AIAM2019 –XXII
Convegno Nazionale di
Agrometeorologia

11-12-13 giugno 2019
Dipartimento di Scienze Agrarie dell'Università
Federico II
Reggia di Portici, Portici (NA)

Effects of soil management on runoff and erosion response to rainfall events of sloping vineyards in the Monferrato area (NW Italy)

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Bagagiolo G., Biddoccu M., Rabino D., Cavallo E., Environmental Research (2018), https://doi.org/10.1016/j.envres.2018.06.048

Location in hilly or mountain areas

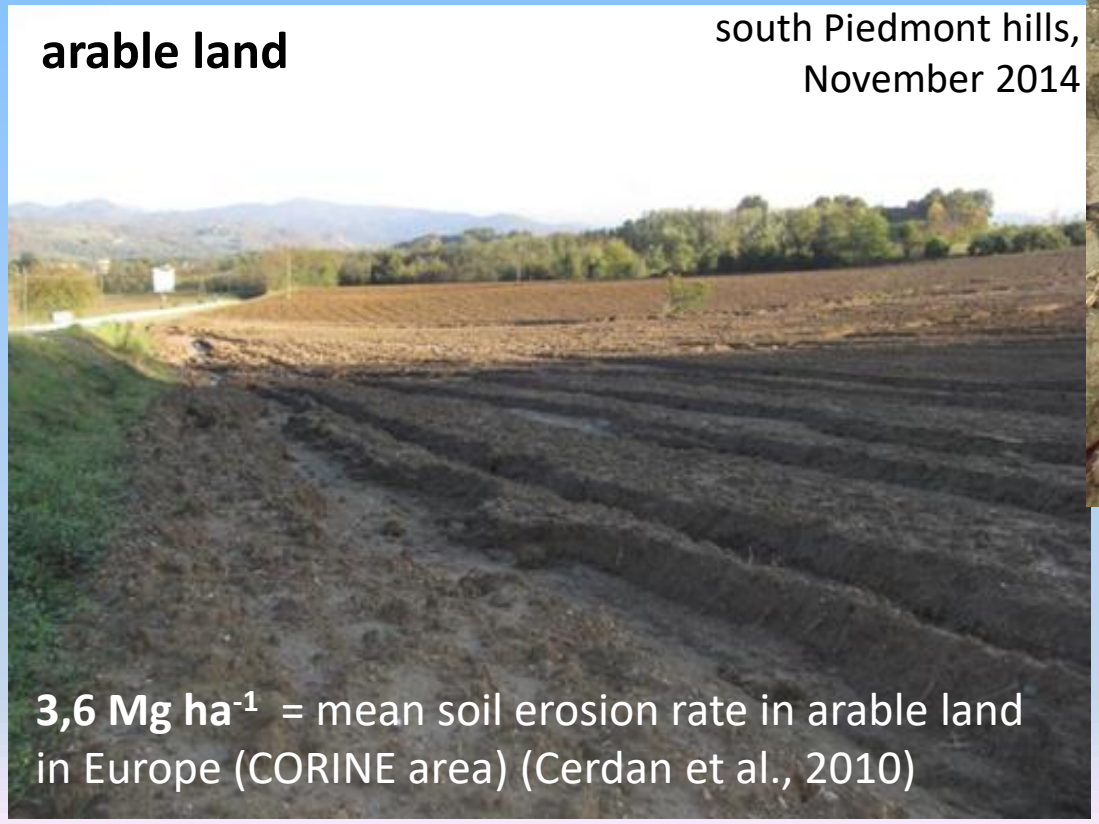
High intensity rainfall

Land use & management

12.22 Mg ha^{-1} = mean soil erosion rate in Europe (CORINE area) in vineyards (Cerdan et al., 2010)

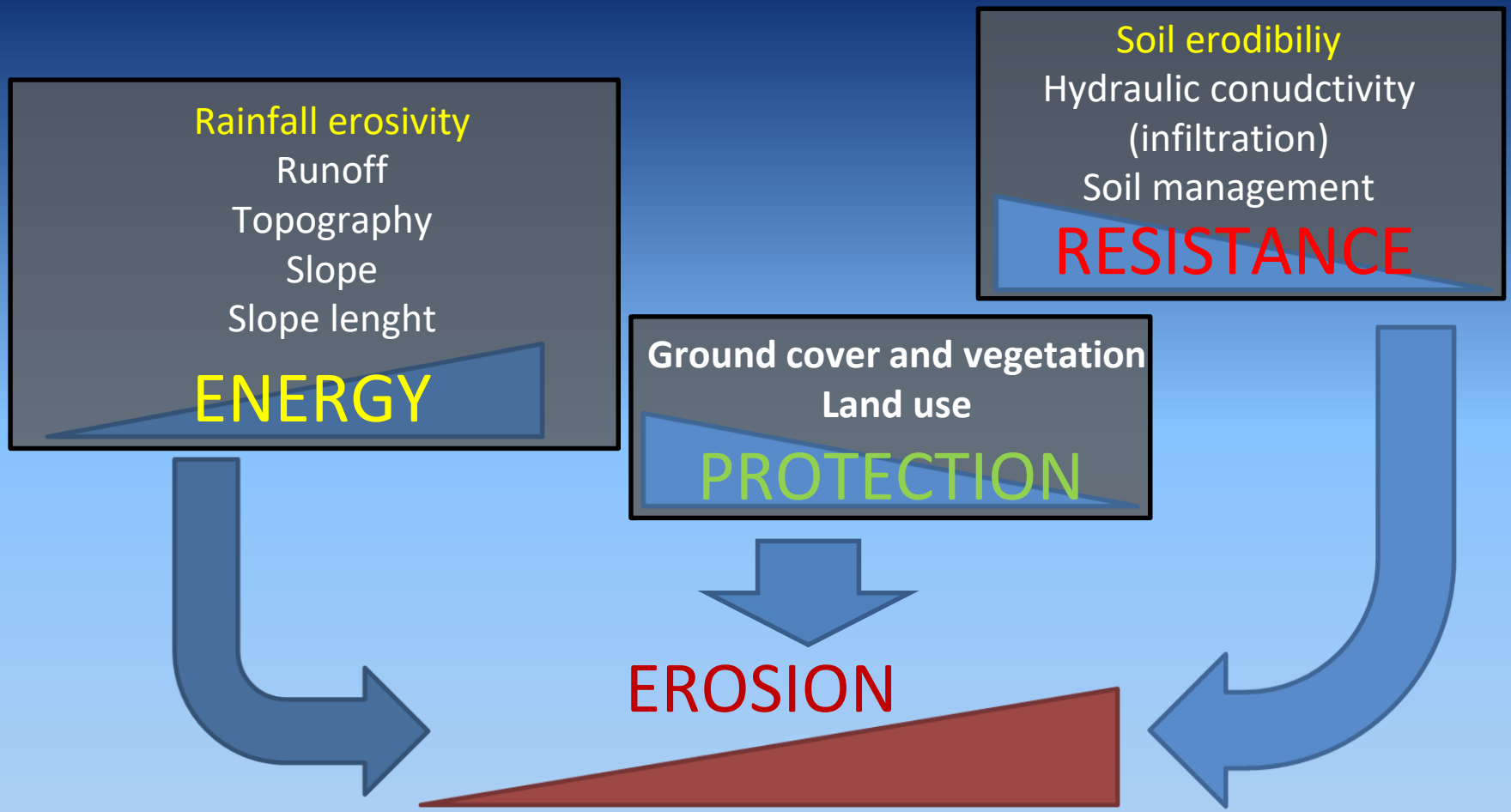
arable land

south Piedmont hills, November 2014



3,6 Mg ha^{-1} = mean soil erosion rate in arable land in Europe (CORINE area) (Cerdan et al., 2010)

