UNIVERSITY OF LJUBLJANA | BF Biotechnical Faculty

Univerza v Mariboru
Fakulteta za kmetijstvo in biosistemske vede

Impact of different tillage systems on soil water availability and erosion potential in agricultural catchments, Example from Slovenia

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G20 GLOBAL LAND INITIATIVE

OPTAIN

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ARIS L4-2625

TOPPS Water Protection ...to prevent pesticide losses to water

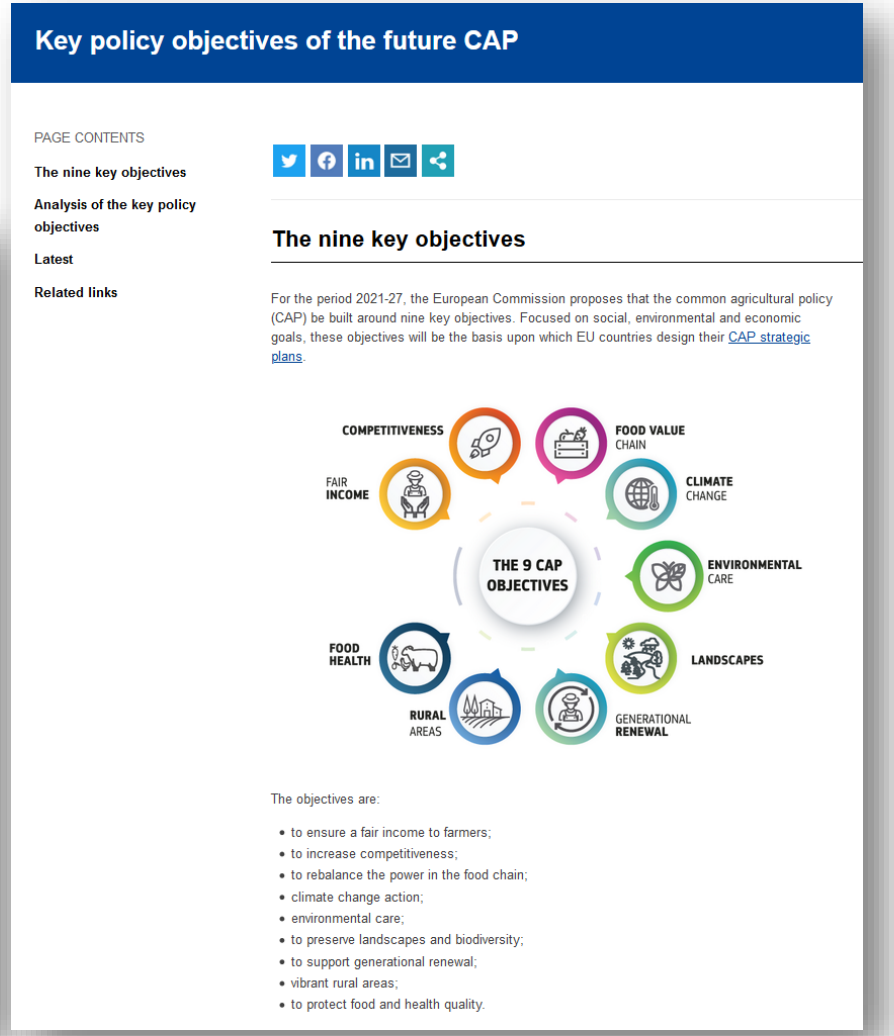
Sofinancirano s programom Evropske unije: Obzorje 2020

ARIS Slovenian Research and Innovation Agency

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA KMETIJSTVO, GOZDARSTVO IN PREHRANO

1
Aim

To examine the environmental and economic sustainability of agricultural **soil water management (abundance, scarcity) and soil management (erosion),** using small measures to **retain water** and **prevent soil erosion** in fields under conventional and conservational minimal tillage.



2 Background

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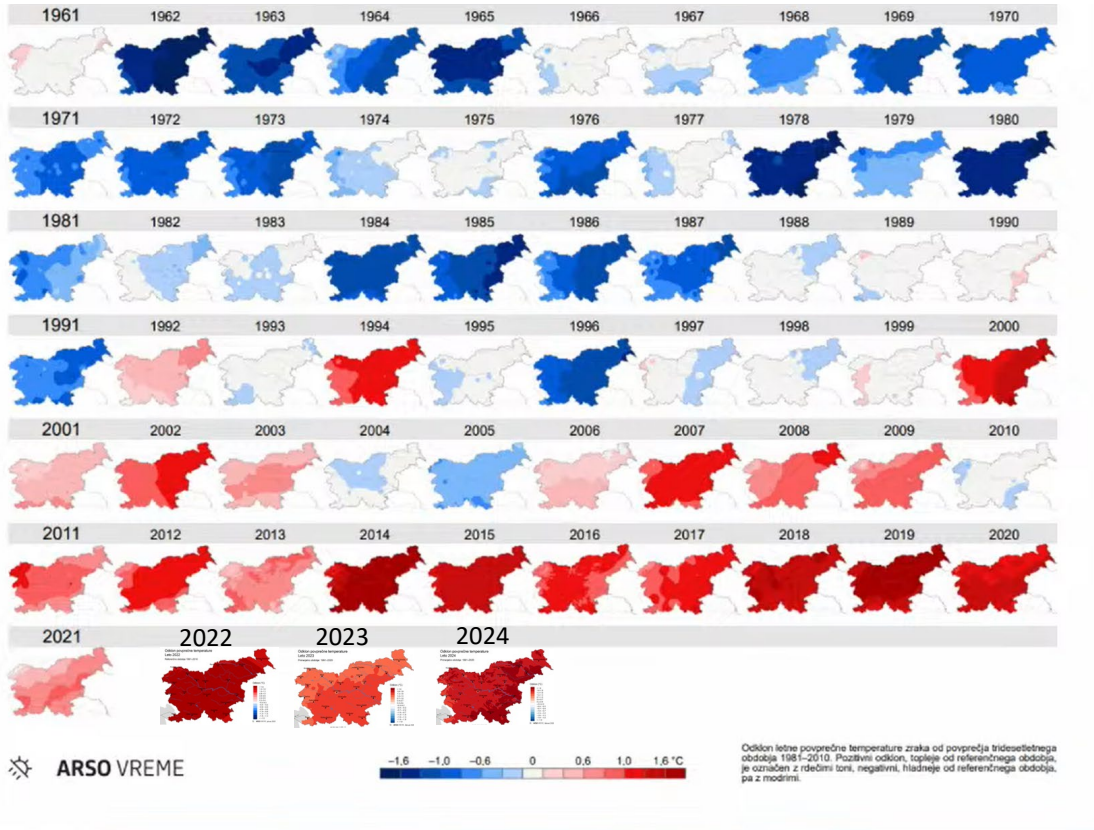
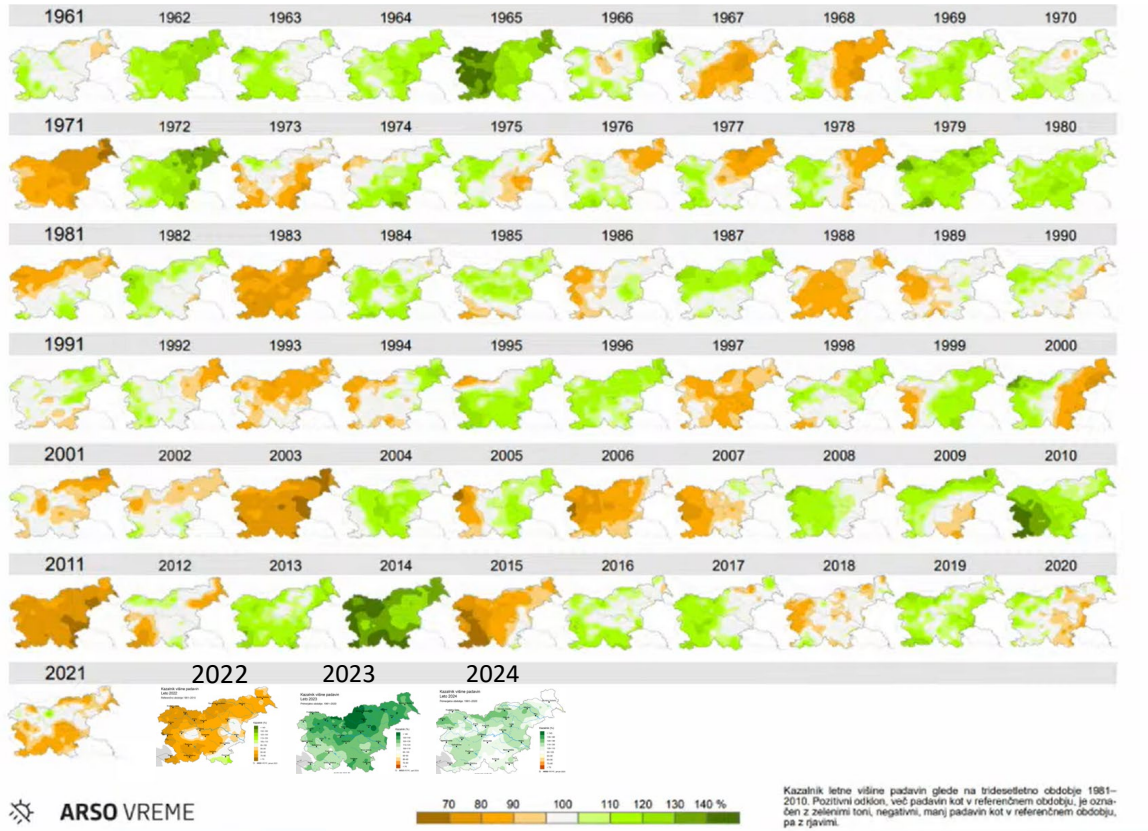
- For every 1°C rise in average temperature, the atmosphere can hold up to around 7% more moisture. With more moisture available, rainfall can become more intense.

