

Triticum heritage varieties and EPs under organic farming as an opportunity

for mountain farms: the Bio2 project

Silvia Folloni¹, Cristina Piazza², Mia Marchini^{1,3}, Andrea Barbieri⁴, Salvatore Ceccarelli¹, Marco Spaggiari³, Margherita Dall'Asta³, Francesca Scazzina³

¹ Open Fields Srl, Italy, s.folloni@openfields.it;

² Azienda Agraria Sperimentale Stuard, Italy;

³ Department of Food and Drug, University of Parma, Italy;

⁴ Molino Grassi SpA, Italy.

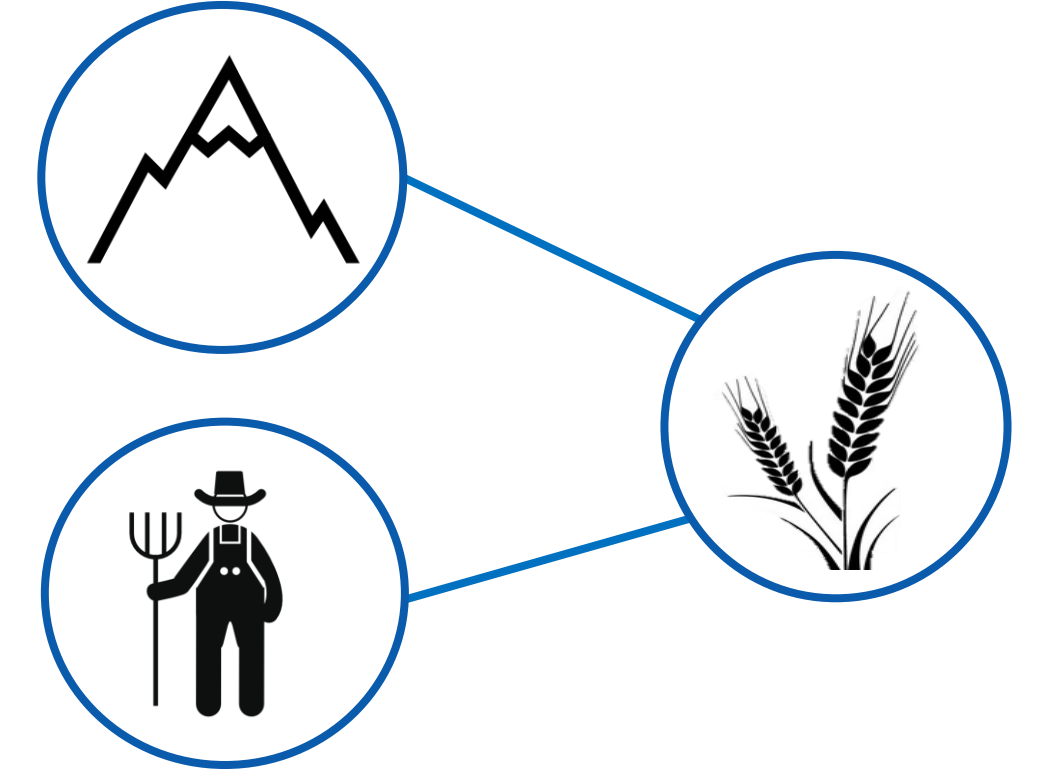


Introduction

Agriculture in mountain and high hill areas is characterized by low-input farming: the transition to certified organic production does not imply major changes in the farm management, but quite conceivably it would increase farm marginality. *Triticum* heritage varieties and ancient species are experiencing a time of rediscovery moved by a strong consumer interest. The mixtures of non-genetically uniform heritage varieties (evolutionary populations, EPs) have a higher capacity to adapt to stress factors and a changing climate than uniform varieties. They can ensure stability of both yield and quality, especially under organic or low-input conditions (Rahmanian et al, 2014).

To increase the competitiveness of mountains and high hills farms, leveraging on the cultivation of local underexploited heritage wheat varieties and EPs under organic farming, promoting *in situ* conservation of agro-biodiversity and broadening the range of cereal products available to consumers.

