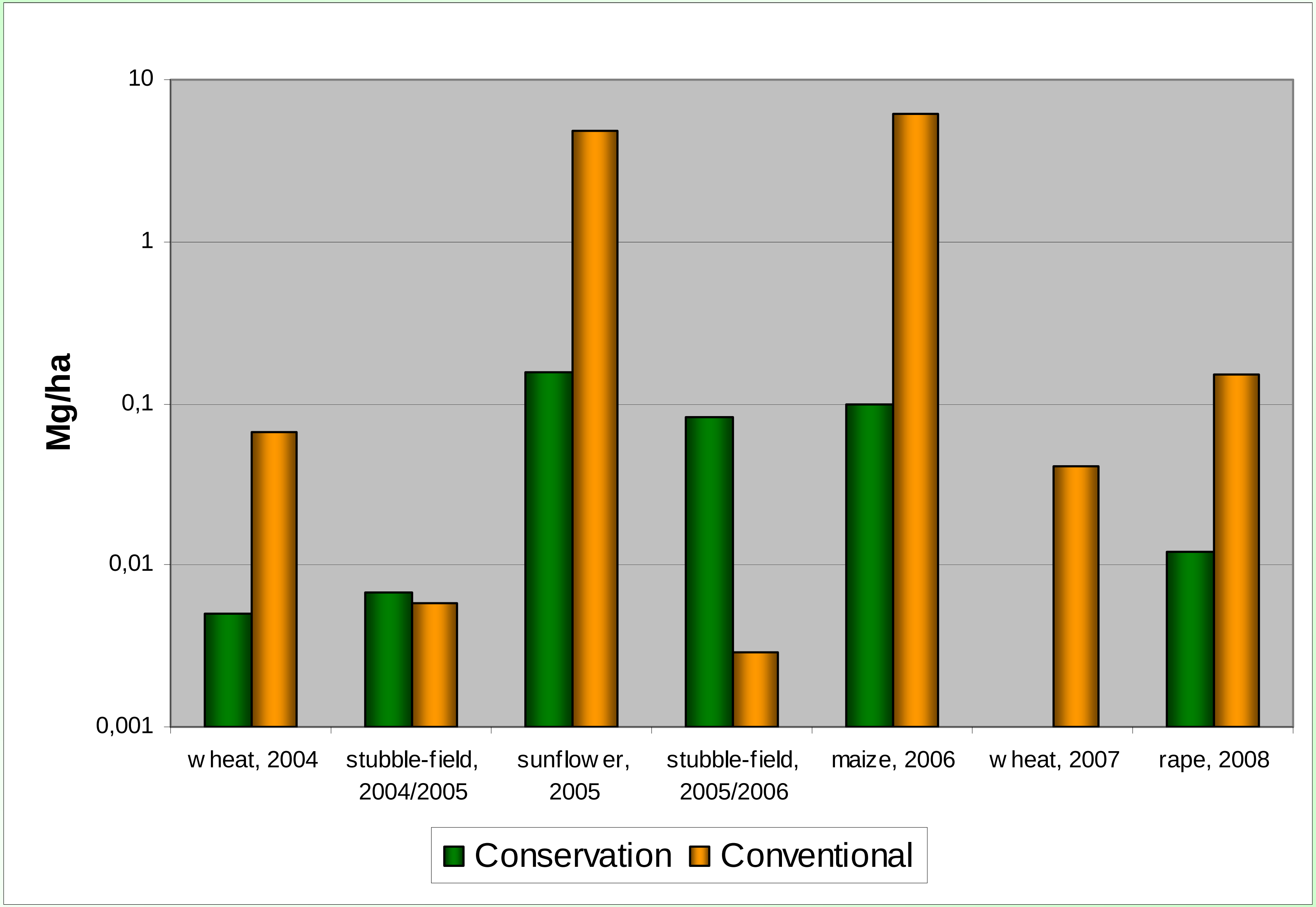
Total amount of runoff
(Szentgyörgyvár experimental plots, 2004-2008)



