Practice Abstracts

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Document Version

Version	Date	Contributor	Summary of Changes
1.0	19.05.2021	Judit Fehér, ÖMKi	Version 1

Table of Content

LIVESEED is funded by the European Union’s Horizon 2020 under grant agreement No 727230 and by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 17.00090.

Summary

6 partners contributed to the writing of the 11 Practice abstracts presented in this document. The titles together with an estimated deadline were collected on Sharepoint. Eight weeks before the deadline the authors received a reminder, with a template and guidelines to submit the first draft within four weeks. The review process was performed within two to four weeks by the Executive Committee. The final versions of the Practice abstracts are published on the LIVESEED website and will be uploaded to EIP-Agri platform as well as to Organic Eprints and Organic Farm Knowledge Platform after final validation.

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Target audience: researchers, seed networks, farmers

How to create diversified variety mixtures based on gene bank resources

Problems

More than one million accessions are kept in European gene banks. However most of these cultivars have a very low intrinsic genetic diversity. In contrast, many farmers are trying to create diversified populations suitable to organic agriculture, that are more adaptable and resilient.

Solutions

A simple but effective strategy to generate a diverse population of a crop is combining different cultivars into a mixture. Around 200 accessions of the chosen species are requested from European or international gene banks, these are multiplied and their agronomic features observed (e.g. lodging, earliness, disease resistances). After 2 to 4 years of multiplication, collectives of farmers can receive mixtures of these cultivars. The farmers can choose the characteristics of the mixtures they receive, based on the traits and qualities observed during the multiplication process.

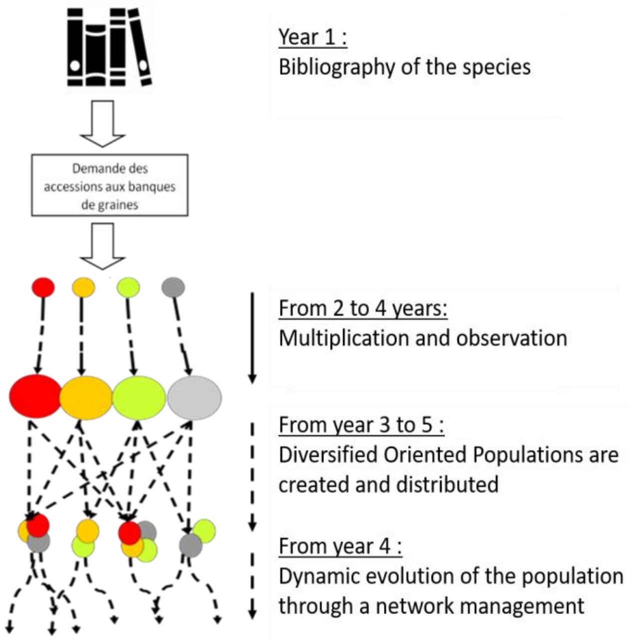

Figure: *Different steps of the method*

Practical

- Mixing numerous varieties coming from gene banks compensates their low intra-varietal diversity
- Creating populations based on phenotypical and agronomical traits accelerates the selection process for farmers
- This method requires a multiplication and observation phase of the individual accessions on single plots for a period of 2 to 4 years. It can be done by farmers' associations and/or researchers both on-farm and in research stations.

Further information

1. Mobilisation of forgotten biodiversity via on-farm selection, on the example of rivet wheat (in French): http://itab.asso.fr/publications/aa-biodiv-oubliee-poulard.php
2. PA#57 Comparison of two breeding strategies for soft wheat populations
3. LIVESEED Booklet#1: "How to implement the organic regulation to increase production & use of organic seed" Part Three - Alternative sources of organic seed https://www.liveseed.eu/tools-for-practitioners/booklets/

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PRACTICE ABSTRACT No. 57

Target audience: researchers, seed networks, farmers

Comparison of two breeding strategies for soft wheat populations

Problems

For many years, French farmers have developed diversified soft wheat farm cultivars for organic farming, by using mass selection, mixtures (called dynamic populations) or manual crosses (CCP). How do we determine which method is best between manual crosses and mixtures? What is the influence of the breeding strategy on the agronomical behavior of populations and their phenotypical diversity?