Aim of the project



Field Trials (Crop 2016/2017)

Small plots (10m²): organic farming @2 mountain farms; 12 bread wheat (Fiorello, Carosella, Verna, Gentilrosso, Autonomia B, Terminillo, Virgilio, Frassineto, Ardito, Mentana, Blasco*, Bologna*), 6 durum wheat (Cappelli, Timilia, Dauno, Russello, Garigliano, Odisseo*), Einkorn (ID331), Emmer (Garfagnana), Spelt (Roquin), Etrusco, Grano del Miracolo, Le Saragolle and 6 EPs (Bio2, Grossi, ICARDA, Novarese, La Collina, Bio2 *durum*) were evaluated in a fully randomized block design with 2 replications using optimized randomization. *modern variety

Big plots (1000 m²): organic farming @5 farms; 4 EPs (Bio2, Grossi, ICARDA and Bio2 *durum*).

Small plots data were analyzed using spatial analysis¹ in GenStat v16 and the resulting BLUEs (Best Linear Unbiased Estimates) were used to produce a GGE biplot. The big plots data were analyzed with a two-way ANOVA in GenStat v. 16 using the sampling within big plots as an estimate of the error variance.

Materials & Methods

Food safety & Nutrition

Mycotoxins
Trichothecenes (A+B) and Zearalenone were analyzed using an UHPLC coupled with a triple quadrupole mass spectrometer equipped with an electrospray source (ESI).

Bread production
Eight breads were produced with direct baking either with *S. cerevisiae* or with sourdough (25%). Flours were from 3 bread wheat EPs (Bio2, Grossi, ICARDA) and Bologna, all cropped in the big plots at one participating farm. Flours from EPs were all Type 1 (ashes ≤0,80) while Bologna was both Type 1 and Type 00 flour (ashes ≤0,55)².

In vitro starch digestibility

The % of starch hydrolysis during the simulated human digestion of the breads was investigated³. Resistant, non resistant and total starch were analyzed by means of AOAC method (2002.02).

Results

Field Trial Results

Var/ genotype	Prod Index %	Yield 13% moisture t/ha	HeW kg/hL	Septoria (p-0-9)	Height cm
Fiorello	93	4,49	76,2	1,0	84,84
Carosella	85	4,09	77,8	2,0	164,25
Verna	90	4,32	77,6	2,0	158,56
Gentilrosso	97	4,67	78,0	1,0	157,83
Autonomia B	113	5,45	81,7	1,0	133,78
Terminillo	98	4,73	77,2	1,0	146,43
Virgilio	102	4,91	77,9	1,5	157,57
Frassineto	69	3,33	75,9	1,0	159,19
Miracolo	85	4,08	76,9	1,0	176,54
Ardito	90	4,34	79,5	4,0	122,52
Mentana	37	1,79	79,2	1,5	142,8
Saragolla	102	4,93	82,7	2,5	158,65
Cappelli	110	5,31	79,8	1,0	144,34
Timilia	103	4,98	82,4	1,5	164,59
Etrusco	109	5,25	78,9	2,5	166,83
Dauno	110	5,30	80,7	3,5	175,32
Russello	111	5,37	82,7	0,0	155,63
Garigliano	109	5,26	79,5	2,5	146,40
ICARDA	105	5,08	79,8	1,0	159,00
La Collina	89	4,30	77,2	1,0	160,40
Novarese	90	4,32	77,7	1,0	156,39
Bio2	89	4,30	78,9	1,0	153,19
Grossi	83	3,99	78,0	1,0	167,64
Bio2 <i>durum</i>	100	4,80	81,5	1,3	168,57
ID331	49	2,38	27,6	0,0	140,94
Garfagnana	95	4,58	40,3	1,0	160,16
Roquin	78	3,75	32,3	1,0	119,54
Blasco	147	7,07	82,3	1,0	82,13
Bologna	101	4,87	79,6	1,0	82,25
Odisseo	131	6,29	81,5	1,0	80,85
All		4,71	74,7	1,39	144,90