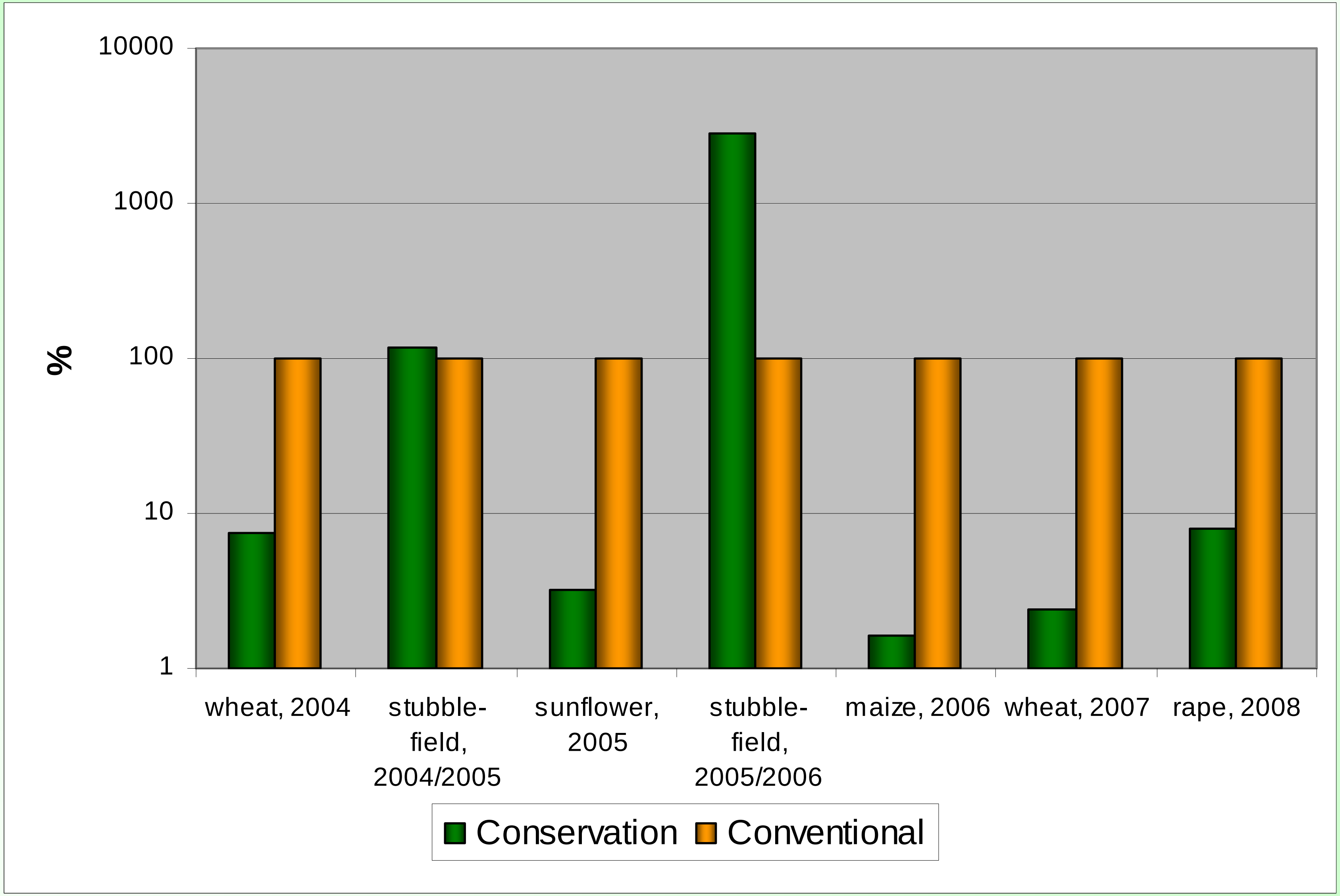
Runoff from conservation and conventional plots given as the percentage of runoff from conventional plots



Total amount of soil loss
(Szentgyörgyvár experimental plots, 2004-2008)