Solutions

Two populations have been created in 2015 : the first one results from the manual two by two crossings of six parents from different populations, whereas for the second one, the six parents were mixed without crossings. The populations were cultivated and observed on two sites for several years and were compared by observing several characteristics, such as phenotypical diversity or agronomical traits. The first results seem to show that after five years of evolution, in different location and under natural and farmer selection, the breeding method had a smaller effect on the agronomical behavior and the phenotypical diversity of a population, than location adaptation and human selection.

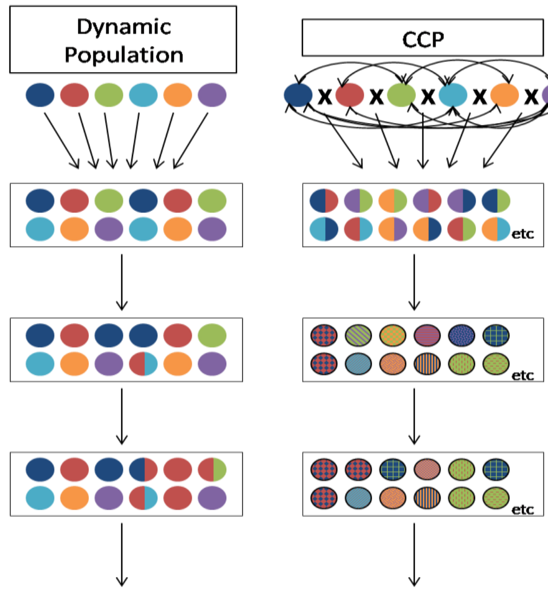

Figure: *Representation of the two methods to build the populations*

Practical recommendations

- Manual crossings do not seem to create more diversity than mixtures in the case of wheat
- The breeding method chosen to create populations does not seem to have an influence on the agronomical behavior of the populations
- Manual crosses can be challenging for farmers and practitioners. Therefore, it is easier and more interesting to start creating diversified population by mixing cultivars, rather than crossing them with one-another.

Further information

1. Comparison of two strategies for creating diversified populations of soft wheat, adapted to organic farming (in French): https://orgprints.org/37983/
2. PA#56 How to create diversified variety mixtures based on gene bank resources
3. PA#58 Influence of location and human selection on two soft wheat populations
4. Comparative analysis of performance and stability among CCPs, variety mixtures and pure lines of winter wheat in organic and conventional (Doering T.F. et al. 2015 dx.doi.org/10.1016/j.fcr.2015.08.009

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Influence of location and human selection on two soft wheat populations

Problems

For many years, French farmers have developed farm varieties for organic farming with high diversity, by using mixtures (dynamic populations) or crosses (CCP). What are the factors that influence the agronomical behavior and the phenotypical diversity of the populations created thanks to those two methods (see PA#57"Comparison of two breeding strategies for soft wheat populations")?

Solutions

Two populations coming from two different breeding strategies (mixture and manual crossing) both were cultivated in two different farms since 2015. Manual crossings were conducted two by two for each variety, meaning that every variety was used as male and as female in the creation of the populations.
Each population has undergone a mass selection by farmer and two bakers in 2018, each one of them choosing 60 spikes with their own criteria.
The agronomical behavior of the populations and their phenotypical diversity were followed, based on criteria such as the height of the straw and spikes, the color of the spikes, the number of fertile spikelets or the yield.

