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Werner VOGT-KAUTE,
Miroslava APACSOVÁ-FUSKOVÁ,
Maria BERNHART, Paul BILSBORROW,
Adam BREZÁNI, Marion CHAMPAILLER,
Peter DOLNIČAR, Vuk ĐORĐEVIĆ,
Heinrich GRAUSGRUBER, Pavel HAUPTVOGEL,
Katarína JANOVIČKOVÁ, Dagmar JANOVSKÁ,
Bojan JOCKOVIĆ, Aleš KOLMANIČ, Peter MIKÓ,
Simon OGRAJŠEK, Mario PAGNOTTA,
Jarosław PLICH, Zsolt POLGÁR, Anna PEARCE,
Beata TATAROWSKA, Ion TONCEA

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ABSTRACT (FOR DISSEMINATION)	Work package 6 “Farmers Participatory trials and breeding” consisted of the three tasks: establishment of a data-recording and management system, farmer participatory field trials and participatory plant breeding. The ECOBREED consortium was able to mobilise 68 farmers in 12 countries. Populations and early lines were distributed to 62 farmers. The farmers participatory trials gave the base to spread know-how to other farmers and stakeholders, increase awareness of organic breeding and increase use of organic seed, organic varieties and organic heterogenous material.
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Executive summary

Work package 6 “Farmer Participatory Trials and Breeding” consisted of three tasks. Task 6.1 - Establishment of a Data-Recording and Management System, Task 6.2 - Farmer Participatory field trials and Task 6.3. - Participatory Plant Breeding.

Establishment of a Data-Recording and Management System

Because of a cyber-attack the data-management system at UNEW was damaged. The data already delivered were lost. Therefore, the concept for the data management of the farmers participatory trials had to be changed. Data input was done by excel sheets that were developed by partners. The results were sent to farmers and published in bulletins 2021, 2022 and 2023.

Farmer Participatory Field Trials

Farmer Participatory field trials started with pre-trials. Bulking up of wheat seed for FPT in 2020-21 took place in the 2019-20 season at SMA (UK) and PRO-BIO (CZ). This involved an early maturing sub-set of varieties for FPT (to be used in Austria, Slovenia and Serbia) and a later sub-set for use in the UK. This initial bulking up of material gave us the potential for an initial screening and evaluation of the selected varieties. Varieties were multiplied by PRO-BIO and sent to partners. Other pre-trials took place at IHAR (PL), NATUR (DE), KIS (SI) with potatoes and PRO-BIO (CZ) with buckwheat,

Farmer participatory field trials were planned with farmers groups and stakeholders. The groups also discussed future training and demonstration events. When in-person meetings were not possible because of COVID-19 restrictions, farmers were asked on the phone. Project partners prepared the trials in video conferences held in August 2020 for wheat and January 2021 for the other crops. Lists of core/common varieties were established. The partner GEO from Crete left the project. Farmer participatory trials from Crete were distributed to other countries. The wheat trials were distributed to Serbia and Italy, the soybean trials to Slovenia and Austria. There were additional trials on wheat in SI and potatoes in DE.

Farmer participatory field trials continued in 2021-2022 according to plan. Only in Romania one trial could not be executed in 2022 and was postponed to 2023.

List of varieties was discussed during field days 2021 and meetings and workshops with farmers and stakeholders. The lists of varieties stayed similar for enabling two years results of as many varieties as possible. Although we lost the US farms we could compensate this with new farms in 2022. The number of genotypes was increased. There were additional trials on wheat in SI, wheat in CZ and potatoes in DE.

Many additional Farmer Participatory field trials took place in 2023. Therefore, in total more Farmer Participatory field trials took place than planned in the beginning. The trials



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gave the opportunity for assessing more data to improve data quality and additional field days and visits that enabled intensifying communication between farmers, researchers and other stakeholders. List of assessments 2023 and data input were finalised. Further trials on microbial inoculants continued.

The ECOBREED consortium was able to mobilise 68 farmers in 12 countries to carry out farmers participatory trials. The FPTs gave the base to spread know-how to other farmers and stakeholders, increase awareness on organic breeding and increase use of organic seed, organic varieties and organic heterogenous material. This was done by field visits, training events, demonstration events, other meetings, publications and presentations.

Trials with seed treatments were carried out in several years. Whereas most results in wheat in UK were good and promising there were no significant results in wheat in Austria. An Austrian seed inoculation for soybeans did not work at all in Germany.

Participatory Plant Breeding.

At 62 farms populations or breeding lines were evaluated or selected. With the distribution of CCPs (composite cross populations) and breeding lines ECOBREED gave farmers the chance to identify future possibilities for activities on their farms both in seed multiplication and breeding.