1.2 Mg ha^{-1} = mean soil erosion rate in Europe (CORINE area) (Cerdan et al., 2010)
1 Mg ha^{-1} = tolerable annual soil erosion rate (van der Knijff et al., 2000)



Adattato da: RPC Morgan, Soil Erosion and Conservation, Longman, 1986

- ✓ Soil, topographic, rainfall characteristics
- ✓ Use of grass cover/cover crops in vines inter-rows
- ✓ Row-orientation (contour vs up-and-down)

→ Runoff and soil erosion

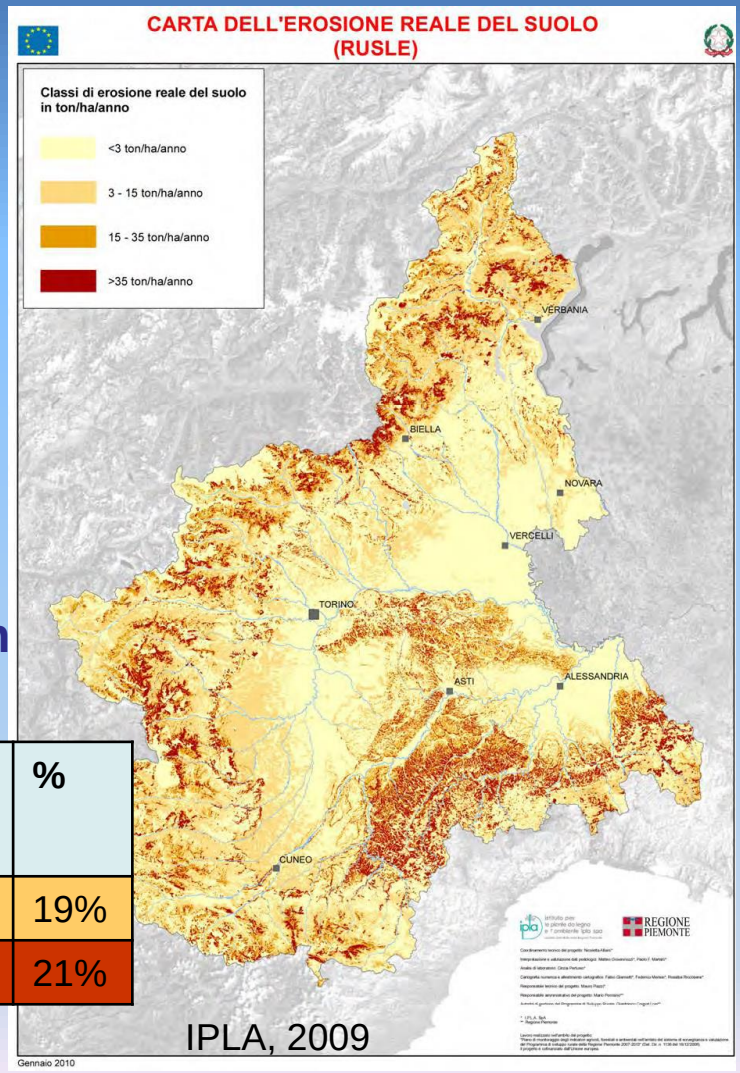
The **Monferrato** area (NW Italy):
is one of the most valuable vine-growing and DOC wine production area in Piedmont Hilly region

- Alpine sublitoranean climate:
- **Precipitation** is mainly concentrated in **Autumn** (October and November) and **Spring**
- Monferrato: MAP **846-905 mm**

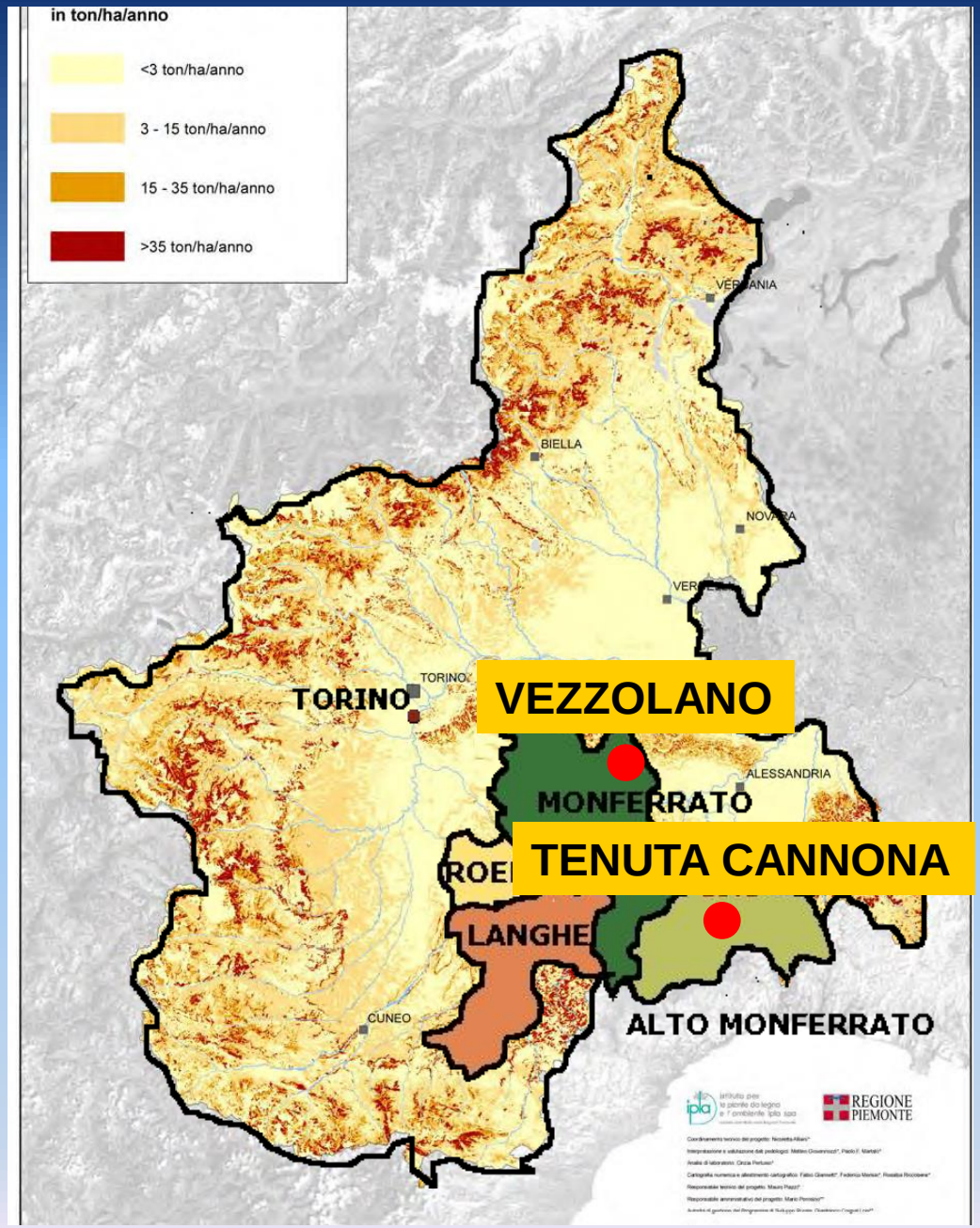
- The hilly sector of southern Piedmont represents the outcroppings of **deposits of the Tertiary Piedmontese Basin**
- Monferrato Hills: Pliocene **deposits of silt and fine sands**