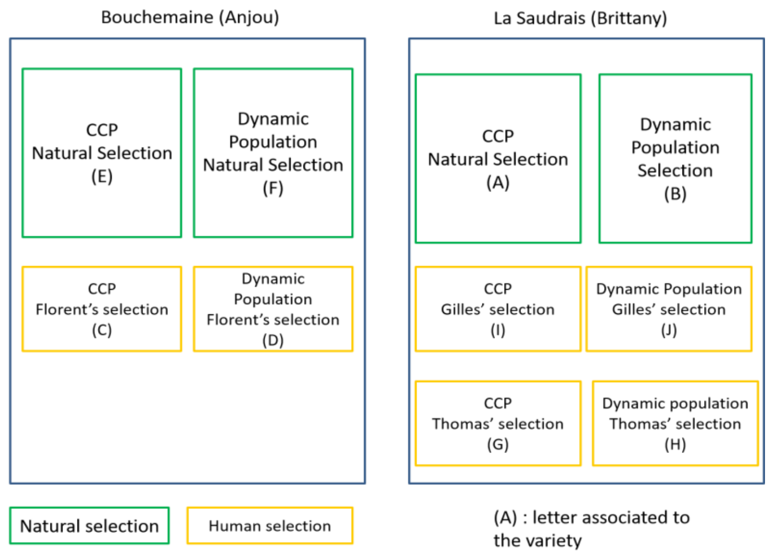

***Figure:** Experimental plots on the two locations*

Practical recommendations

- This experiment shows that the environment of a population is a more important factor than the breeding strategy (manual crossing or mixtures). It is even more important in organic farming where we do no seek for a homogenized environment.
- Human selection (as it was conducted by the actors involved in this experiment) seems to be the most important factor on the evolution of a population, at least for the first year after the selection. Mass selection can enhance the agronomical criteria without reducing the diversity of a population.

Further information

1. Comparison of two strategies for creating diversified populations of soft wheat, adapted to organic farming (in French): https://orgprints.org/37983/
2. PA#57 Comparison of two breeding strategies for soft wheat populations

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Treating wheat seed with vinegar against common bunt

Problems

Common bunt is a devastating seed borne disease in wheat and related cereals. Starting from just a few spores in a seed batch, the disease can develop in the crop reducing grain yield and especially quality.

Vinegar treatment in a cement drum. (Photo: Matteo Petitti)

Solutions

Vinegar treatment

Acetic acid is very effective to control common bunt in wheat. Seed treatments with white vinegar can easily be applied on-farm, but germination can be harmed if it is not applied properly.

Caution: *A vinegar treatment will protect seeds from bunt spores on the seed, but not in the soil. It is efficient after proper seed cleaning (→ Practice Abstract no. 2). Can be used to protect related (hulled) cereals (such as spelt and emmer) from bunt, but might be less effective, or greater quantities are needed.*

Practical recommendations

- **For 100 kg seed → approx. 1,7 l of vinegar (4%)** *(If the concentration is more then 4%, dilute with cold water to reach 4%. According to practical experience, 1,7 l of liquid for 100 kg of seed is usually enough to treat all seeds without wetting them too much, but you may need to adjust according to seed humidity.)*
- On-farm, you can use a cement drum to treat seed batches. For small seed quantities (e.g. in collections), you can simply use a hand-sprayer for treating, while shaking the seeds in a small container.
- Avoid using high concentrations: beyond 5% acetic acid, germination rates are reduced in some experiments.
- Dry quickly and thoroughly the seeds after treating to preserve seed quality.
- If the treated seed is actively dried after treatment (e.g. by a hot airstream), let the vinegar work on the seed for approximately a minute before drying.
- Make sure that the entire seed surface is covered! It is crucial that the application is as uniform as possible, as fast as possible, to avoid the acetic acid from evaporating and the seed from imbibing too much liquid.

Further information

1. Video on bunt treatment methods: https://www.liveseed.eu/tools-for-practitioners/videos/
2. Webpage on bunt management: http://itab.asso.fr/activites/gc-eng-carie-gestion.php
3. Borgen, A. og B.J.Nielsen 2001: Effect of seed treatment with acetic acid in control of seed borne diseases. In: Proceedings from BCPC Symposium No. 76: "Seed Treatment: Challenges & Opportunities", eds. A. J. Biddle. BCPC, Farnham, 135-140.
4. Commission implementing regulation (EU) 2015/1108 of 8 July 2015 approving the basic substance vinegar in accordance with Regulation (EC) No 1107/2009, amending the Annex to Commission Implementing Regulation (EU) No 540/2011
5. Review report on vinegar: https://mst.dk/media/173693/vinegar_final_rr_2018.pdf