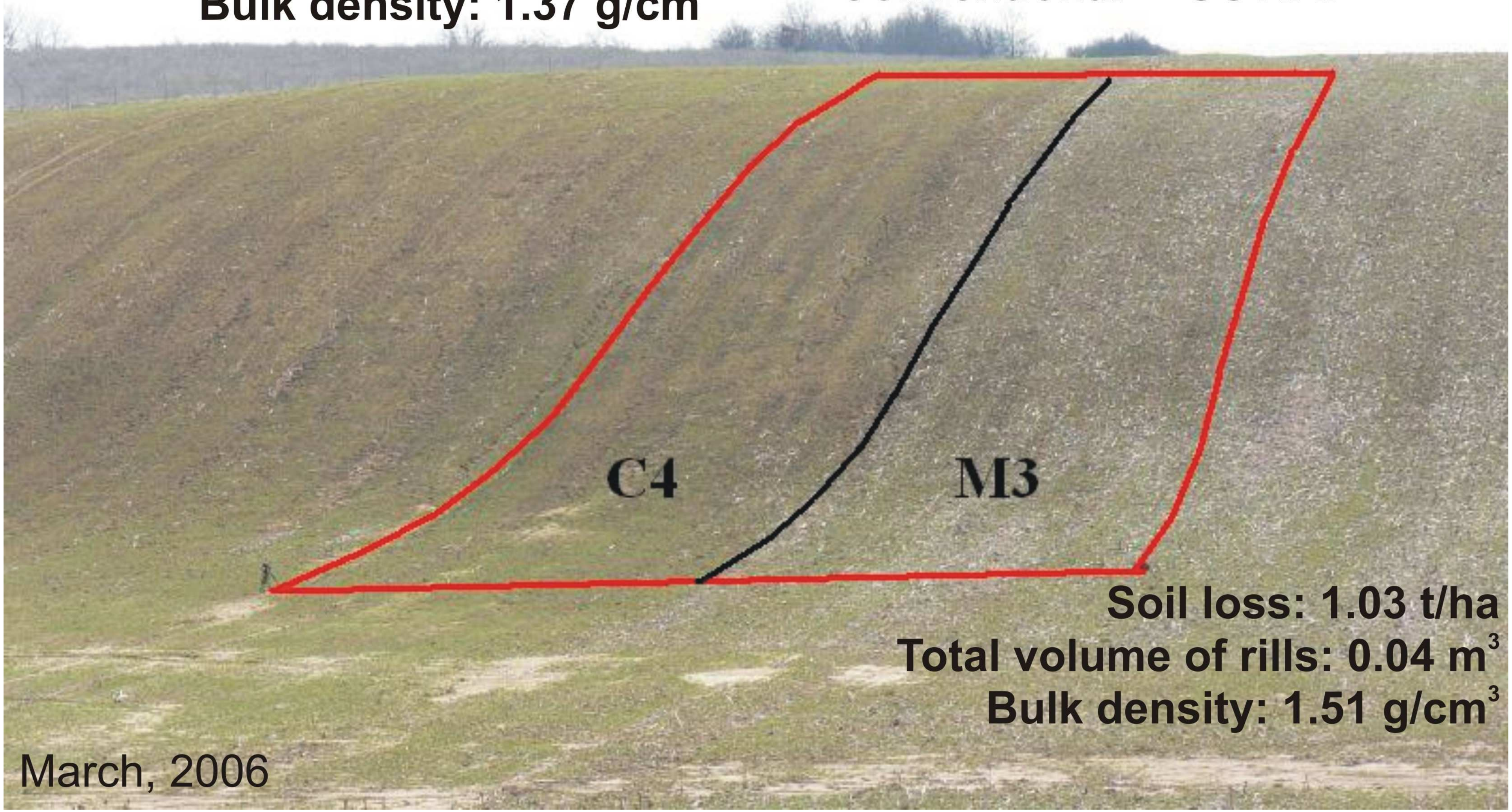
Soil loss from conservation and conventional plots given as the percentage of soil loss from conventional plots