Very intense erosional activity in the hilly region

class	Erosion rate (t/ha*y)	ha	%
3	15-35	75935	19%
4	>35	85463	21%



IPLA, 2009



- Permanent grass in inter-rows is one of the most used and effective soil conservation practices adopted in temperate climate
- **Used on 15.4 % of Piedmont's orchards and vineyards**

→ compare the effects of **grass cover** with **conventional tillage** in terms of runoff and soil loss in hillslope vineyards with **different row orientation**;

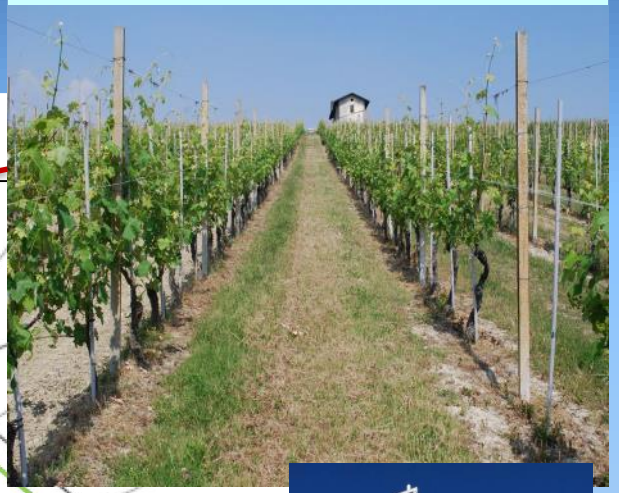
→ evaluate **the influence of event rainfall characteristics** in determining the hydrological and erosive response of vineyard.

TENUTA CANNONA EXPERIMENT (2000-2014)

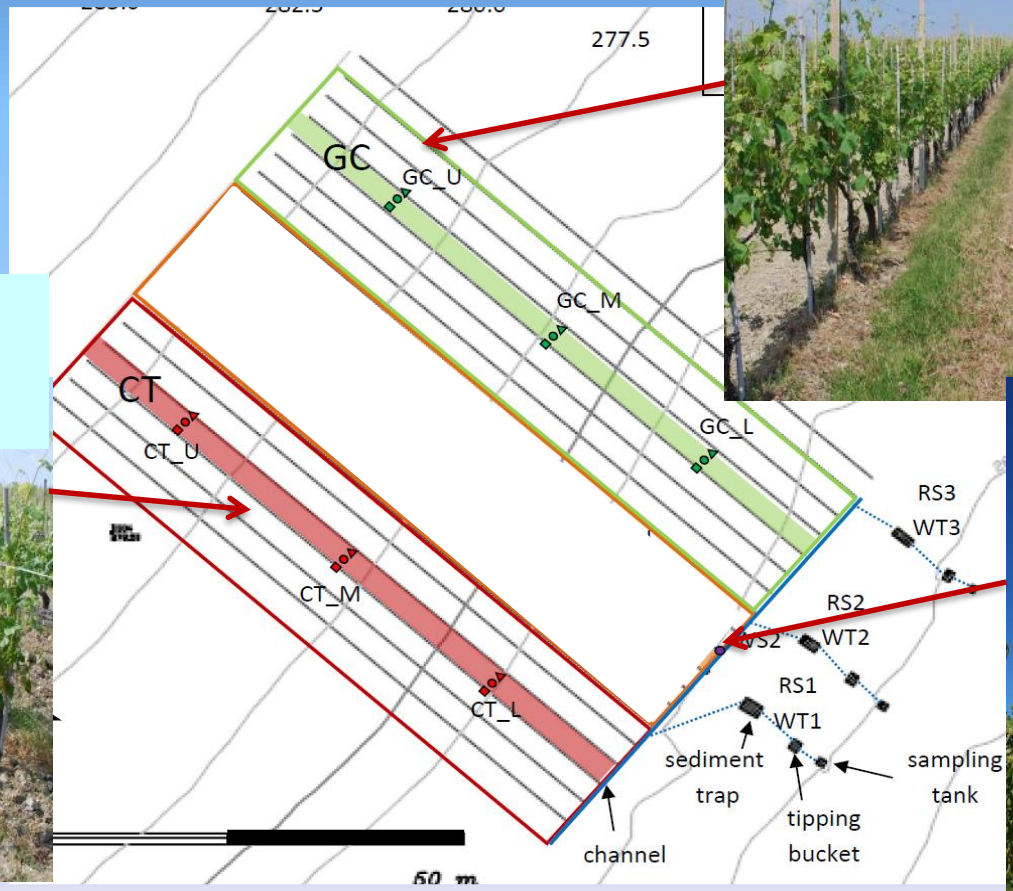
- **Vines up and down the slope ("rittochino")**
- Elevation 290 m, SE aspect, slope: 15%
- Texture: silty clay loam soil / silt loam soil