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PRACTICE ABSTRACT No. 60
Target audience: public authorities, breeders, researchers

AGES LIVESEED

Usability of results from conventional trials for organic rye cultivation

Problems

Winter rye was cultivated in Austria 2019 on 15.899 ha on organic farms. That corresponds to an area of 36.4 % of the total cultivated rye area. Since 2015, this percentage increased continuously from 29.3%. Nevertheless, not in all regions results of organic trials are available.

Solutions

In Austria, organic trial results from randomised plots are available in the "Waldviertel", in the Northern foothills, in the Carinthian basin and in alpine regions of Styria. In other regions sometimes conventional trials are performed. The research question was, whether those trials could be used as a decision base for organic farming as well. That is why organic (ORG) and conventional (CON) trials of two sites in the "Waldviertel" from 2016 to 2020 were taken into the correlation analysis, comparing the behavior of a collection of 22 usually grown varieties.

Practical recommendations

The data showed that:

- The mean values of most of the observed parameters were significantly different between ORG and CON (only heading and hectoliter weight showed the same level).
- However, the high correlations found in several parameters suggest that varieties behave nearly in the same way: date of heading, date of ripening, plant height, yield, protein content, amylograph values.
- The behaviour of other parameters are moderately to largely comparable between the two systems: lodging, hectolitre weight, falling number.
- Only at the thousand kernel weight no correlation was found.

Parameter	Convent. trials	Organic trials	Intervar. correlation, r=…
Yield, dt/ha	89,1	72,3	0,94**
Date of heading, days from 1st Jan.	138	138	0,93**
Date of ripening, days from 1st Jan.	202	196	0,94**
Plant height, cm	153	139	0,97**
Lodging, score 1-9	4,4	3,0	0,59**
Thousand kernel weight, g dm	27,0	27,7	0,38
Hectolitre weight, kg	74,2	74,7	0,71**
Protein content, % dm	9,5	8,8	0,84**
Falling number, s	254	277	0,67**
Amylograph gelatinization maximum, AU	1046	1363	0,85**
Amylograph gelatinization temperature, °C	71,7	74,4	0,72**

Table: *Comparison of results in rye under conventional and organic cultivation (10 trials per system 2016-2020, adjusted means, intervarietal correlation, 22 varieties*

Further information

1. BAES (2020): 12_Cereals in organic farming (available only in German). In: Austrian Descriptive list of varieties 2020 – Agricultural species. https://bsl.baes.gv.at/pdf-version/
2. Oberforster M (2006): Ist die Sortenzulassungsprüfung biogerecht? Bericht Österreichische Fachtagung für biologische Landwirtschaft, 15-20.

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Usability of results from conventional trials for organic triticale cultivation

Problems

Winter triticale was cultivated in Austria 2019 on 17.293 ha on organic farms. That corresponds to an area of 28.9 % of the total cultivated triticale area. Since 2012, this percentage increased continuously from 17.6 %. Nevertheless, not in all regions results of organic exact trials are available.

Solutions

In Austria, organic trial results from randomised plots are available in the "Waldviertel", in the Northern foothills, in the Carinthian basin and in alpine regions of Styria. In other regions often only conventional trials are performed. The research question was, whether those trials could be used as a decision base for organic farming as well. That is why organic and conventional trials with commonly grown varieties of two sides in the "Waldviertel" and one of the Northern foothills from 2016 to 2020 were taken into the correlation analysis.

Practical recommendations

The data showed that:

- The mean values of grain and protein yield, heading and ripening date, plant height, hecto-litre weight and protein content are significantly lower in organic than in conventional farming. The mean values of the deceases and the thousand kernel weight were indiscernible.
- However, the high correlations found in most of the parameters suggest that varieties behave nearly in the same way: date of heading, date of ripening, plant height, lodging, thousand kernel weight, hectolitre weight.
- At other parameters the behaviour of the varieties is highly comparable between the two systems: yield, brown and yellow rust, *Rhyncho-sporium*, falling number, protein content.
- The lowest correlations were found in protein yield.