Deviation of the annual average temperature (1981-2010)



Deviation of the annual average precipitation (1981-2010)

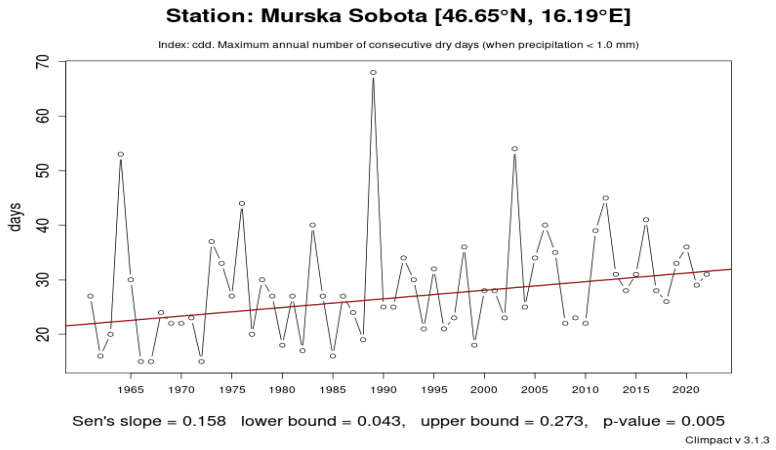


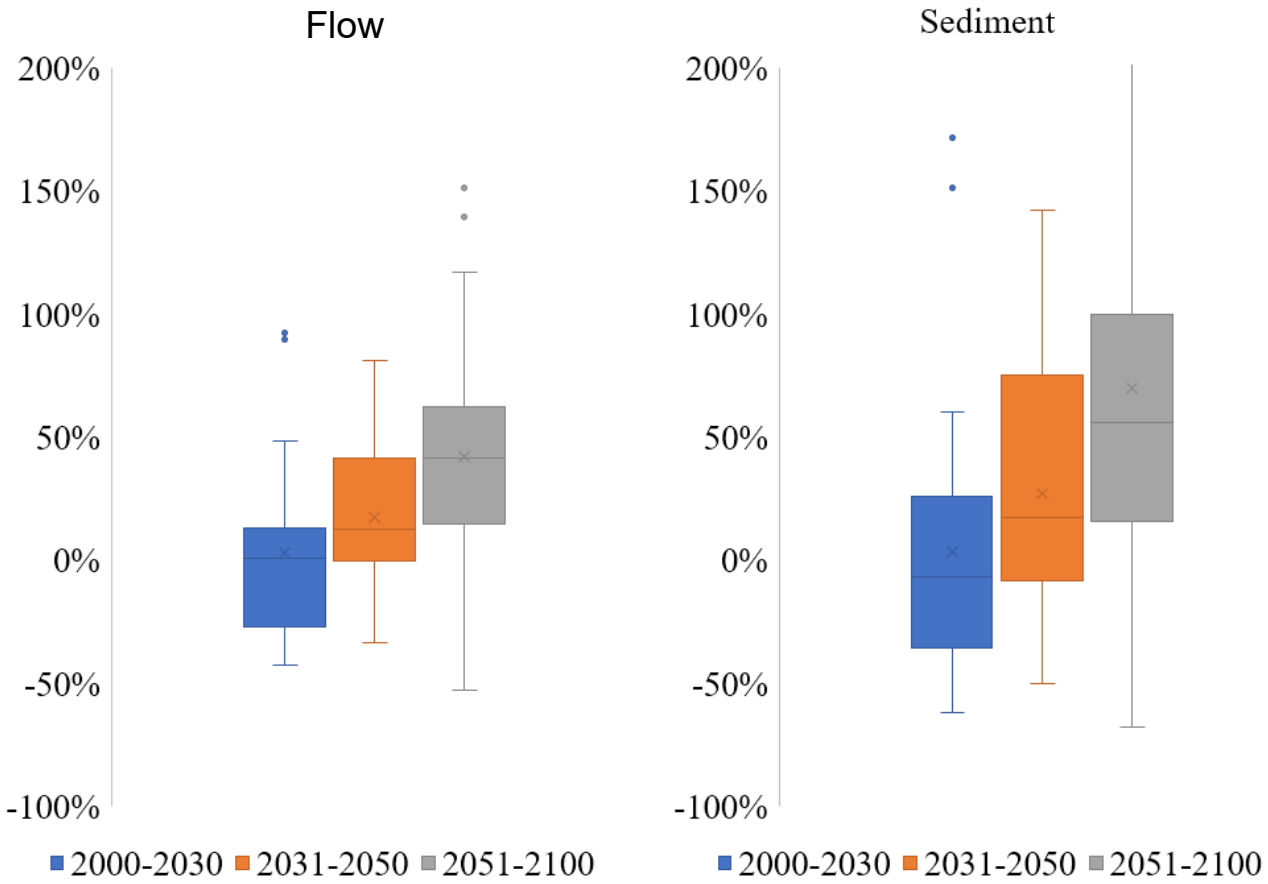
- **Slovenia is already 2°C warmer from pre-industrial area**