Dióskál 1, Hungary

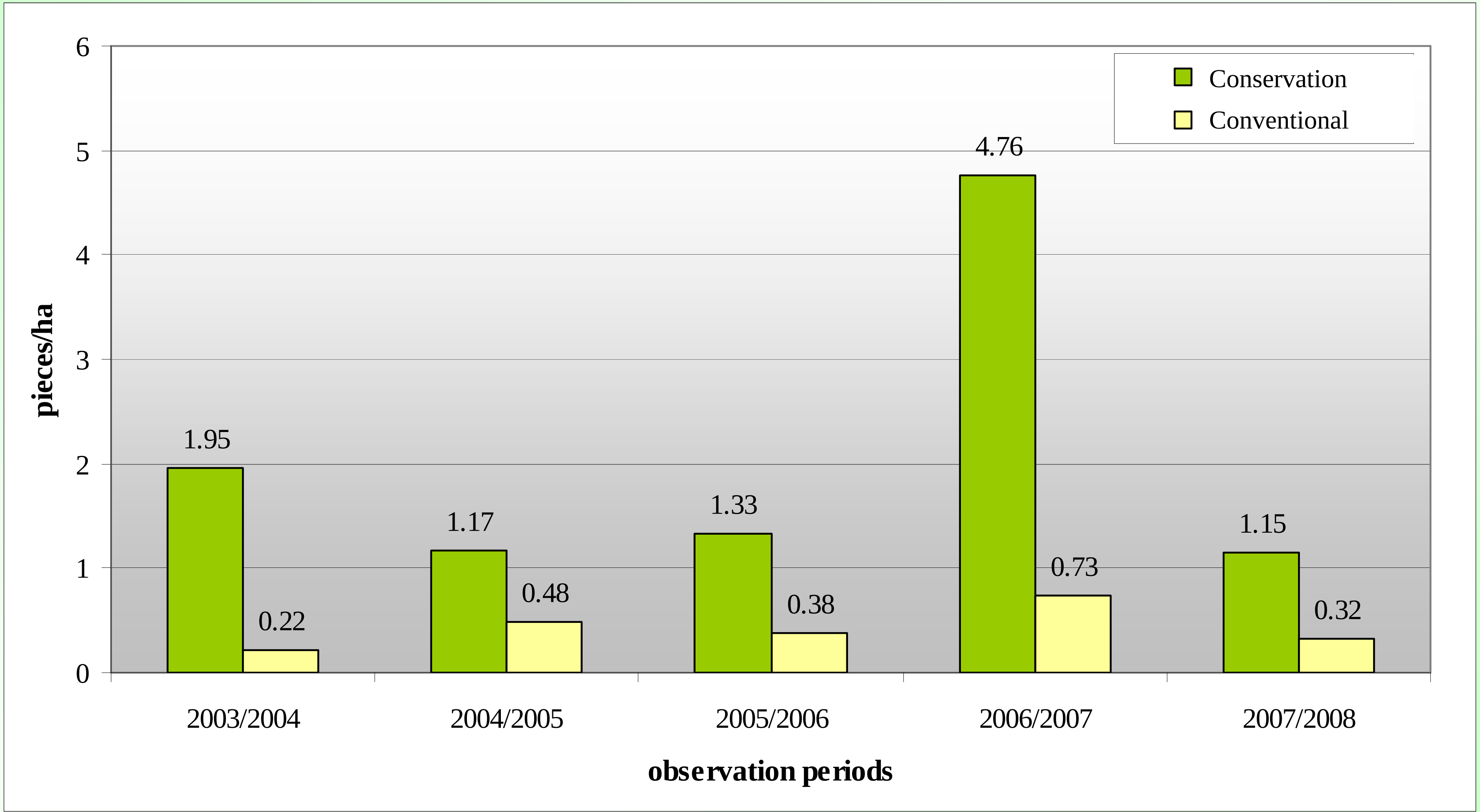
Soil loss: 17.31 t/ha
Total volume of rills: 0.33 m^3
Bulk density: 1.37 g/cm^3