Parameter	Convent. trials	Organic trials	Intervar. correlation, r=…
Yield, dt/ha	98,6	67,1	0,81**
Protein yield, dt/ha	11,1	6,5	0,50*
Date of heading, days from 1st Jan.	144	140	0,92**
Date of ripening, days from 1st Jan.	198	194	0,88**
Plant height, cm	115	103	0,99**
Lodging, score 1-9	2,8	1,8	0,95**
Yellow rust, score 1-9	2,8	2,5	0,78**
Brown rust, score 1-9	3,5	3,3	0,84**
Rhynchosporium leaf bloch, score 1-9	2,7	2,1	0,86**
Thousand kernel weight, g dm	38,4	38,2	0,92**
Hectolitre weight, kg	72,8	71,3	0,87**
Protein content, % dm	13,1	11,1	0,75**
Falling number, s	109	97	0,79**

Table: *Comparison of results in triticale under conventional and organic cultivation (15 trials per system 2016-2020, adjusted means, intervarietal correlation, 14-20 varieties)*

Further information

1. BAES (2020): 12_Cereals in organic farming (available only in German). In: Austrian Descriptive list of varieties 2020 – Agricultural species. https://bsl.baes.gv.at/pdf-version/
2. Oberforster M (2006): Ist die Sortenzulassungsprüfung biogerecht? Bericht Österreichische Fachtagung für biologische Landwirtschaft, 15-20.

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PRACTICE ABSTRACT No. 62

Target audience: public authorities, breeders, researchers

AGES LIVESEED

Susceptibility of winter wheat cultivars to various isolates of common bunt (*Tilletia caries*)

Problems

Common bunt (*Tilletia caries*) is a damaging fungal disease, affecting the spikes and seeds, which especially impacts organic farming. Winter wheat is most frequently affected. Several races of the fungus have been identified, each of which has different pathogenicity.

Solutions

Given the limited options to treat seeds under organic farming conditions, it is desirable to increase the resistance of organic crop plants to seed-transmitted diseases. Several race-specific, effective resistance genes to bunt have been identified (Hoffmann and Metzger 1976, Goates 2012). It would be possible to achieve broadly effective resistance by pyramiding several *Bt* resistance genes.

Practical recommendations

The wheat cultivars 'Capo' (without bunt resistance), 'Tillexus' (*Bt10*), 'Tilliko' (*BtZ*) and 'Tillsano' (*Bt5* group; Borgen A., Loeschenberger F., pers. communication) were included in the study. Seeds were artificially inoculated with 10 spore isolates of common bunt (3 g per kg). These are not single spore isolates. The spores originated from naturally infected spikes collected from different regions of Austria. The trials were carried out using a randomised block design with 2 replicates. The cultivar 'Capo' was heavily infected by all spore isolates (65.7–81.9%). Because 'Tillexus', 'Tilliko' and 'Tillsano' displayed varying reactions, this confirms that they carry different resistance genes. The cultivars reacted similarly to spore isolates 1, 4 and 7 and 2, 6, 9 and 11, respectively. Isolates 3 and 5 or 4 and 8 also elicited similar reactions from the cultivars. 'Tillexus' was more strongly infected by six and 'Tilliko' by two spore isolates. 'Tillsano' showed good resistance to all isolates (3.0–8.5% infected spikes).