Two experimental plots with different soil Management

Grass Cover (GC): grass, mech. controlled twice a year

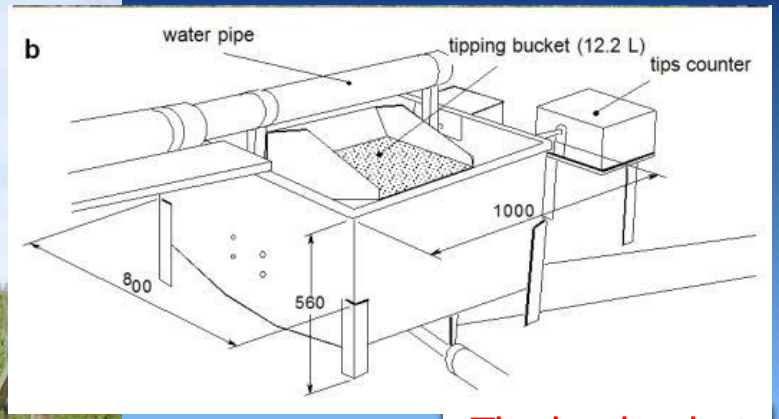


Conventional Tillage (CT): chisel, 0.25 m depth twice a year



TENUTA CANNONA EXPERIMENT

hydraulically bounded 75 m x 16.5 m (7 rows) 1221 m^2



Tipping bucket device

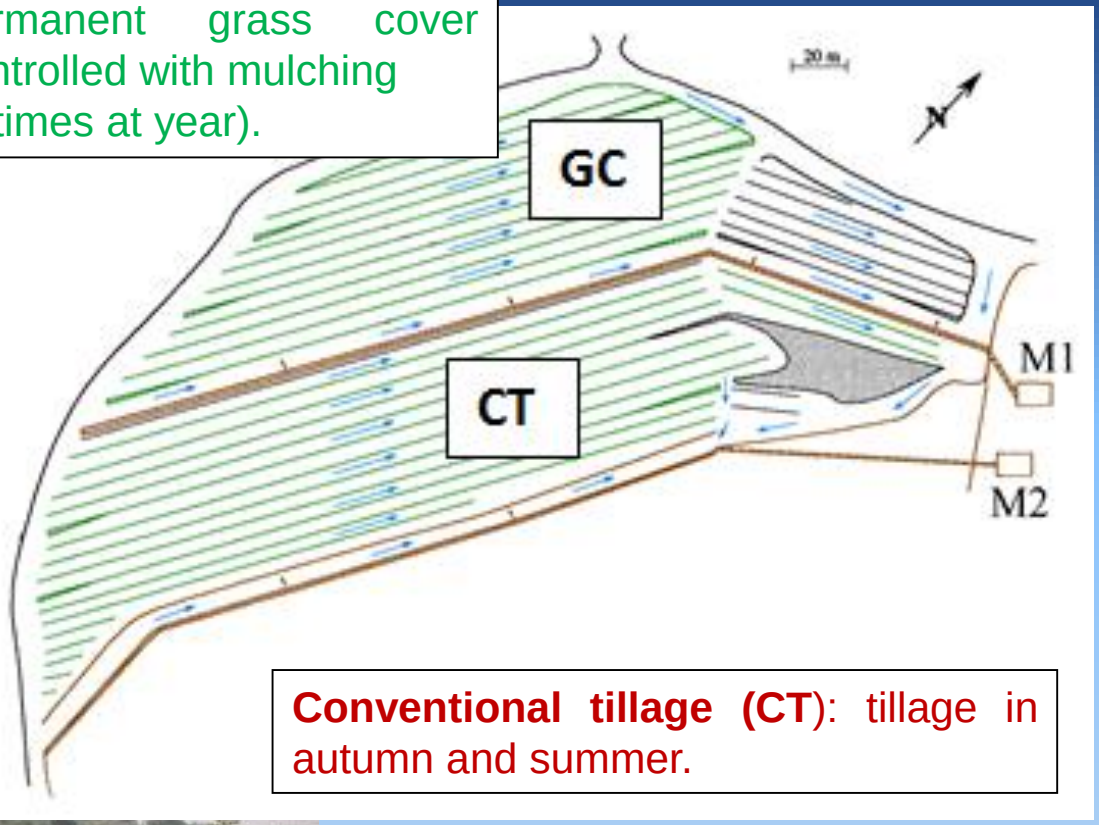
Runoff measurements and water sampling

Period 2000-2014: 86 erosive events

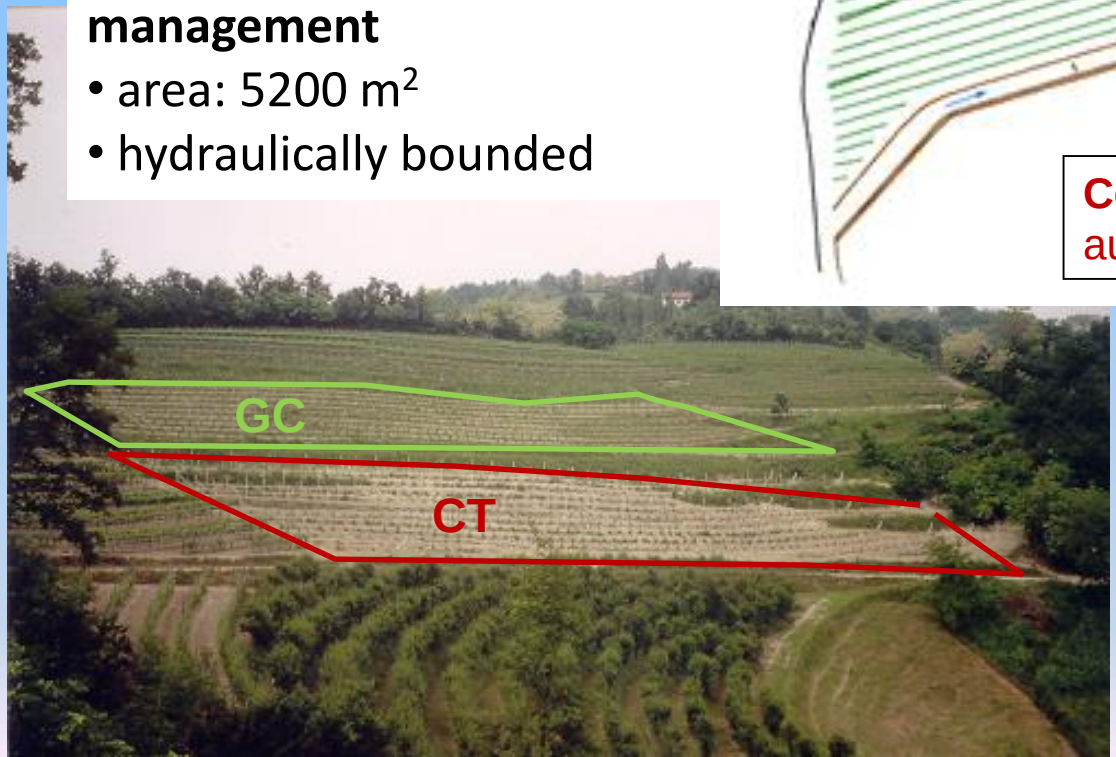
VEZZOLANO EXPERIMENT

- **Vines along contour lines**
- Elevation 530 m, S aspect, slope: 15%
- Texture: silty loam soil
- **Two experimental plots with different soil management**
- area: 5200 m^2
- hydraulically bounded

Grass cover (GC): permanent grass cover controlled with mulching (3 times at year).



Conventional tillage (CT): tillage in autumn and summer.



Period 1992-1996: 72 erosive events (runoff measurements + sediment yield)

Tenuta Cannona 86 events

Erosive rainfall events classified in
- **long-lasting** (RF_duration > 50hrs)
- **intense** (RF_Imax30> 16mm/h)
- **normal** (other events).