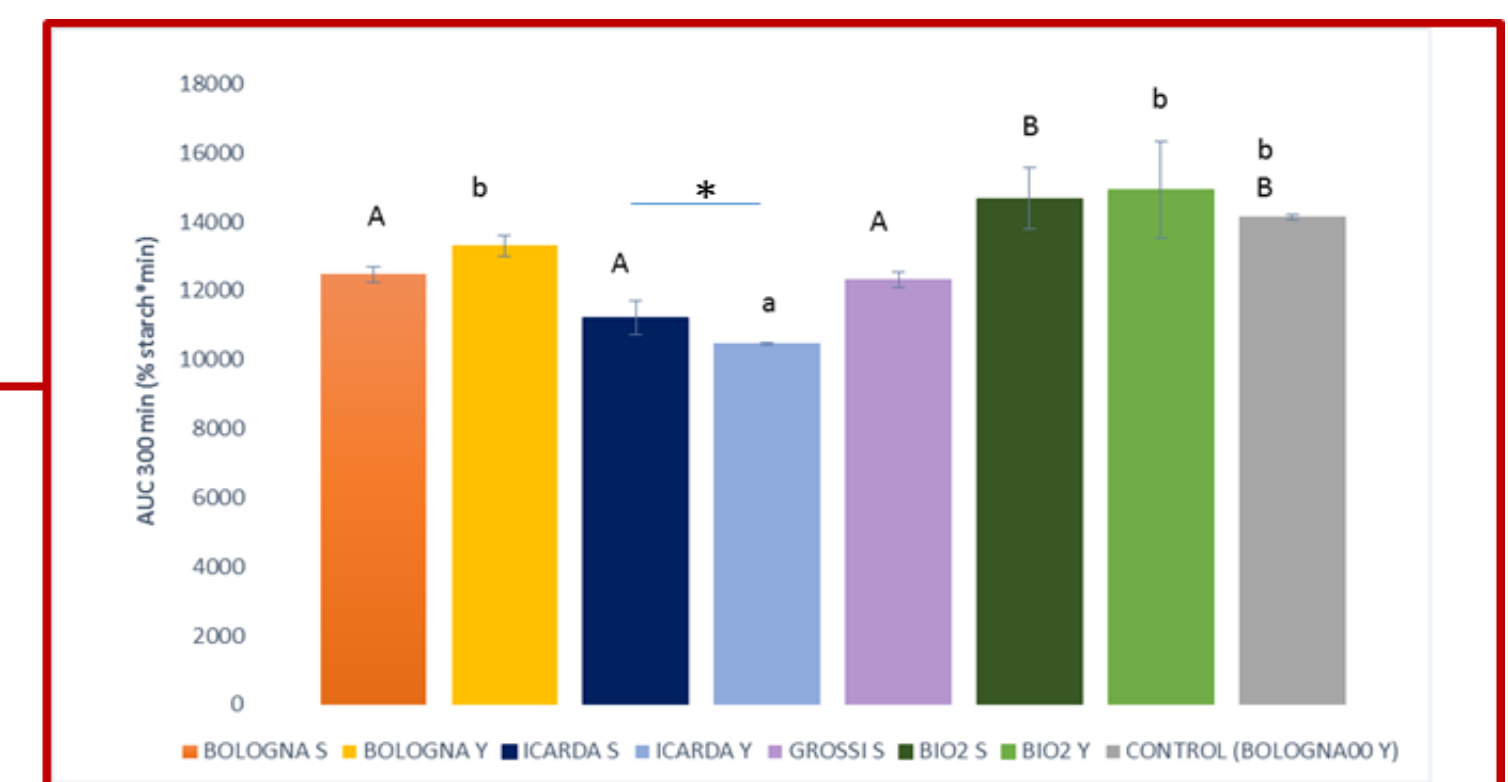