= potentially, the air can already contain 14% more moisture

3
The problem - Climate analysis and climate modelling

- The number of consecutive dry days is increasing
- Climate change models show that the number of days with heavy rainfall will increase
- Surface runoff will increase and with it river flow
- Unless we change the way we manage our land, soil erosion and the amount of sediment and nutrients in surface waters will increase





RCP 8.5

Vipava (V) - Pesnica (P) - Ledava (L)

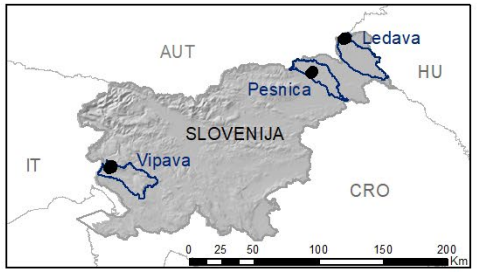
Fields included in the measurements

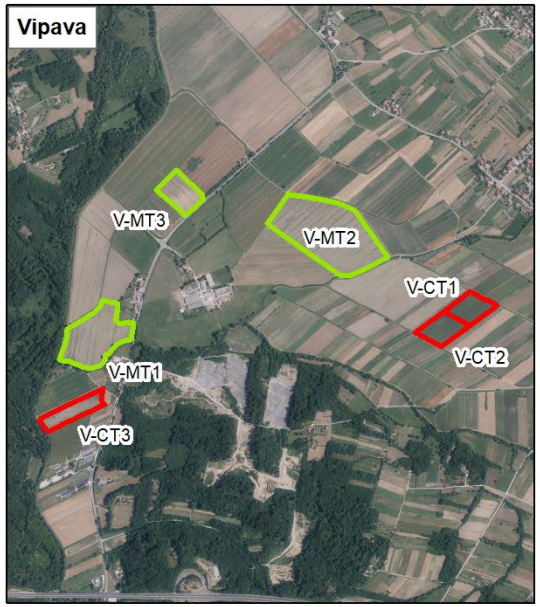
C - conventional tillage (ploughing)

M - minimum tillage

0 0.25 0.5 1 1.5 2 Km

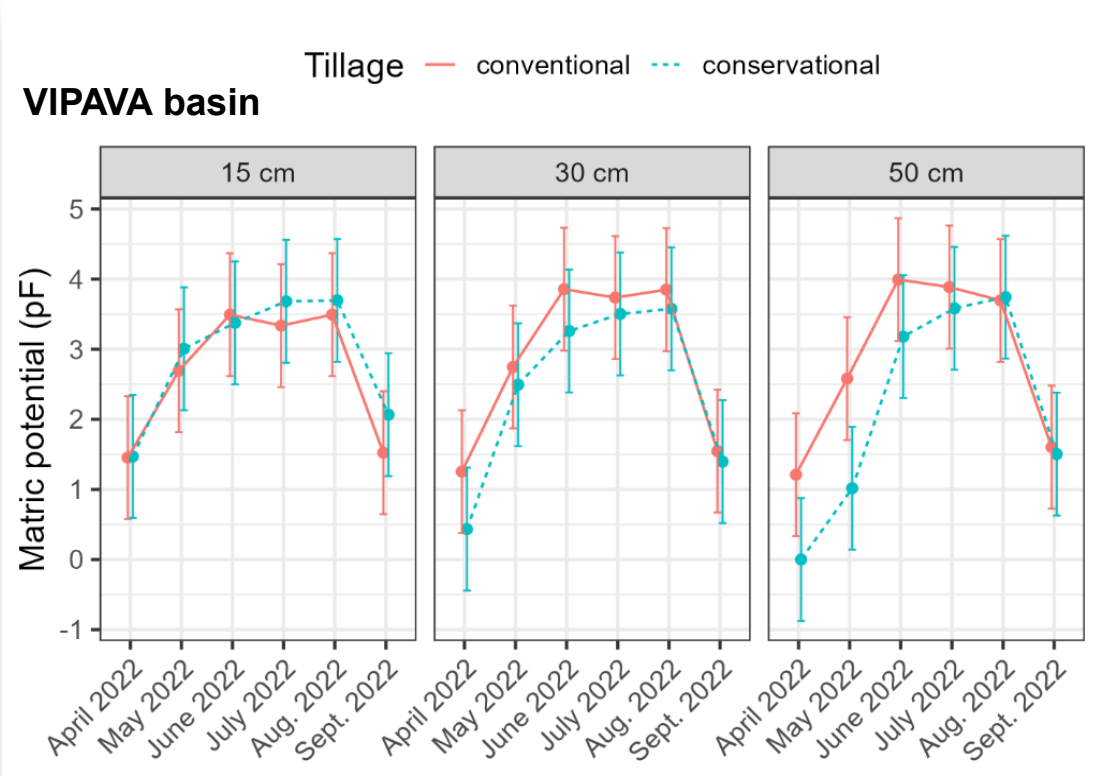
Aerial orthophoto (Ministry of Agriculture, Forestry and Food, 2023)