Isolate	Capo (–)	Tillexus (*Bt10*)	Tilliko (*BtZ*)	Tillsano (*Bt5*)
Nr. 1	69.5	0.6	0.5	6.1
Nr. 2	77.9	28.0	6.7	3.9
Nr. 3	76.9	69.1	35.2	6.1
Nr. 4	69.7	7.2	3.2	6.5
Nr. 5	65.7	66.5	31.6	4.6
Nr. 6	80.8	48.2	19.3	5.0
Nr. 7	72.7	2.2	1.5	3.0
Nr. 8	81.9	12.9	2.9	5.3
Nr. 9	78.2	28.9	14.9	8.5
Nr. 11	76.4	33.2	15.2	3.3

Table: *Spikes displaying symptoms of common bunt infection (%) from four winter wheat cultivars after the seeds were inoculated with 10 spore isolates (average of 4 trials, 2019-2020).*

Further information

1. Hoffmann J.A., Metzger R.J. (1976): Current Status of Virulence Genes and Pathogenic Races of the Wheat Bunt Fungi in the Northwestern USA. Phytopathology 66:657-660. DOI: 10.1094/Phyto-66-657
2. Goates B.J. (2012): Identification of New Pathogenic Races of Common Bunt and Dwarf Bunt Fungi, and Evaluation of Known Races Using an Expanded Set of Differential Wheat Lines. Plant Disease 96(3):361-369. DOI: 10.1094/PDIS-04-11-0339

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PRACTICE ABSTRACT No. 63

Target audience: national authorities, expert groups, seed producers, farmers

ORGANIC RESEARCH CENTRE

LIVESEED

Farmers' perspectives on the use of organic seed in European organic agriculture

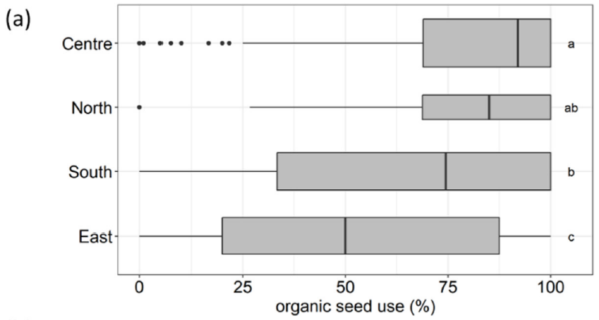
Problems

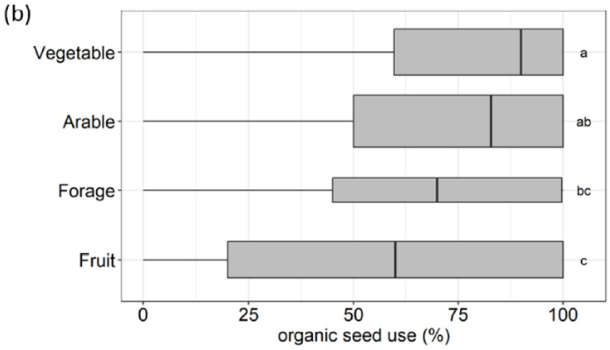
The European Organic Regulation 2018/848 aims to phase derogations for the use of untreated non-organic seed by 2036, the use of organic seed by farmers in Europe is still low. How reali is this target and what factors drive seed choice?

Solutions

A survey was conducted to identify the factors affecting the use of organic seed, with a sample of about 750 organic farmers in Central, Eastern, Northern and Southern Europe.
Our results show that:

- Farmers in Central Europe use more organic seed than in the other regions (Figure a).
- Farm saved seed plays an important role in the coverage of organic seed, especially in Eastern and Southern Europe.
- Organic seed use is highest in the vegetable sector, followed by the arable, forage and fruit sector (Figure b).





- Organic seed is mainly used by farms in short and specialised supply chains.
- Organic seed use decreases as farms get larger and more recently converted.
- The main issue reported by the farmers is the availability of organic seed for the varieties they need.
- Decision to use organic seed is influenced by perception of societal expectations, particularly from the consumer and the organic certifier.

Practical recommendations

The supply of organic seed for a large range of crops species and cultivars should be improved to meet farmers' demand, so that crop and market diversification is not at risk. From the demand side, the communication of societal expectations in the public discourse can stimulate organic seed use.