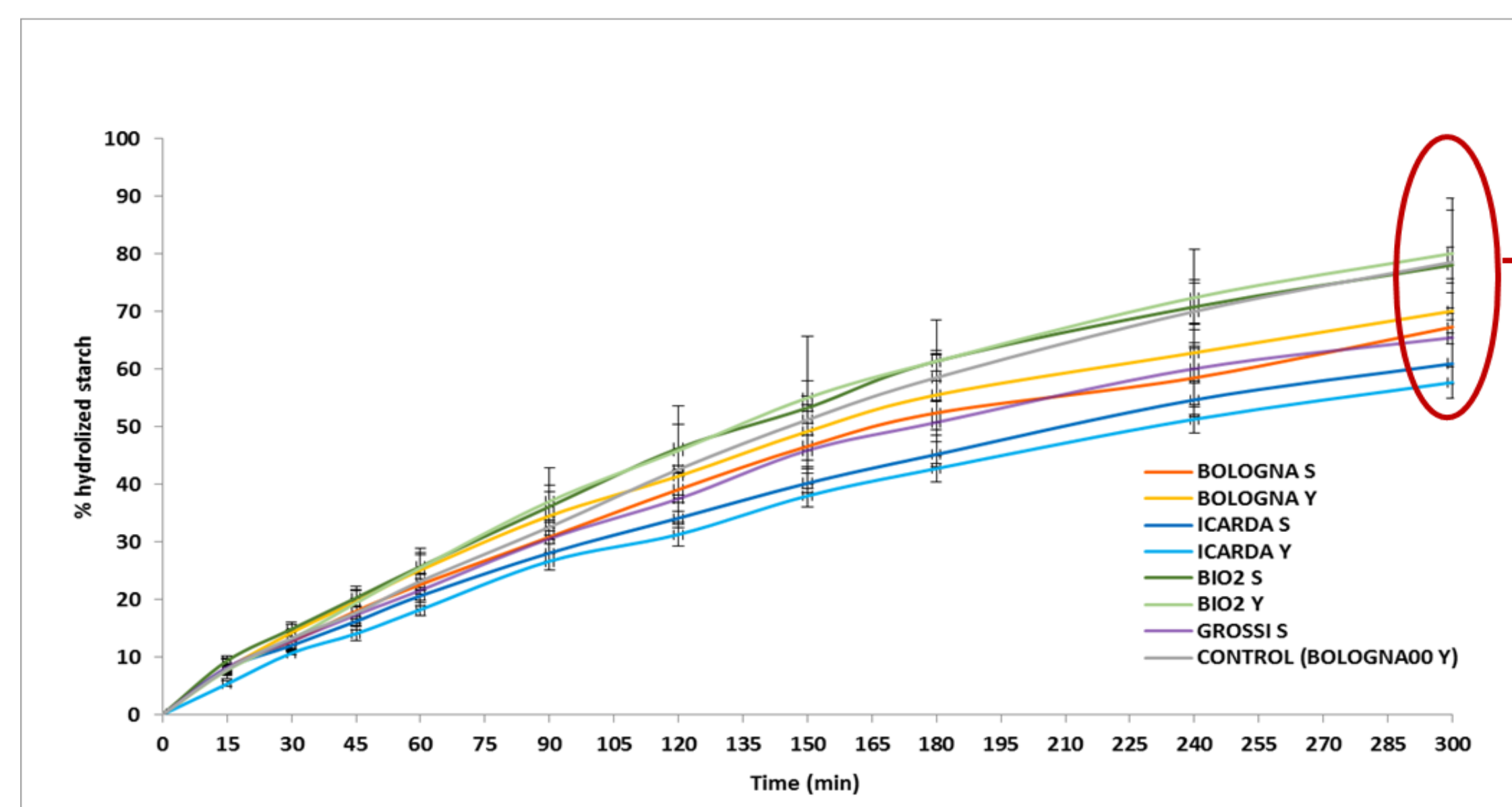