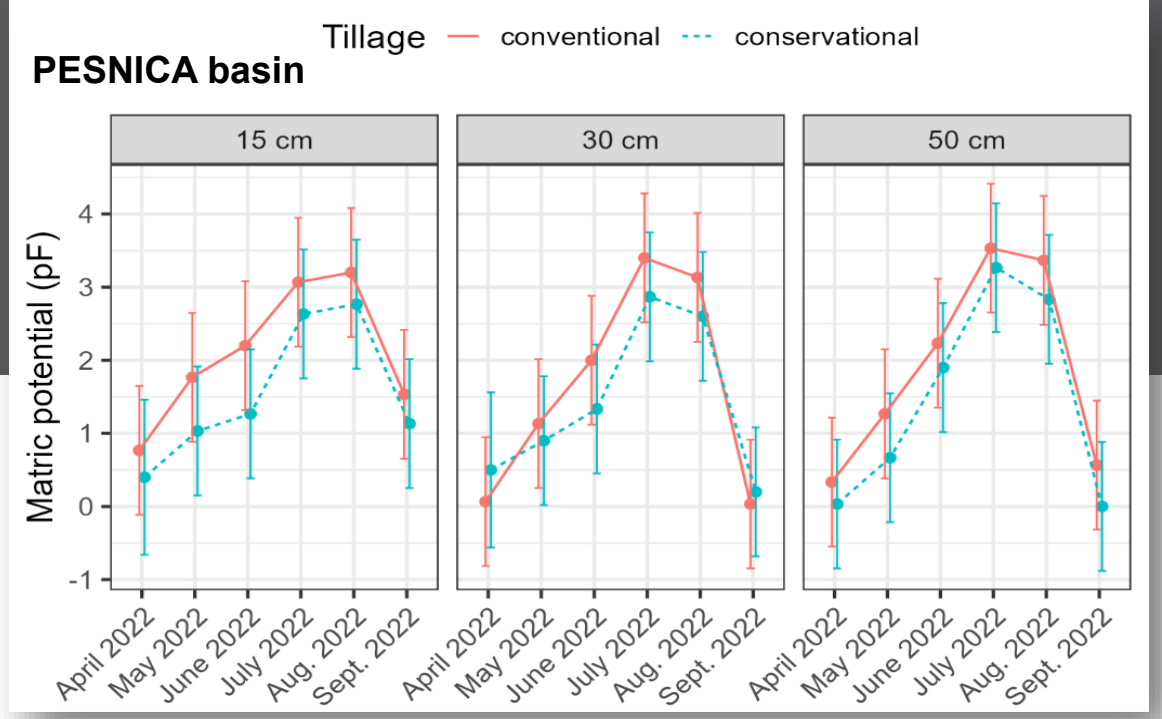


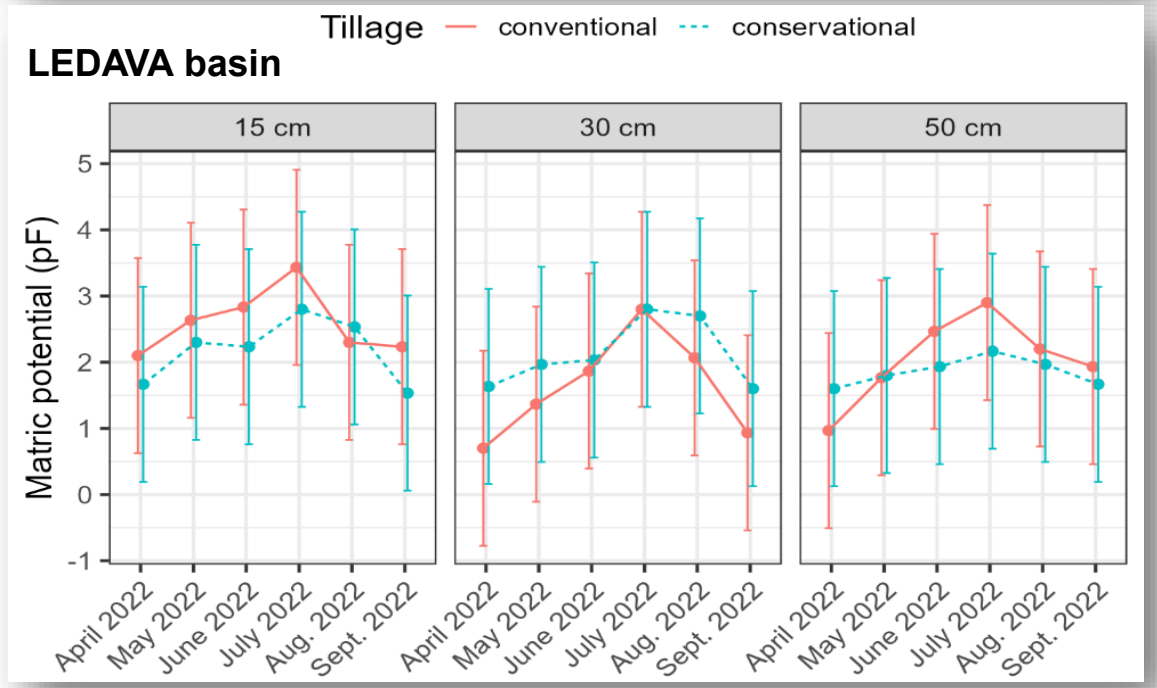


5
Matric potential (pF) and soil water content (θ)

Coventional (C) vs. conservational minimal tillage (M)

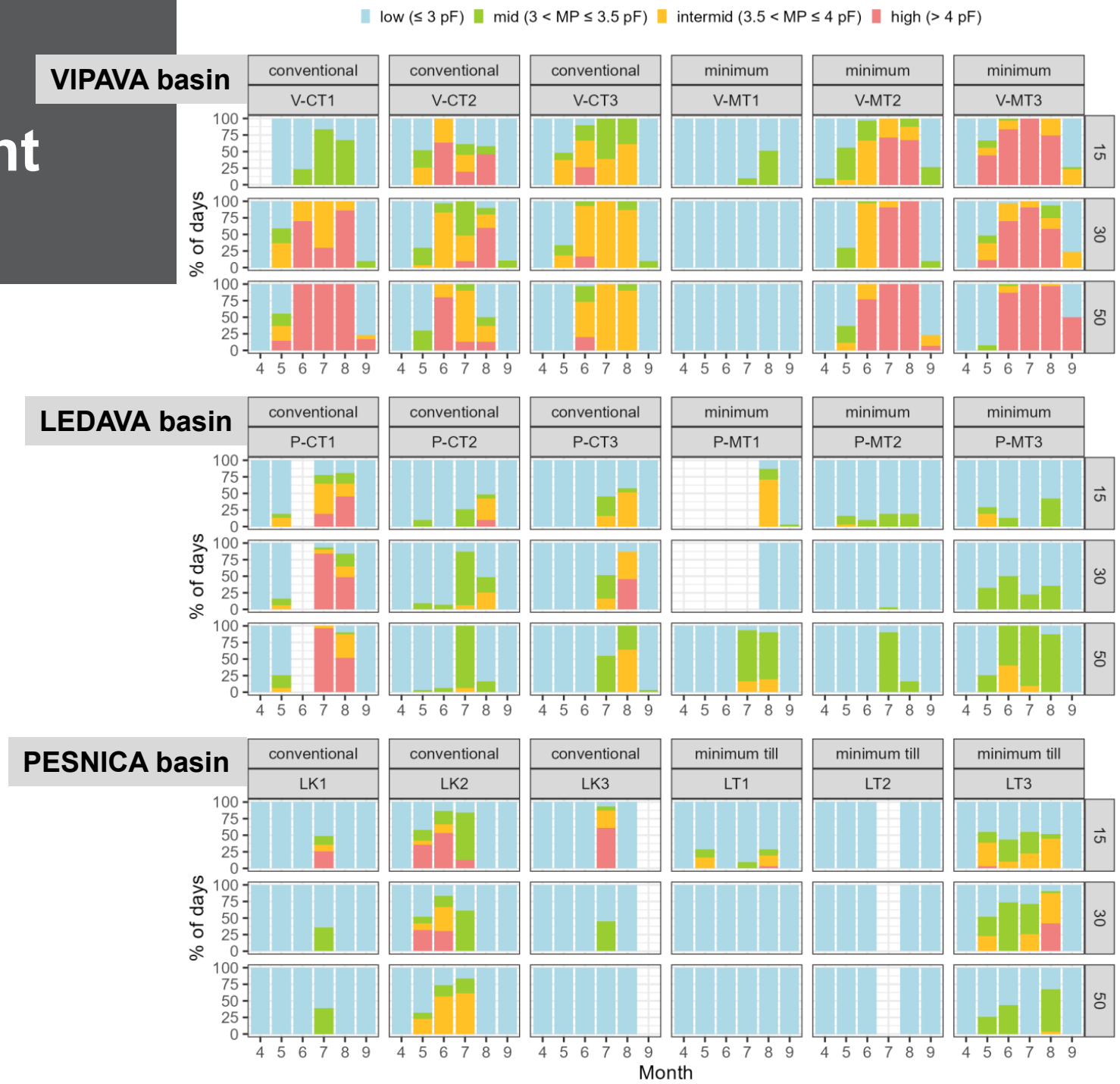






6 Categories of plant water availability

The measurement of soil matric potential between the different tillage systems showed **similar soil water status in terms of percentage of days within the different category of plant water availability**, expressed as pF value.