Conventional SOWAP

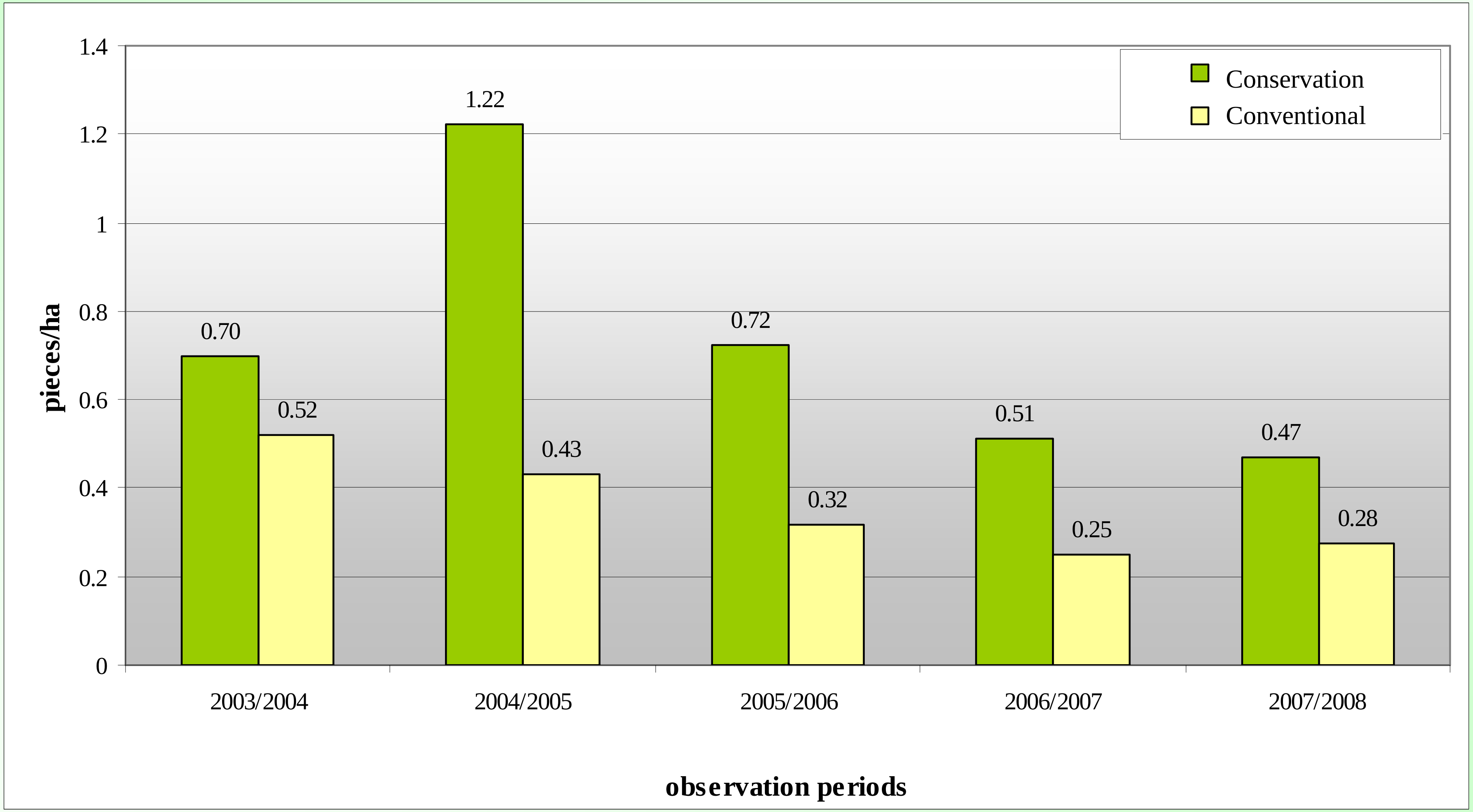


Cultivation

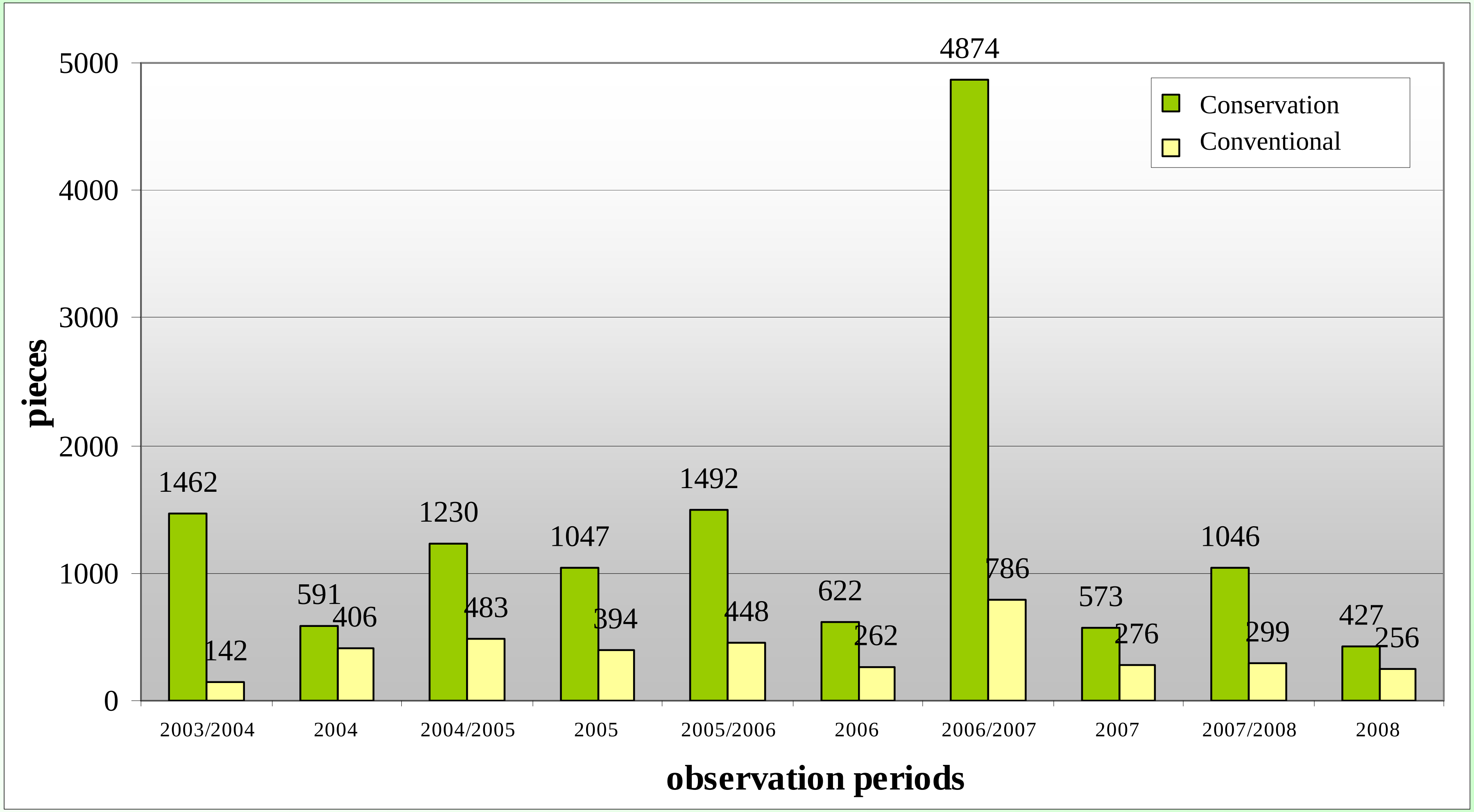
Number of birds per hectare during the winter observation periods in 2003-2008 presented by tillage types. The goose species and the starling were skipped.