Table 1. Small Plots results

Heritage varieties/landraces of bread and durum wheat yielded 4,44 and 5,20 t/ha respectively, while modern varieties yielded 5,97 and 6,29 t/ha respectively. EPs yielded 4,46 t/ha. Only data from farm 1 (Bismantova) are reported. Yields in farm 2 (Angus) were significantly lower as plants were damaged by wild boars.

In vitro starch digestibility of breads

- ✓ The area under the curves (AUC) of hydrolyzed starch (%) was:
 - ✓ for SOURDOUGH-made breads: BIO2=Control (Bologna 00)>Bologna=Grossi=ICARDA
 - ✓ for *S. cerevisiae*-made breads: BIO2=Control (Bologna 00)=Bologna=Grossi>ICARDA
- ✓ No differences were found between the two breads made with the same flour but with the different baking method (sourdough (S) and *S. cerevisiae* yeast (Y)), except for ICARDA (p=0.045)



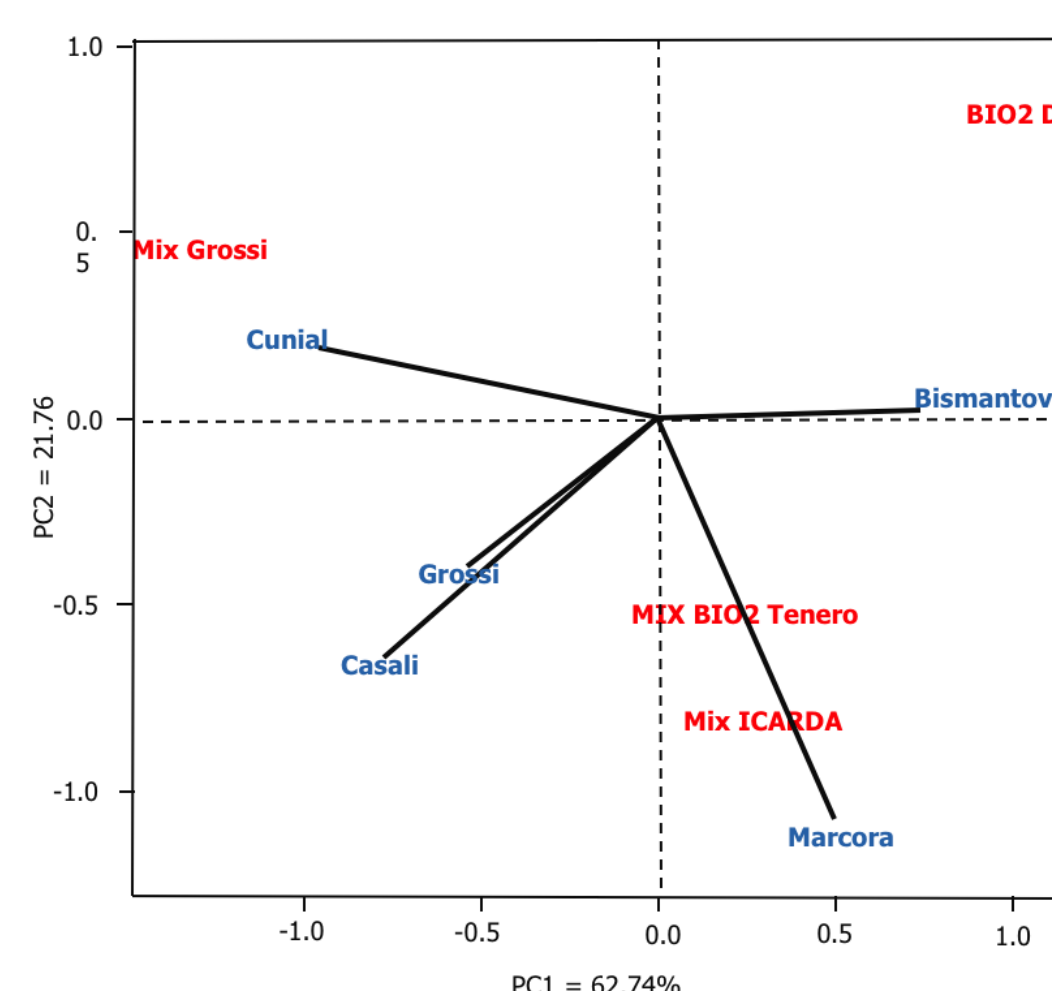
One-way ANOVA, post-hoc LSD (p<0.05). Different letters indicate statistical significance among the breads within the same type of preparation (sourdough (S) uppercase letters) or yeast (Y) (lowercase letters). *Statistical significance after the test-t between the breads made with the same flour but either with yeast or sourdough (p<0.05).