7
Soil Erosion
How much does it cost?

In a few hours conditions change!

According to estimates, with a loss of 1 ton of soil:

- The farmer loses €50,
- The local community has costs of €15-20 for the rehabilitation of various hydrological and transport infrastructure,
- Downstream ?

7
SOIL EROSION

28. april 2021

10. Junij **2021**

2. June **2022**

Erosion = 60 t/HA

7
SOIL EROSION

7
SOIL EROSION

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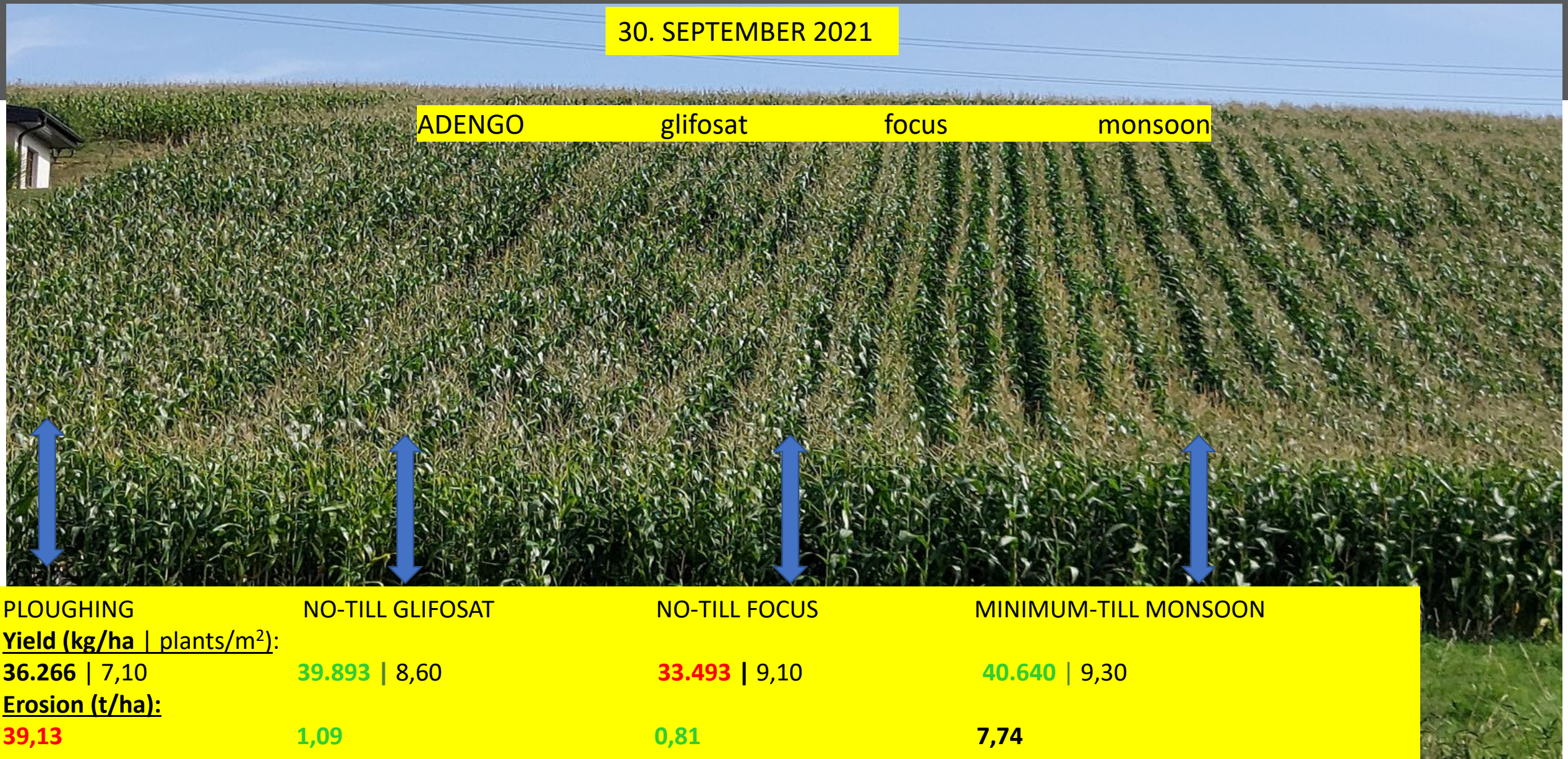
Conventional tillage Soil herbicide before germination 4,5 t/ha	No-till – herbicide application before germination 0,15 t/ha	No-till – late application after germination 0,08 t/ha	Minimum till – herbicide after germination 1,9 t/ha

Amount of soil and water lost on a steep field depending on soil cultivation method and herbicide application timing – APPROXIMATELY 1 MONTH AFTER SOWING

7
SOIL EROSION

UL | BF



PLOUGHING	NO-TILL GLIFOSAT	NO-TILL FOCUS	MINIMUM-TILL MONSOON
Yield (kg/ha | plants/m^2):			
36.266 | 7,10	**39.893** | 8,60	**33.493** | 9,10	**40.640** | 9,30
Erosion (t/ha):			
39,13	**1,09**	**0,81**	**7,74**

7
SOIL EROSION

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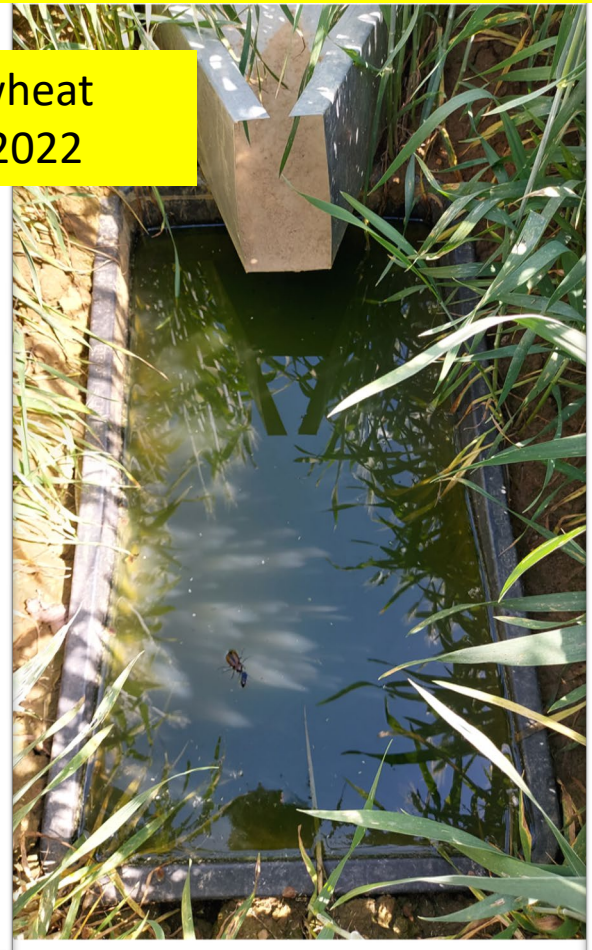
Cumulative amount of eroded soil per ha from sowing on November 28 to June 7