Situation on availability of populations varied in the different crops. In wheat some CCPs were already available at the beginning of the project (Wakelyns, Liocharls, MV elit CCP) and could be used from the beginning of the project in the pre-trials 2019-2020. As the CCP developed by KIS/RGA did not show promising results in the first trials at ATK work on that CCP did not continue. MAGIC population was developed by BOKU and other partners and could be grown by some partners 2022-2023. IFVC developed the new CCP NS Obi, ATK MV Bio 2020.

For soybean and buckwheat, populations had to be developed in the ECOBREED project. Formation and multiplication were done by IFVC for soybean and RGA for buckwheat. Distribution of soybean and buckwheat CCPs had to be postponed from month 36 to month 48 to have enough seed for several trials.

Wheat selection by farmers was particularly common in Hungary. In other countries it was more of an evaluation. Therefore, the trials in Hungary provided the most interesting results on the creation of sub-populations by farmers. In 2023, the trials were overshadowed by a severe outbreak of yellow rust, which had never been seen before in Hungary, and the appearance of common bunt in the populations. In the UK, farmers liked the Wakelyn population. The population grew well. It was stable, never the highest yielding and never the lowest. However, the Wakelyn population had a good protein level: The tendency to lodge was too high on sites with high yield potential. Growers started to experiment with variety mixtures in 2023 but did not see any benefit in growing the



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mixtures in our trials. The results of the mixtures were very similar to the average of the pure varieties that made up the mixtures. In the Slovak Republic, MV elit CCP had medium results. In 2023, new populations were tested with a wide range of yield results. In Austria, the Liocharls and MV elit CCP populations did not perform well, but these populations were not developed for Austrian conditions. There is a lot of competition in wheat breeding for organic farming, so it is very difficult for a population to find its place in the market and become popular. More activity is needed in breeding populations. The results from Hungary show how a ready-made system can work. The environmental stability of the populations was often lower than expected, but the adaptability is a very interesting trait under changing climatic conditions.

It was interesting, that trials with populations, increased farmers' interest in variety mixtures. Variety mixtures seem to be easier to understand for farmers and can show good results. We also see a growing interest in variety mixtures in different countries (United Kingdom, Germany, Romania, France) but we need more knowledge to create variety mixtures that out-perform the individual varieties/lines.

As the soybean and buckwheat populations were new to the farmers, selection on these CCPs had not yet started. The CCPs did not look heterogeneous enough to make immediate selection attractive. Usually, the evaluation and selection was done by researchers and farmers together (Saatzucht Gleisdorf), which is similar to the potato breeding system chosen in the project. However, there seems to have been some adaptation of CCPs in some locations in the second year, so it will be interesting to see what happens in the future. The buckwheat populations had a very long vegetation period, with uneven maturity and long flowering. Such populations are not suitable for cereal production, but they can be an excellent forage for bees.

The observations and results of the ECOBREED project show that CCPs/OHM are still far from reaching a high percentage of production. ECOBREED has provided some basis for future activities. Many breeding efforts are needed in many crops to develop competitive CCPs.

For potatoes a different strategy for participatory plant breeding was chosen. There were discussions with farmers and partners. Farmers do not wish to get potato CCPs. Instead of distribution of CCPs, early lines were distributed to farmers for farmer's evaluation (similar to the Dutch system). IHAR started this in 2021 with distribution of 14 lines to 2 farms (10 tubers per line and farm).



General conclusions

Organic plant breeding – breeding for organic agriculture

ECOBREED had a focus on developing populations and participatory plant breeding. As the EU organic standards also have a focus on organic heterogeneous material (OHM) the ECOBREED project came at the right time to get more knowledge about populations and participatory plant breeding. In wheat some CCPs (composite cross populations) were already available and could be tested from the beginning of the project. Therefore, results of several years are available. In soybean and buckwheat, populations had to be developed and could be tested in the field by the end of the project. In potatoes the focus was on participatory evaluation by farmers and researchers. Many ECOBREED partners could develop their breeding programmes towards breeding for organic agriculture to get varieties that are better adapted to conditions of organic farming. It is not clear whether certified organic plant breeding programmes will be established in the future. Some partners are very close to an organic certification (KIS, ATK) but the EU organic standards still create more questions than answers. Furthermore, contradictions between organic standards and seed laws must be solved. Therefore, partners are unsettled whether they can start. Both certified organic plant breeding programmes and conventional plant breeding programmes for organic agriculture have a benefit for organic agriculture and help to improve organic farming systems. Success of organic breeding also depends on the differences of traits being important for conventional and organic farmers.