Farm	EPs	Yields 13% moisture (t/ha)	Farm Prod Index	HeW (kg/hL)	1000 kernel weight (g)	Height (cm)
Casali	Bio2	2,45	91	77,3	44,3	132,5
Casali	Bio2 <i>durum</i>	1,69	63	77,4	51,4	132,3
Casali	ICARDA	3,30	123	78,9	44,5	125,8
Casali	Grossi	3,33	124	75,8	46,6	143,0
Casali	Average	2,69 c		77,3 a	46,7 a	133,4
Bismantova	Bio2	4,26	102	75,97	42,23	145,67
Bismantova	Bio2 <i>durum</i>	5,00	120	78,03	50,27	155,05
Bismantova	ICARDA	4,29	103	77,37	41,77	135,30
Bismantova	Grossi	3,09	74	77,13	44,84	141,57
Bismantova	Average	4,16 a		77,13 a	44,78 ab	144,40
Grossi	Bio2	3,86	103	73,0	42,8	148,1
Grossi	Bio2 <i>durum</i>	3,68	98	76,3	51,0	127,1
Grossi	ICARDA	3,72	99	70,6	40,2	138,7
Grossi	Grossi	3,81	101	71,4	41,2	137,8
Grossi	Average	3,77 ab		72,8 b	43,8 bc	137,9
Cunial	Bio2	1,45	93	68,7	40,9	104,0
Cunial	Bio2 <i>durum</i>	1,37	87	69,8	48,0	101,9
Cunial	ICARDA	1,53	98	74,1	39,6	74,4
Cunial	Grossi	1,92	122	71,9	39,2	98,6
Cunial	Average	1,57 d		71,1 b	41,9 c	94,7
Angus	Bio2	3,51	108	76,7	42,3	125,6
Angus	Bio2 <i>durum</i>	3,07	94	80,7	50,5	141,9
Angus	ICARDA	3,80	117	76,7	44,1	119,8
Angus	Grossi	2,64	81	77,7	44,9	124,8
Angus	Average	3,26 bc		78,0 a	45,4 ab	128,0
Farm		p<0,001		p<0,001	p=0,006	p<0,001
ICARDA		3,329		75,53 ab	42,03 b	
Grossi		2,957		74,78 bc	43,33 b	
Bio2 <i>durum</i>		2,963		76,43 ab	50,23 a	
Bio2		3,108		74,33 c	42,5 b	
EPs		p=0,5		p<0,001	p<0,001	p=0,007
Farm*EP		p=0,067		p<0,001	p=0,9	p=0,10
Average		3,09		75,3	44,5	



Table 2. Big Plots results

Results of the big plots on the EPs from the first cropping cycle showed significant differences between the farms (p<0.001, one-way ANOVA), with yields varying from 1,6 to 4,2 t/ha (average 3,1 t/ha). The yield ranking of the different EPs varied from farm to farm, due to the different adaptability to soil characteristics and microclimate (see biplot).



Mycotoxins

- ✓ Very low degree of trichothecenes contamination found
- ✓ Only nivalenol (NIV) quantified in 4 out of 134 samples @ <600 µg/kg d.w.

Conclusions

Results from the organic cultivation of EPs in the 5 farms show that these are suitable materials to increase marginality of high hill and mountain farms as well as to increase the cultivated biodiversity.

Bio2 bread released an higher amount of starch during the *in vitro* simulated digestion compared to the other breads, excepted for the control (Bologna 00). These data need to be confirmed by an *in vivo* human trial.

References: 1. Singh et al. Exp Agr. 2003, 39: 1-10; 2. DPR n. 187/2001; 3. Brighenti et al. Eur J Clin Nutr. 1995; 49 Suppl 3:S81-8.