Vezzolano farm 72 events

Inter-row's management effect on RO, SSC, SL

Non-parametric Rank test

Effect of inter-row's management and type of event + interaction on RO, SSC, SL

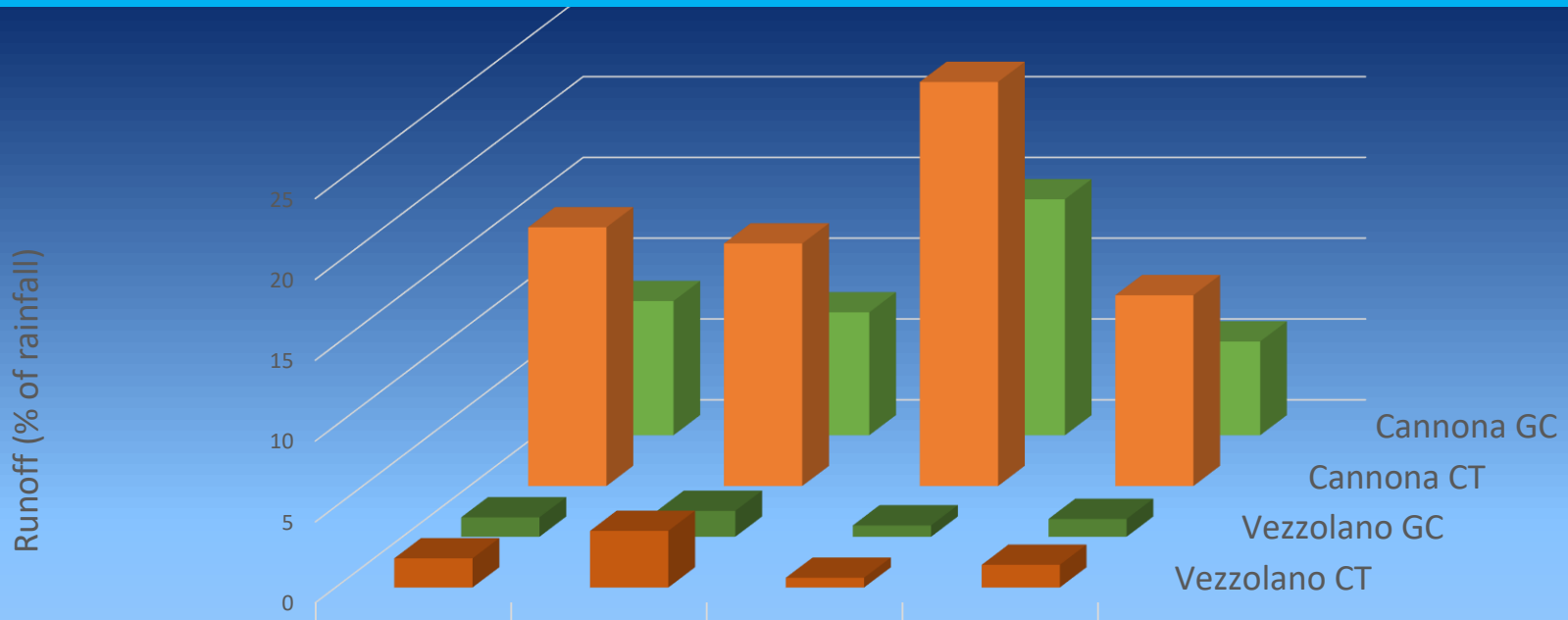
ANOVA

Correlations among RO, SSC, SL and rainfall characteristics

Pearson correlation matrix and stepwise MLR

Effect of row orientation on RO, SSC, SL

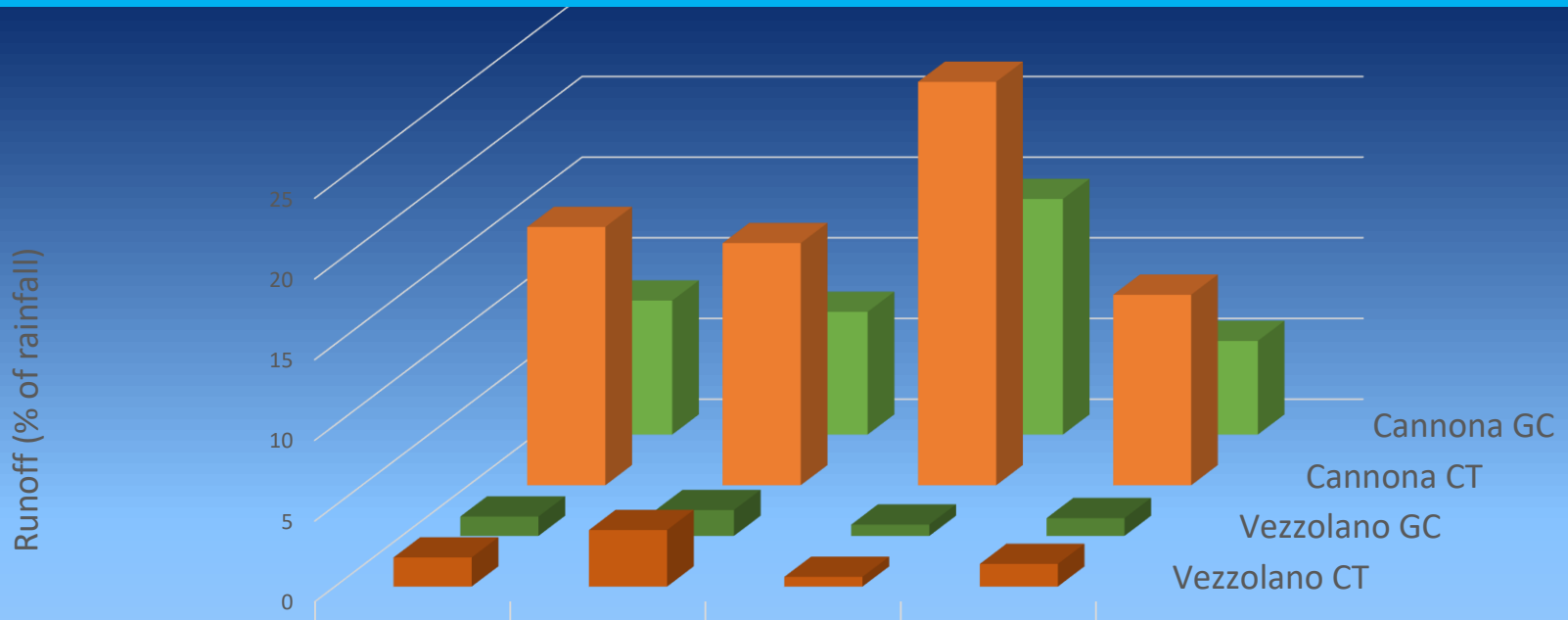
Mann-Whitney test



	All events	Intense	Long-lasting	Normal
Vezzolano CT	1.8	3.5	0.6	1.4
Vezzolano GC	1.2	1.6	0.7	1.1
Cannona CT	16	15	26.8	11.8
Cannona GC	8.3	7.6	14.6	5.8

Runoff in Vezzolano (contour)

- ✓ For 68% of events RO (GC) < RO (CT)
- ✓ 5 largest events (17% of P =94% of erosivity) → **47% and 48 % of total runoff in CT and GC**
- ✓ Mean runoff coefficient < 3,5% (max for **intense events** in CT)
- ✓ GC reduces RO for «normal» and «intense» events, while for «long-lasting» events RO (GC) > RO (CT)



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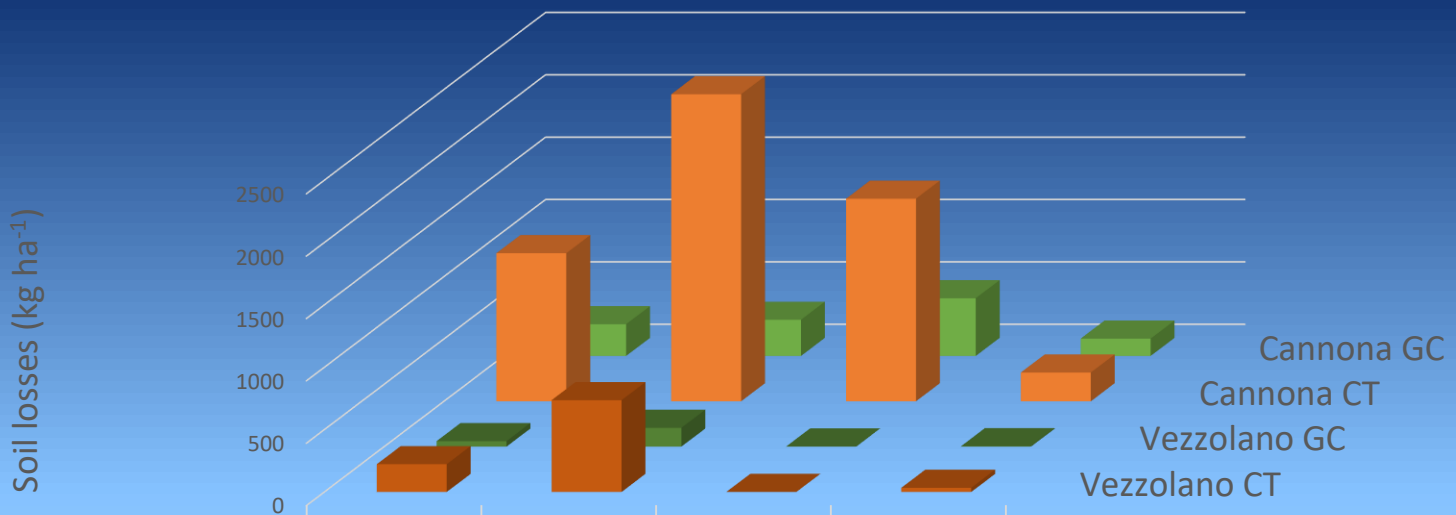
Cannona GC	8.3	7.6	14.6	5.8