PLOUGH transversely	PLOUGH longitudinally	NO-TILL	MINIMUM-TILL
7,55 t/ha	26,45 t/ha	2,45 t/ha	17,9 t/ha



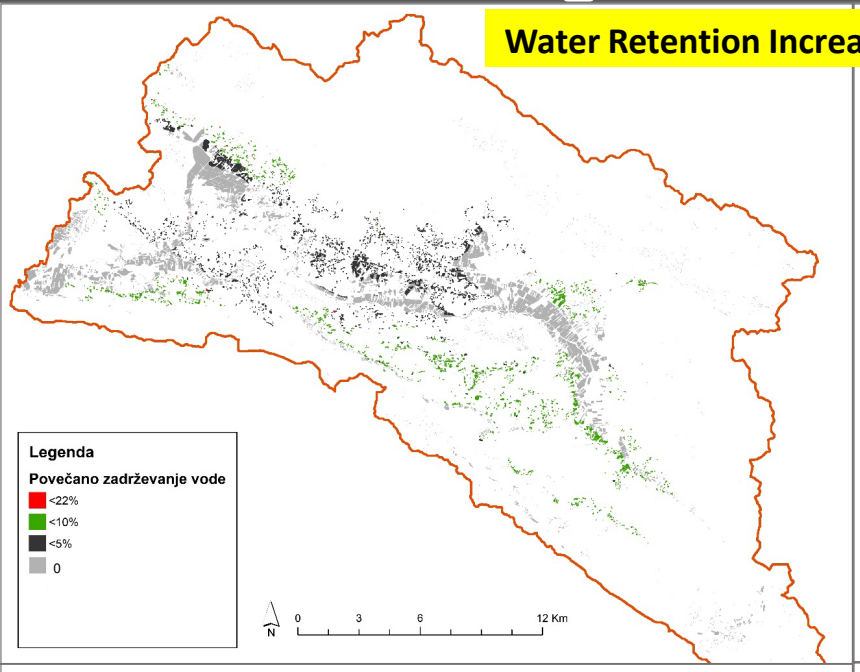
8
Modelling economic efficiency of measures

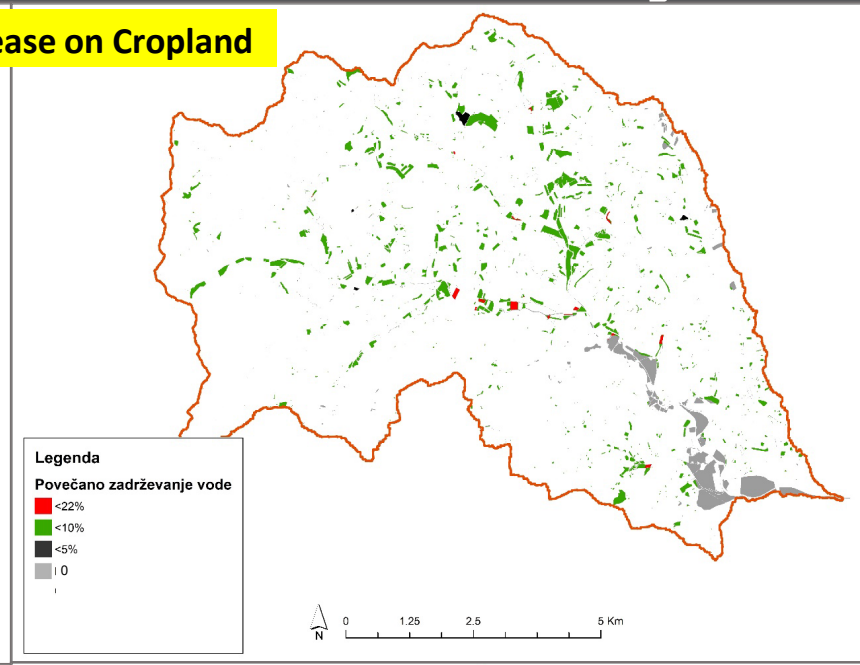
Percentage change in gross margin between baseline and alternative agricultural production scenarios

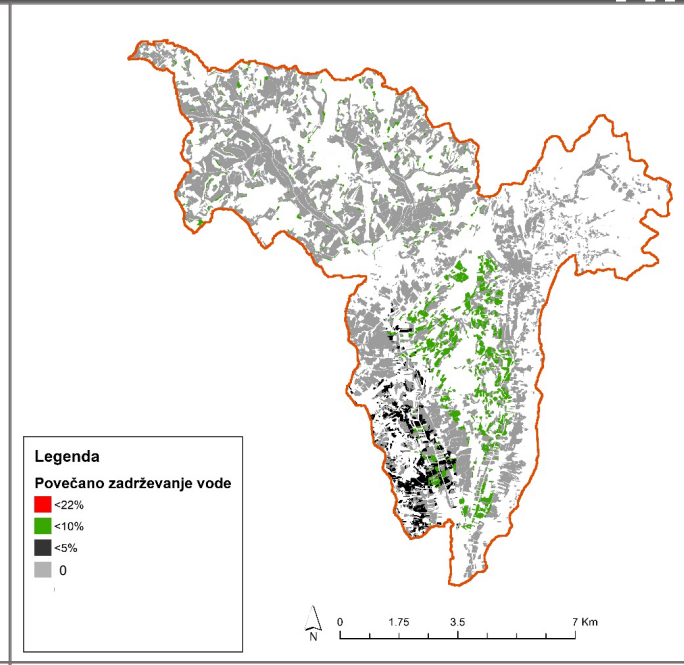
Scenario	Change in average gross margin for scenarios (economic efficiency)					
	Base	Winter cover crops	Buffer strips	Conservational (Min) tillage	Contour tillage	Convert arable land to permanent grassland
Cattle	0%	34%	-16%	-7%	10%	-140%
Pig	0%	-56%	-6%	17%	10%	6%
Crop (Vipava)	0%	1%	-5%	35%	10%	31%
Pig (Pesnica in Ledava)	0%	2%	-7%	48%	10%	-8%