Further information

1. Orsini S, Costanzo A, Solfanelli F, Zanoli R, Padel S, Messmer MM, Winter E, Schaefer F (2020) Factors Affecting the Use of Organic Seed by Organic Farmers in Europe. Sustainability, 12(20), 8540 https://doi.org/10.3390/su12208540

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How to increase the efficiency of cultivar choice in organic farming

Problems

All farmers are searching for the best performing cultivars, but there is still lack of knowledge on the most efficient way to choose these cultivars in organic agriculture. Additionally, there is a strong limitation in the number of cultivars that can be tested annually with current on-farm trials.

Solutions

The use of small plot trials in on-farm testing environments as an initial screening trial would greatly increase the number of cultivars that could be examined under the targeted organic conditions. Cooperation between farmers and nearby research institutions would give the possibility to establish small plot trials on farmers' fields with research machinery.

In the case of winter wheat, the best (in NIR, e.g. protein and gluten) and worst (in grain yield) performing group of cultivars are the same in on-farm testing and small plot trials, thus effective further testing on-farm can be carried out. Testing of such preselected cultivars under farming conditions (mainly for yield) would help to choose the most reliable wheat cultivar(s) for the target environment.

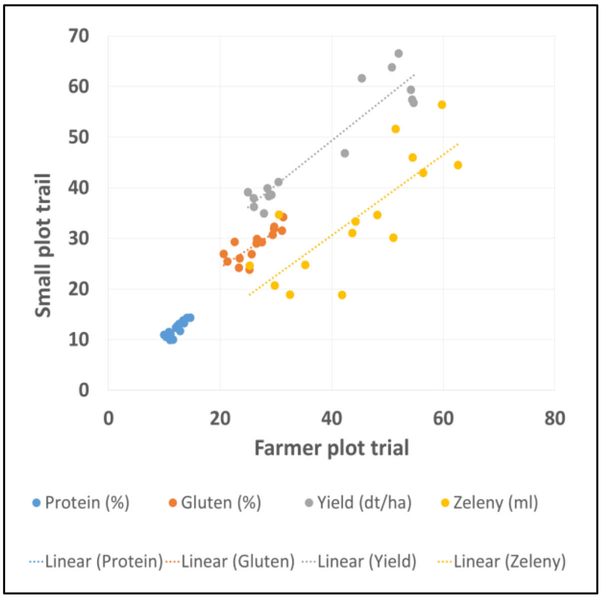

Figure: *Correlation between wheat trial types (2019-2020, Hungary)*

Practical recommendations

- The first step is testing cultivars in replicated randomized small plot trials for two years, assessing the most important traits like yield, disease resistance, lodging and quality.
- Based on the ranking of the tested cultivars, the best performing ones could be tested on large farm plots for one more year, following a more detailed assessment protocol. Rapid NIR measurement is adequate to determine a ranking regarding quality traits.

Further information

1. Eucarpia-LIVESEED 2021 conference abstract/poster on winter wheat by Mikó et al. https://eucarpialiveseed2021.eu/posters/p44-on-farm-comparison-of-trials-based-on-different-plot-sizes-to-help-farmers-wheat-cultivar-choice/

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PRACTICE ABSTRACT No. 65
Target audience: farmers, breeders, researchers

On-farm breeding for wheat mixtures

Problems

In recent years farmers showed a growing interest in **cultivating wheat variety mixtures**, and in **selecting on-farm** populations that are adapted to the local context. However, **many practices exist for creating and breeding for mixtures**: from mixing a small number of carefully chosen cultivars, to mixing a large diversity which perform well in the farm, selecting within cultivars before mixing, selecting within the mixture, adding cultivars over the years, … Understanding the impact of different selection practices on mixtures behavior, should help farmers breed their own adapted mixture on farm.

Solutions

Three selection practices were identified and compared using a 3-year experimental design: two years of selection within components before mixing (M1); one year of selection within components, mix these selection and one year of selection within this new mixture (M2); and two years of selection within the mixture. The selected mixtures were compared to the non-selected mixture (M4). Each farmer created mixtures from the components of his/her choice. Results showed a **larger response to selection for some productivity and morphological traits when selecting within the mixture** (M3), with a tendency **to conserve more diversity when selecting within components before mixing** (M1).Gains obtained with selection depended mostly on farmers' selection intensity.