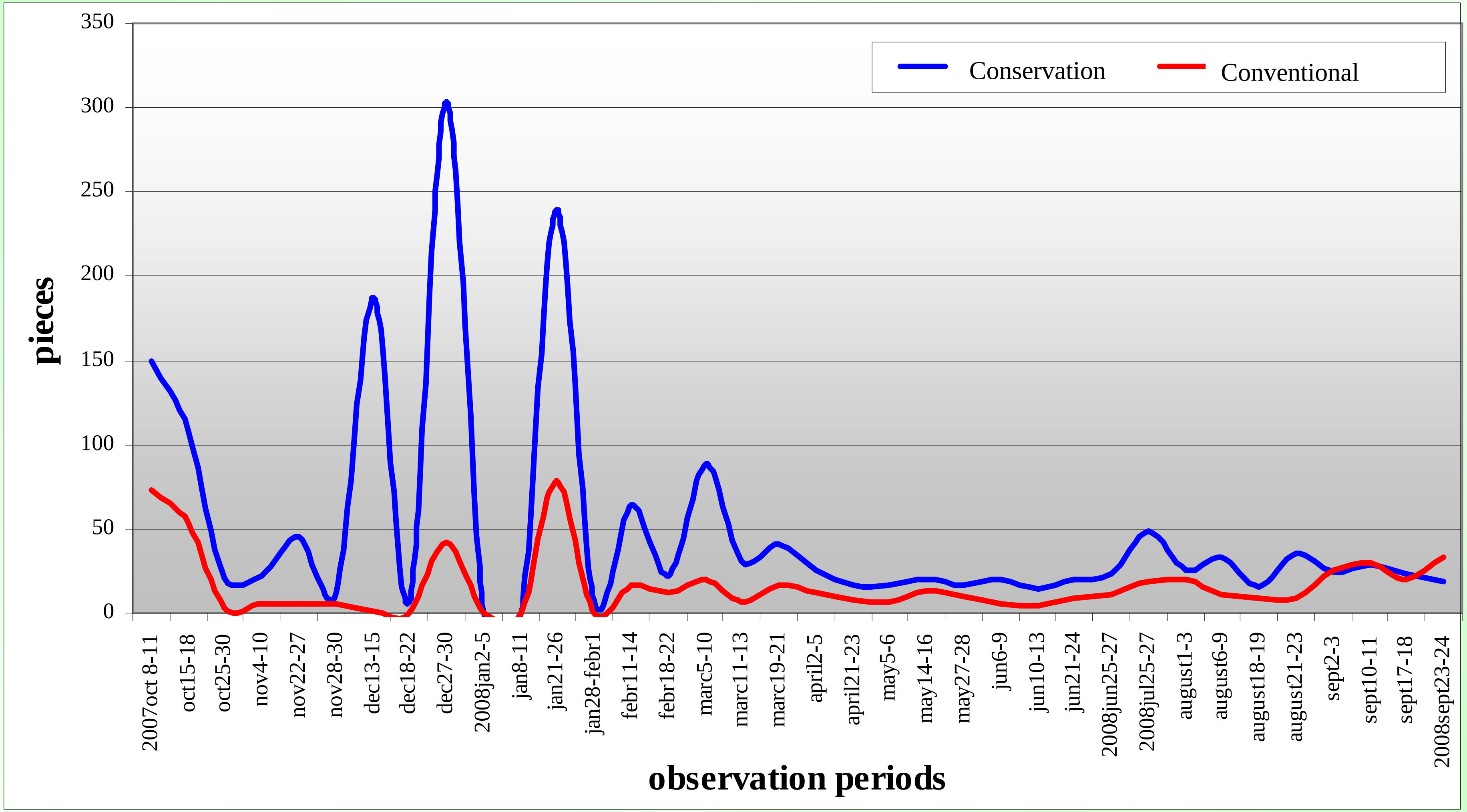
Number of birds per hectare during the summer observation periods in 2003-2008 presented by tillage types. The starling was skipped.