Runoff in Cannona (up-and-down)

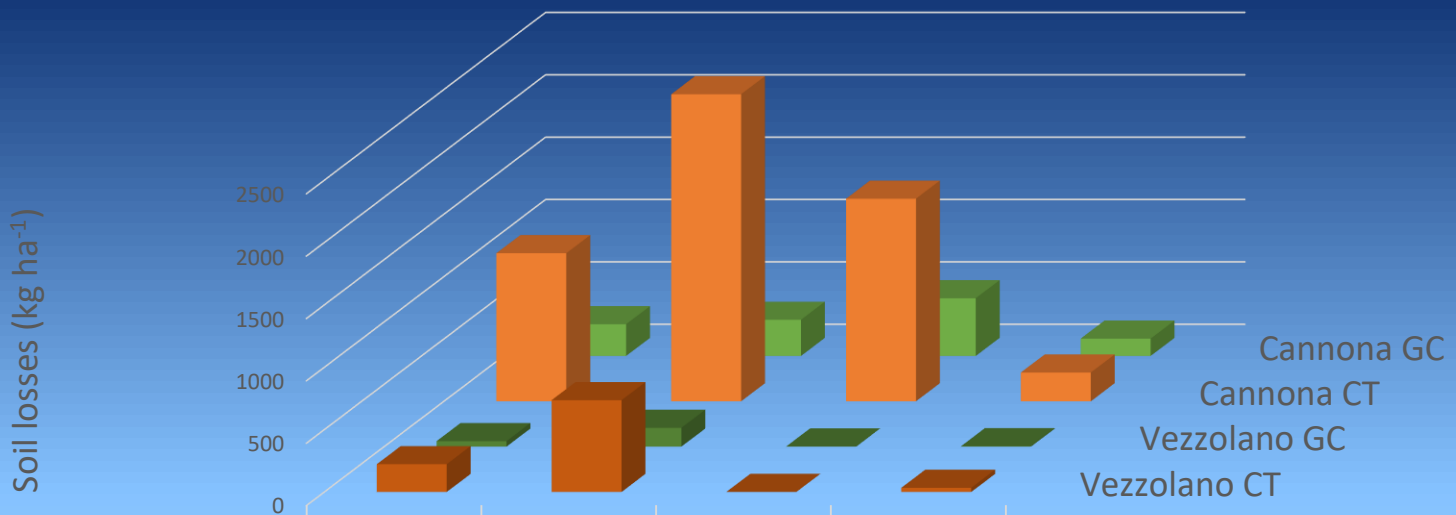
- ✓ For 86% of events RO (GC) < RO (CT)
- ✓ 5 largest events (20% of P = 42% of erosivity) → **34% and 40 % of runoff in CT and GC**
- ✓ **Long lasting** events produced significantly higher RO than other types
- ✓ RO ranged between 5,8-26,8 % (reduction of about 50% by GC)
- ✓ Positive correlation between **Rdepth** and RO for the totality of events



	All events	Intense	Long-lasting	Normal
Vezzolano CT	222.6	735.9	0.8	33.3
Vezzolano GC	44.0	150.6	1.1	3.6
Cannona CT	1187.3	2462.1	1624.4	230.8
Cannona GC	254.3	289.6	463.0	138.9

Soil losses in Vezzolano (contour)

- ✓ For 61% of events SL (GC) < SL (CT)
- ✓ 5 largest events (17% of P = 94% of erosivity) → **95% and 94 % of soil losses in CT and GC**
- ✓ SL max for **intense** events
- ✓ No interaction effect between treatment and type of events
- ✓ Type of event influences SSC: Intense events have significant impact on SSC
- ✓ Positive correlation between I30 and RO, SSC, SL for the totality of events



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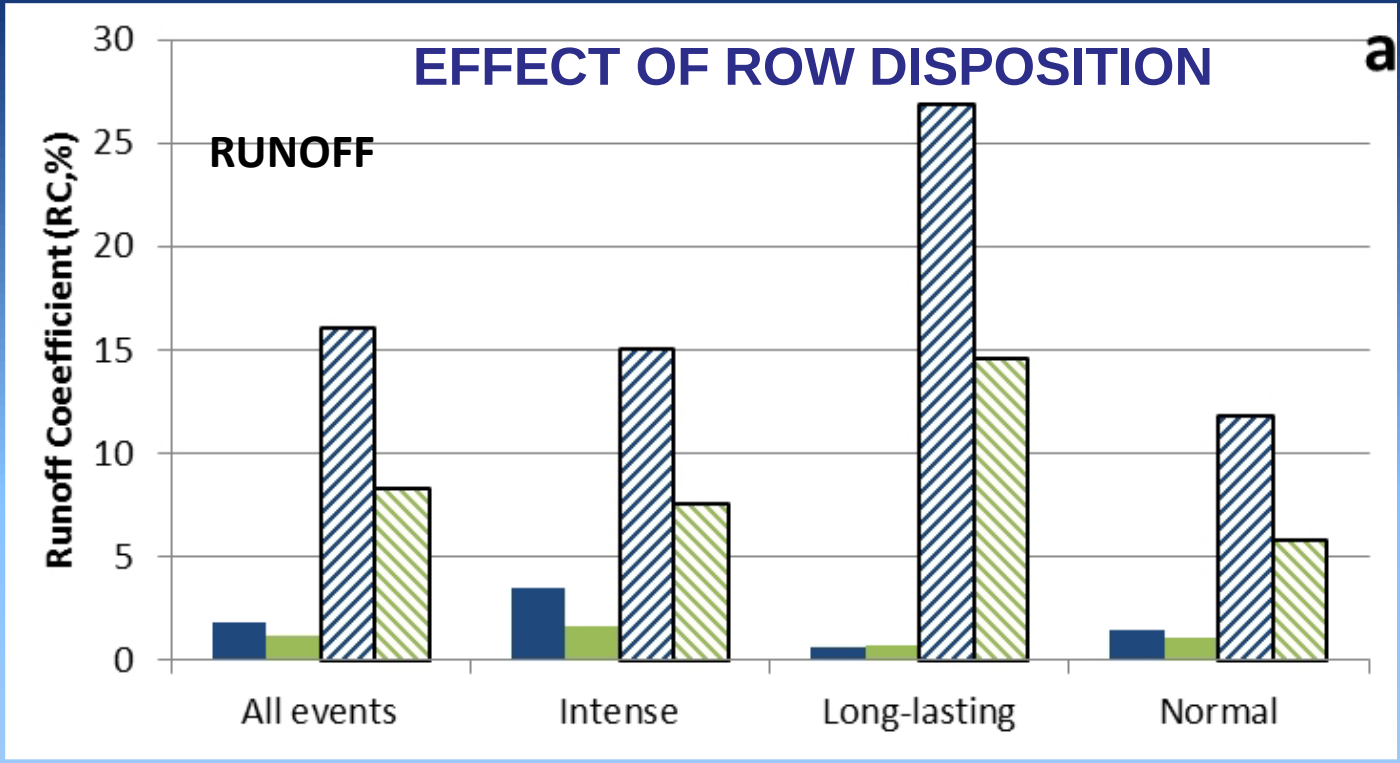
Cannona CT	1187.3	2462.1	1624.4	230.8
Cannona GC	254.3	289.6	463.0	138.9