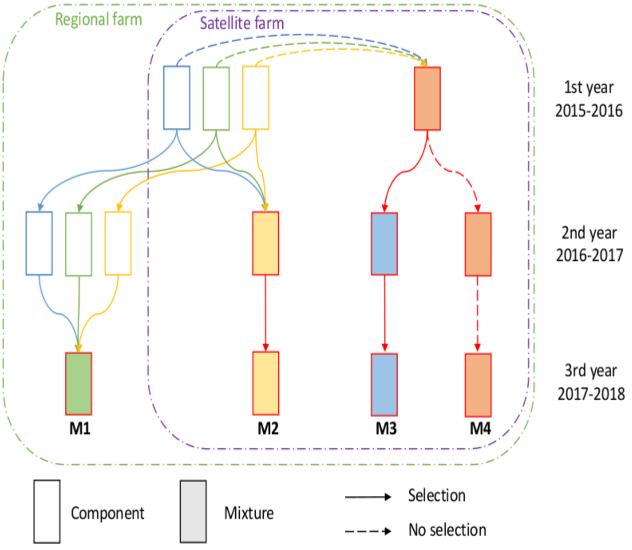

Figure: *Scheme of the 3-years experimental design to compare mixtures selection practices*

Practical

- Grow different cultivars, landraces and populations over two or three years to choose the ones adapted to your objectives.
- Determine your constraints in terms of cultivars, time and machinery: need for specific characteristics, possibility to sow multiple plots to select within components ...
- Identify the assembly rules (PA#19) and practices that are adapted to your breeding goals and constraints: select within the mixture to obtain a quicker response to selection or select within components if your goal is to conserve more diversity.

Further information

The experiment was co-constructed with farmers from the Réseau Semences Paysannes in France.

1. PA#19 Co-design of locally adapted wheat variety mixtures
2. Gaëlle van Frank 2018 (PhD thesis) www.theses.fr/2018SACLS525

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PRACTICE ABSTRACT No. 66

Target audience: national authorities, expert groups

ORGANIC RESEARCH CENTRE

LIVESEED

Organic seed for forage crops: recommendations for a level playing field

Problems

Forage crops are the fertility engine of the organic sector, accounting for 45% of organic farmland in Europe (Willer et al. 2020). At present the use of organic seed for forages is scarce. Also, forage crops are normally sown as mixtures, but there is not a common rule across Europe: some countries consider the organic content in the seed mixture as a whole, whilst others consider the organic content of each seed component individually.

Solutions

The number of derogations is lower in countries where an established share of seed in the mixture as a whole has to be organic. This share is often set at 70%, as shown in Table 1. Some countries using the whole component approach have successfully managed to gradually increase the threshold of organic seed required, (e.g. from 30% to 70% in the UK). On the other hand, the number of derogations is higher in countries where farmers need to apply for derogations for every individual component of the seed mixture (in other words all components of the mixture have to be organic). In this case, derogations are the only option whenever a particular component is not available organically. This occurs especially when farmers want to use a highly diversified mixture.

Table 1: Thresholds of organic seed in forage mixture applied in some European countries.

Criteria to avoid derogation request	Countries
All components of the seed mixture need to be organic	Austria, Denmark, Italy, Netherlands
At least 70% of organic seed is required	Belgium, France, Germany, UK
At least 60% of organic seed is required	Switzerland

Practical recommendations

Expert groups should establish a minimum share of seed in the forage mixture that need to be organic. Although this threshold should gradually increase over time, it is advisable that a certain amount of conventional seed is allowed. This way farmers can diversify and include in the mixture minor crops for which it is currently very difficult to find organic seed. With such an approach, it would also be easier to harmonise the composition requirements across countries, ultimately resulting in a level playing field on trade in forage mixtures.

Further information

Willer H., Schlatter B., … The World of Organic Agriculture 2020: Statistics and Emerging Trends; Research Institute of Organic Agriculture (FiBL): Frick, Switzerland; IFOAM—Organics International: Bonn, Germany, 2020.

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