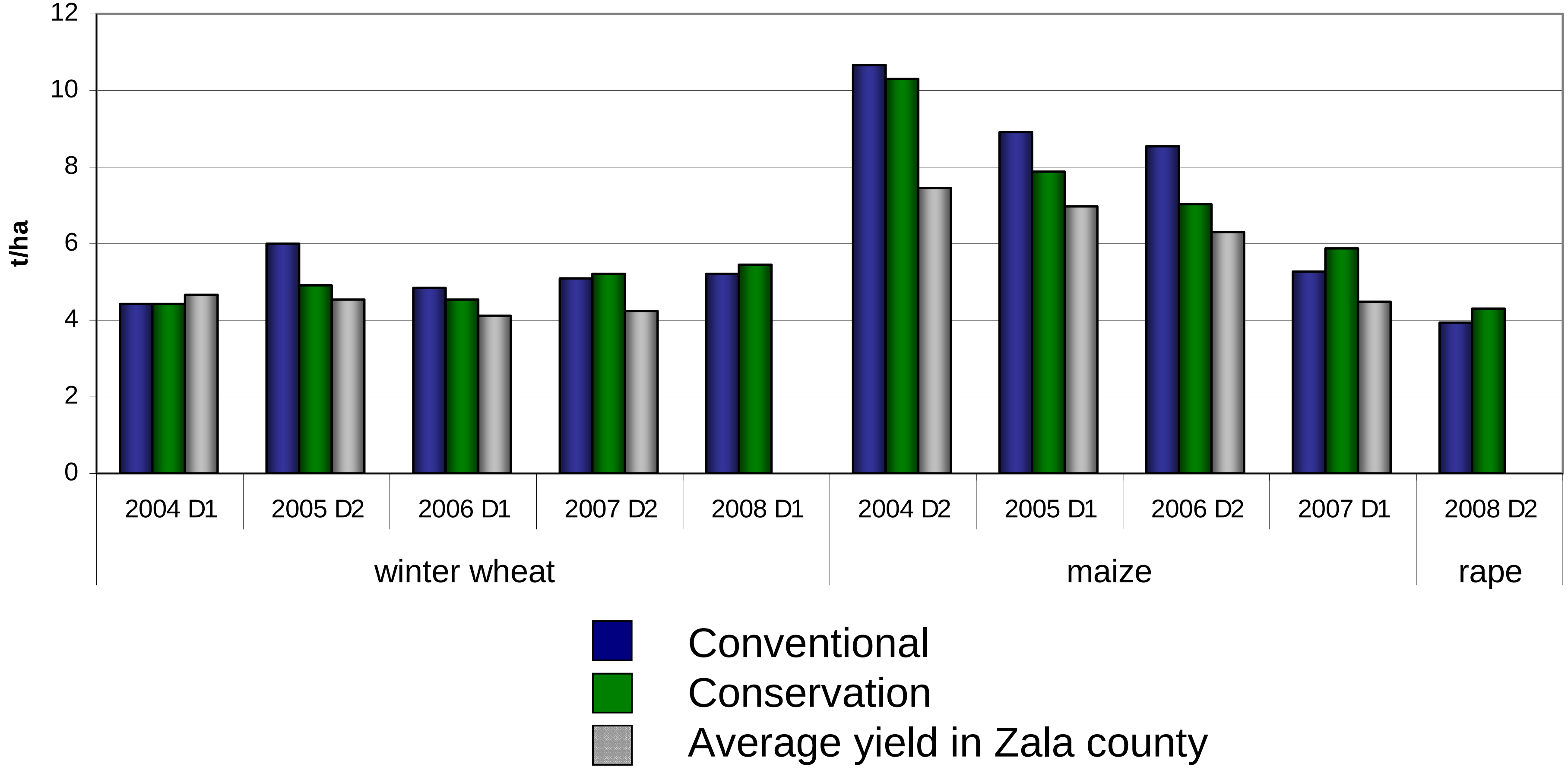
Summarised data of ornithological observations at the agro ecological plots of the SOWAP project in 2003-2008 presented by tillage types and periods



Number of birds between October 2007 and September 2008 presented by tillage types



Yield values at Dióskál (2004-2008)



Conclusions

- CA compared with conventional has significant advantages both for the soil itself and for the environment
- Results of the SOWAP project support the above statement
- CA should be supported by every possible tool at EU, regional and local levels

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