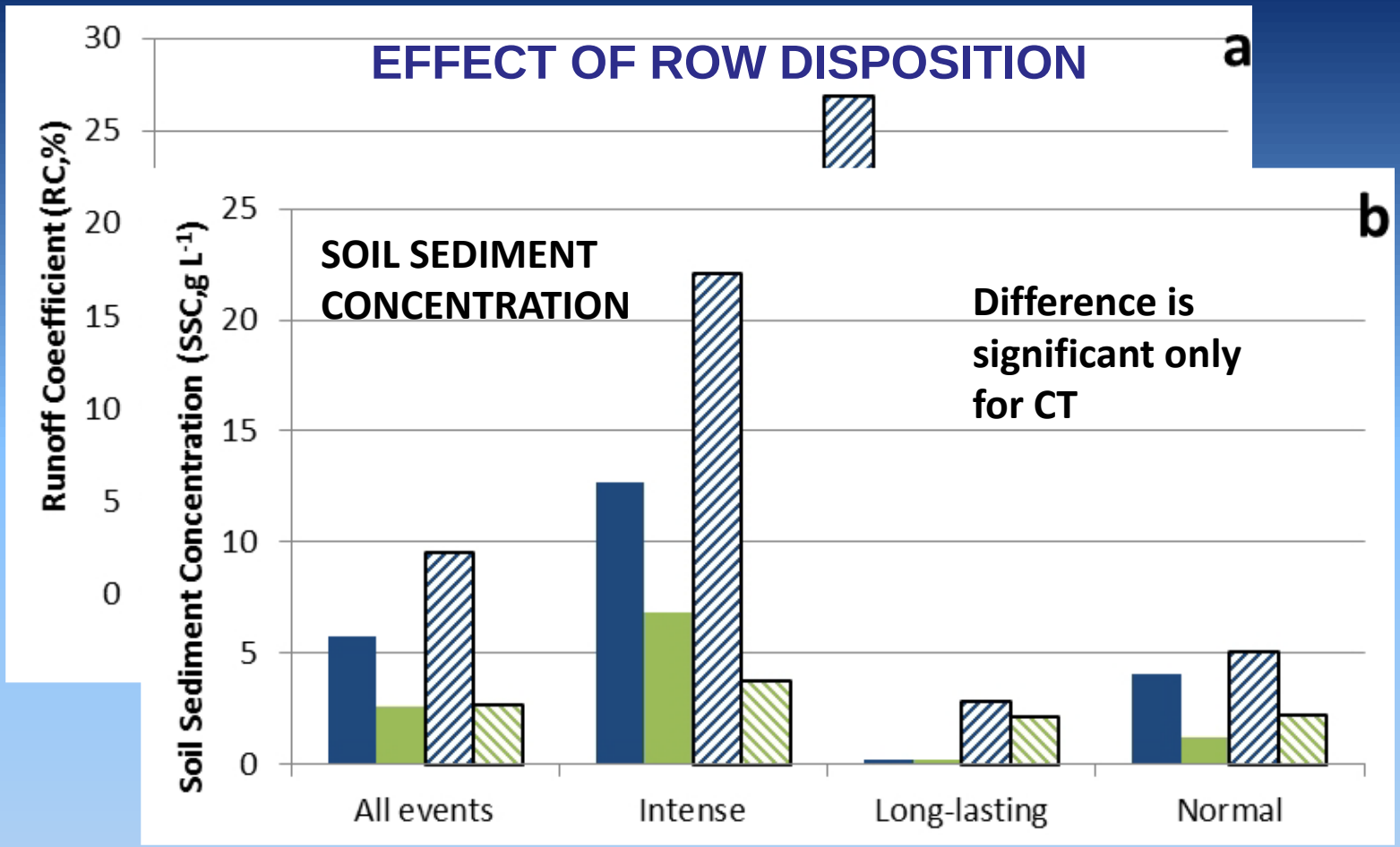
Soil losses in Cannona (up-and-down)

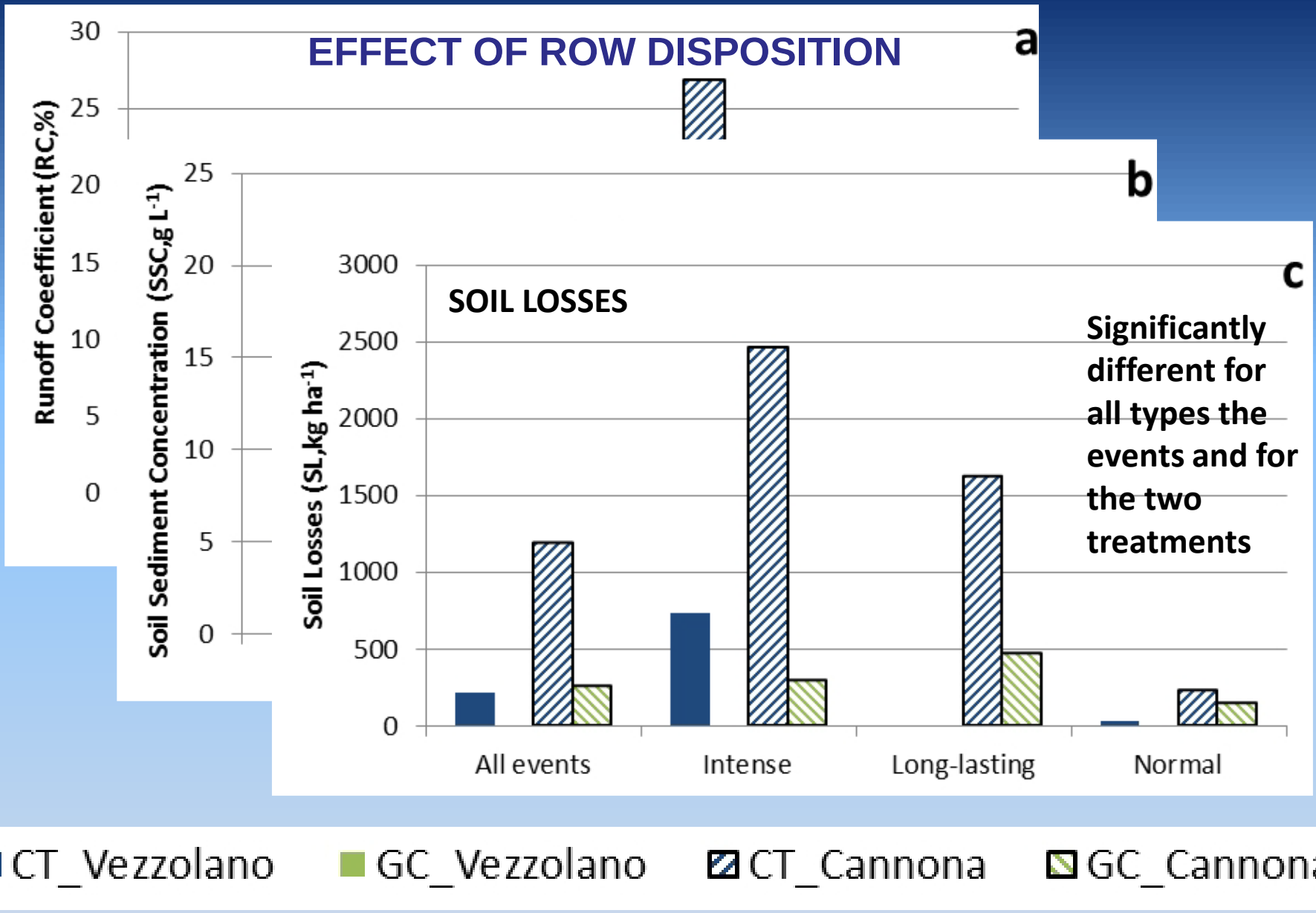
- ✓ For 92% of events SL (GC) < SL (CT)
- ✓ 5 largest events (20% of P = 42% of erosivity) → 59% and 54% of soil losses in CT and GC
- ✓ SL max for **intense** events **(CT)** and **long-lasting** events **(GC)**
- ✓ Significant effect of treatment, type of event and interaction effect on all variables
- ✓ Influence of rainfall characteristics on investigated variables is very different considering treatments and type of events