8 Modelling environmental efficiency

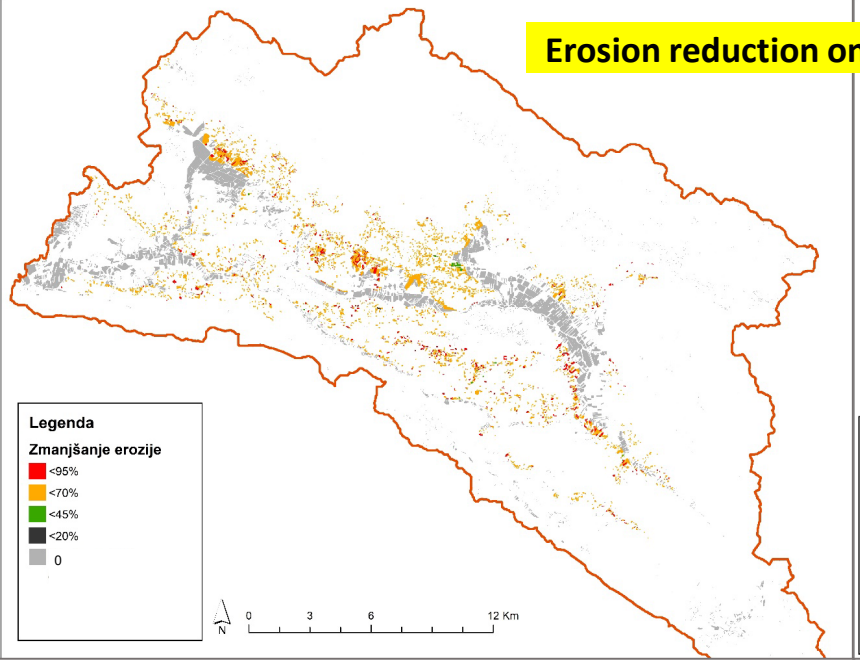
Water Retention Increase on Cropland

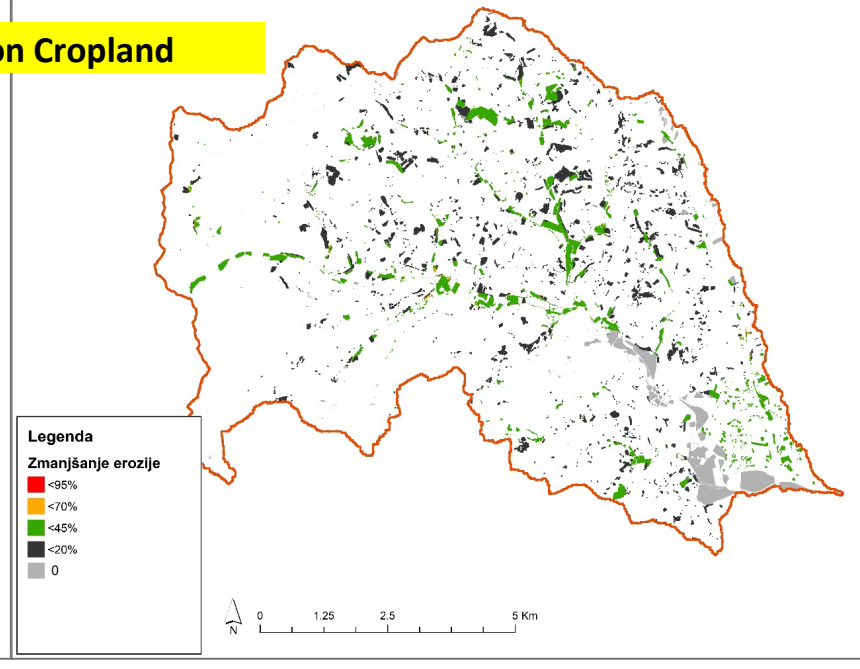


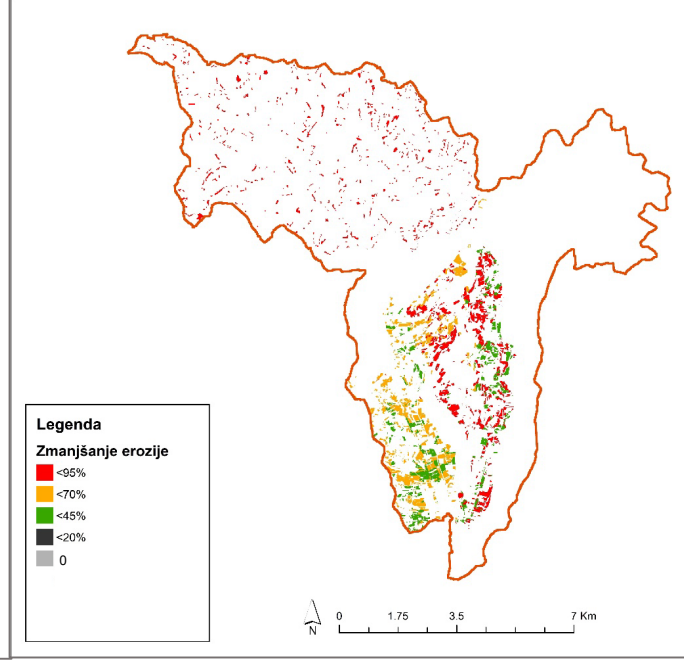




Erosion reduction on Cropland



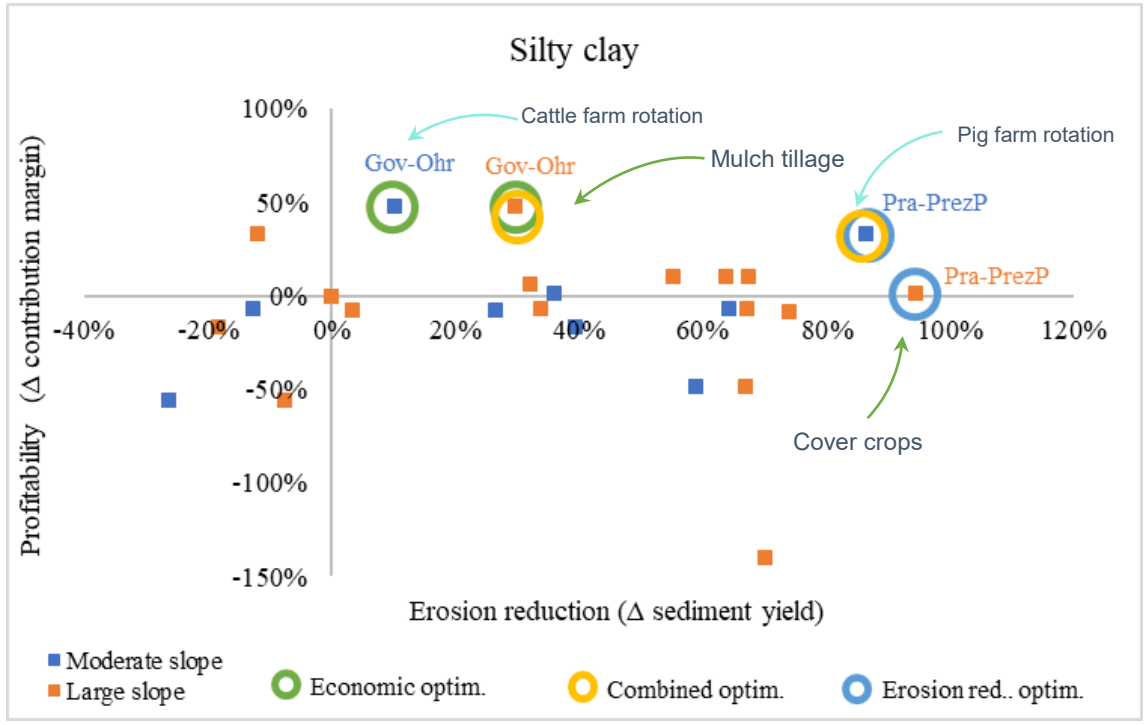




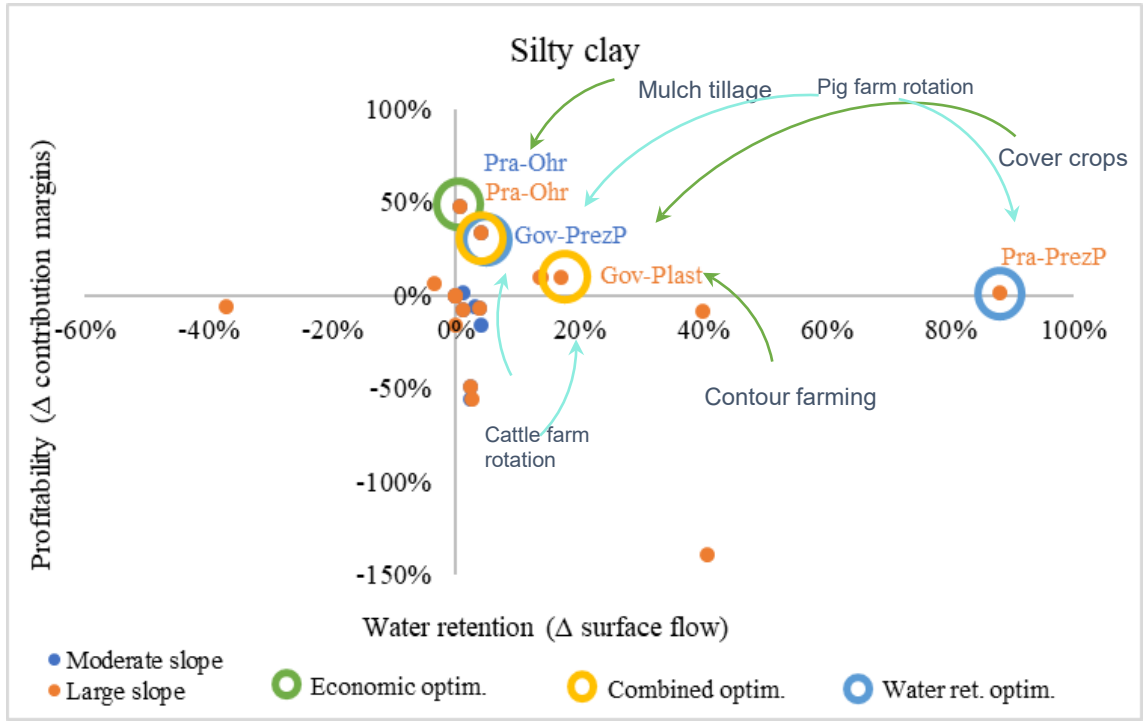
9
Optimize environmental and economic efficiency of measures

- OPTIMISATION- to find the best scenario

Erosion prevention



Water retention



10
Identifying socio-economic potentials and constraints of measures implementation

10
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M1 - Winter cover crops,

M2 - Arable fields at steeper slopes converted to grassland,

M3 - Mulch till,

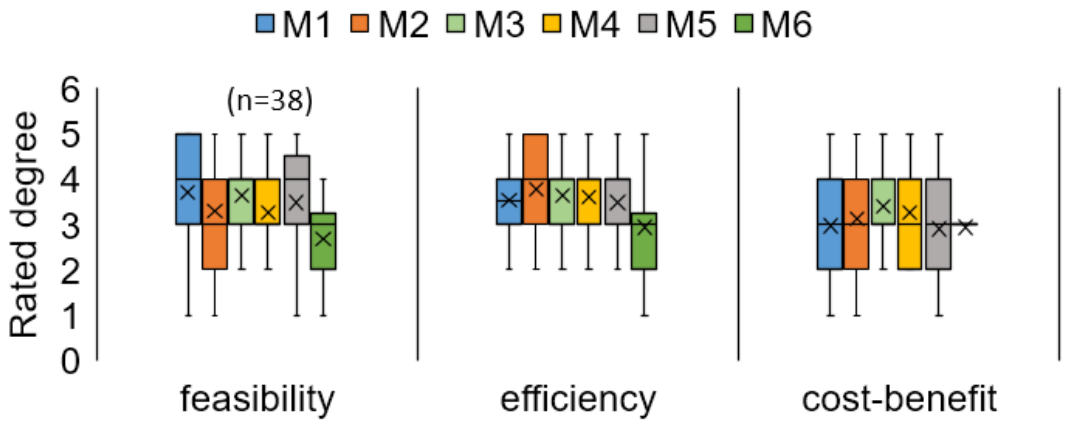
M4 - Contour tillage,

M5 - Grassed buffer strips,

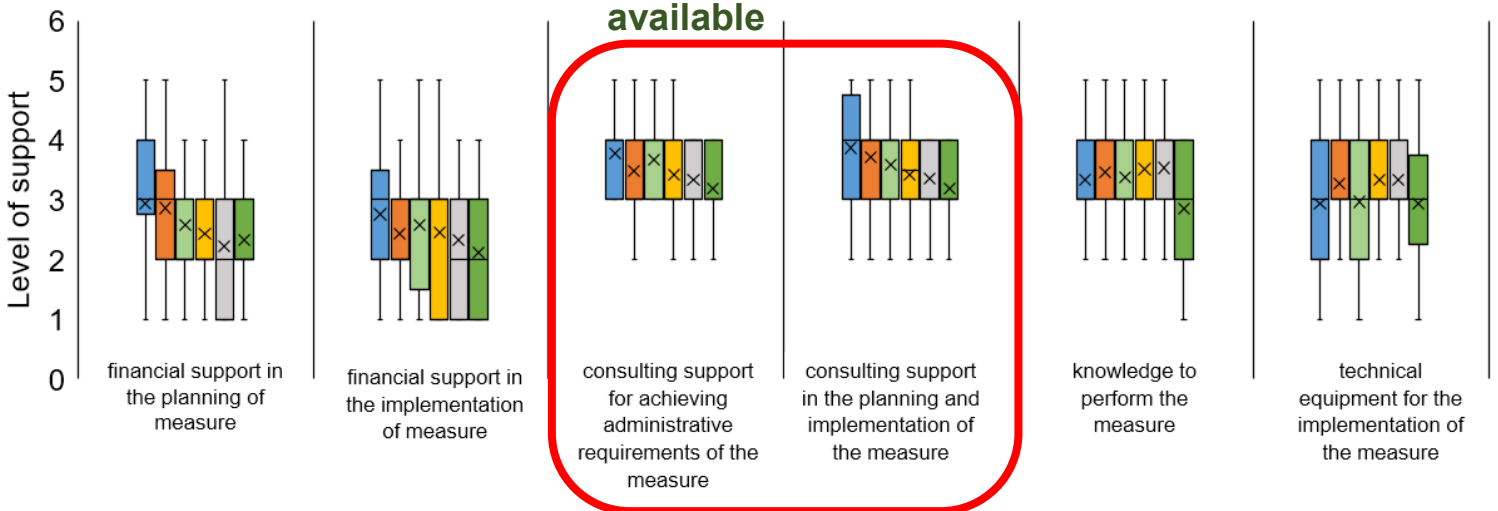
M6 – Retention ponds

Degree of feasibility, efficiency and cost-benefit

(n=38)



Level of financial support, administrative support, knowledge needed and technical equipment available



11
Systemic approach for the development

- By hesitating to introduce sustainable farming practices, we are causing economic, environmental and farm developmental damage.
- Neither the farmers nor the local communities know much about the extent of the damage caused by economically and environmentally outdated/inefficient farming practices.
- There are no real environmental and economic assessments of the presented processes as part of an integrated management system for Slovenia.

Thank you for attention?

Acknowledgement:
This research was carried out within the framework of the CRP L4-2625 CeVoTaK project (web page), funded by the Slovenian Research And Innovation Agency and the Ministry of Agriculture, Forestry and Food, the OPTAIN project funded from the European Union's Horizon 2020 research and innovation program under grant agreement No. 862756 (https://www.optain.eu/).