Significantly different for all types the events and for the two treatments

CT_Vezzolano GC_Vezzolano CT_Cannona GC_Cannona


EFFECT OF ROW DISPOSITION
a
Runoff Coeefficient (RC,%)
30
25
20
15
10
5
0
b
Soil Sediment Concentration (SSC,g L-1)
25
20
15
10
5
0
SOIL SEDIMENT CONCENTRATION
Difference is significant only for CT
All events
Intense
Long-lasting
Normal
CT_Vezzolano
GC_Vezzolano
CT_Cannona
GC_Cannona


EFFECT OF ROW DISPOSITION
a
Runoff Coeefficient (RC,%)
30
25
20
15
10
5
0
b
Soil Sediment Concentration (SSC,g L-1)
25
20
15
10
5
0
c
SOIL LOSSES
Soil Losses (SL,kg ha-1)
3000
2500
2000
1500
1000
500
0
All events
Intense
Long-lasting
Normal
Significantly different for all types the events and for the two treatments
CT_Vezzolano
GC_Vezzolano
CT_Cannona
GC_Cannona

RAINFALL CHARACTERISTICS

- The highest runoff and soil losses depend on a **few extreme rainfall events**, namely "long-lasting" (rainfall duration > 50h) or "intense" events (rainfall Imax30 > 16mm/h)

- **Rainfall maximum intensity** and **rainfall depth** resulted the most important rainfall variables in predicting the degree of runoff and soil loss.

VINEYARD MANAGEMENT

- **Effectiveness of grass cover (GC) in preventing runoff and soil erosion in sloping vineyards with respect to conventional tillage (CT) was obderved** especially during "intense" erosive events.

- **The GC effectiveness varied according to the type of the event and in relation to row orientation** → GC was particularly performing in vineyards with rows up and down the slope

- Fundamental **role of rows orientation along contour lines in preventing runoff and soil losses** in vineyards

Please cite this article as: Bagagiolo, G., Environmental Research (2018), https://doi.org/10.1016/j.envres.2018.06.048

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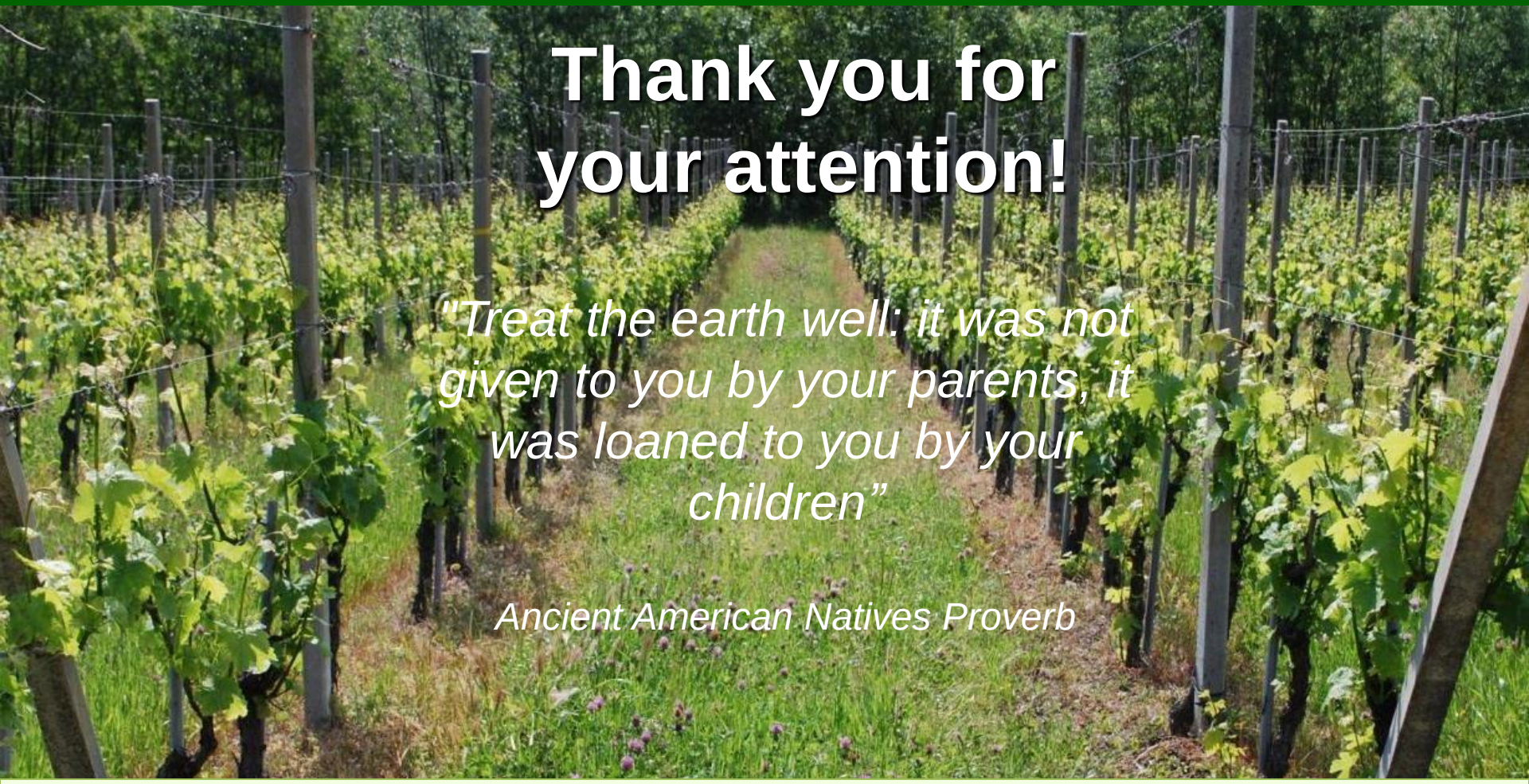

Thank you for your attention!

"Treat the earth well: it was not given to you by your parents, it was loaned to you by your children"

Ancient American Natives Proverb

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This study was conducted with the support of Fondazione CRT (research project "Recupero e valorizzazione delle serie storiche di dati agro-meteorologici di Vezzolano").

Fondazione CRT