Demonstration events – training events – field visits

The farmer participatory field trials were not much influenced by the Covid pandemic. All trials could be established according to plan. But the communication with farmers and stakeholders was influenced a lot. Even after the ending of restrictions, farmers were not sure whether they should attend field days and many meetings in 2020/2021 had a low number of attendees or had to be postponed. Beside the “official” demonstration events more field visits took place often organised as “unofficial” by the farmers themselves.

New varieties/populations

Developing a variety usually needs about 10 years. Therefore, most of the outcomes of the ECOBREED breeding activities will come to market after the end of the project. But some varieties are already in the pipeline of registration (soybean NS ECOB, potato Balatoni sárگا). We can be happy that the partners IFVC and RGA were fast in developing new populations of soybeans and buckwheat for evaluation during the project.



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International cooperation

The ECOBREED project improved the international cooperation between partners. In the farmer participatory field trials often varieties from other countries were grown that farmers did not know before. Additional knowledge about breeding goals could be reached. Additional cross visits between partners took place. Partners cooperated in preparing field days, demonstration and training events at a national and international level.

Organic Seeds

The focus of the ECOBREED project was on plant breeding not on organic seed multiplication. The outcomes of the ECOBREED project support availability of organic seeds indirectly. Varieties that are better adapted to organic conditions will be multiplied under organic conditions separately instead of only taking some untreated seeds from a conventional seed lot. Therefore, the availability of organic seeds and varieties that perform well under organic conditions will be increased.

Ready to use breeding systems

Populations were delivered to farmers so they could use them immediately. But we had to see that only a few farmers are interested in starting plant breeding on their farm. The more promising approach seems to be the cooperation between farmers, advisers and researchers. Partners learn from each other and develop new perspectives and ideas.

Seed treatments

Several trials with seed treatments and growth promoters were established. Results were different from country to country. Older results were confirmed that treatments in organic farming often work better under cooler and milder weather conditions than for dry and hot weather conditions.

Task 6.1. Establishment of a data-recording and management system

Because of a cyber-attack the data-management system at UNEW was destroyed. The data already delivered was lost. Therefore, the concept for the data management of the farmers participatory trials had to be changed. Data input was thereafter done by excel sheets that were developed by partners. The results sent to farmers and published in bulletins for 2021, 2022 and 2023. Data were uploaded to Zenodo (see references).



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Task 6.2. Farmer Participatory Field Trials

Farmer Participatory field trials started with pre-trials. Bulking up of wheat seed for FPT in 2020-21 took place in the 2019-20 season at SMA (UK) and PRO-BIO (CZ). This involved an early maturing sub-set of varieties for FPT (to be used in Austria, Slovenia and Serbia) and a later sub-set for use in the UK. This initial bulking up of material gave us the potential for an initial screening and evaluation of the selected varieties. Other pre-trials started at IHAR (PL), NATUR (DE), KIS (SI) with potatoes and PRO-BIO (CZ) with buckwheat, Farmer participatory field trials were planned with farmer groups and stakeholders. The groups also discussed future training and demonstration events. When in-person meetings were not possible because of COVID-19 restrictions, farmers were asked on the phone. Project partners prepared the trials in video conferences held in August 2020 for wheat and January 2021 for the other crops. Lists of core/common varieties were established. Trials from Crete were re-distributed. The wheat trials were re-distributed to Serbia and Italy, soybean trials to Slovenia and Austria. There were additional trials on wheat in SI and potatoes in DE.

Farmer participatory field trials were continued in 2021-2022 according to plan. Only in Romania one trial could not be executed and had to be repeated in 2023. List of varieties was discussed in field days 2021 and meetings and workshops with farmers and stakeholders. The lists of varieties was similar thereby enabling two years results for as many varieties as possible. Although we lost the US farms, we could compensate this with new farms in 2022. The number of genotypes could be increased. There were additional trials on wheat in SI, wheat in CZ and potatoes in DE.

Many additional Farmer Participatory field trials took place in 2023. Therefore, in total many more Farmers Participatory field trials took place than planned at the beginning. The trials gave the opportunity for assessing more data to improve data quality and additional field days/field visits that enabled intensifying communication between farmers, researchers and other stakeholders. List of assessments 2023 and data input were finalised. Further trials on microbial inoculants were also continued.

The ECOBREED consortium was able to mobilise 68 farmers in 12 countries to carry out farmer participatory trials. The FPTs gave the base to spread know-how to other farmers and stakeholders, increase awareness on organic breeding and increase the use of organic seed, organic varieties and organic heterogeneous material. This was done by field visits, training events, demonstration events, other meetings, publications and presentations.

Trials with seed treatments were carried out in several years. Whereas most results in wheat in UK were good and promising there were no significant results using wheat in Austria. An Austrian seed inoculation for soybeans did not work at all in Germany.



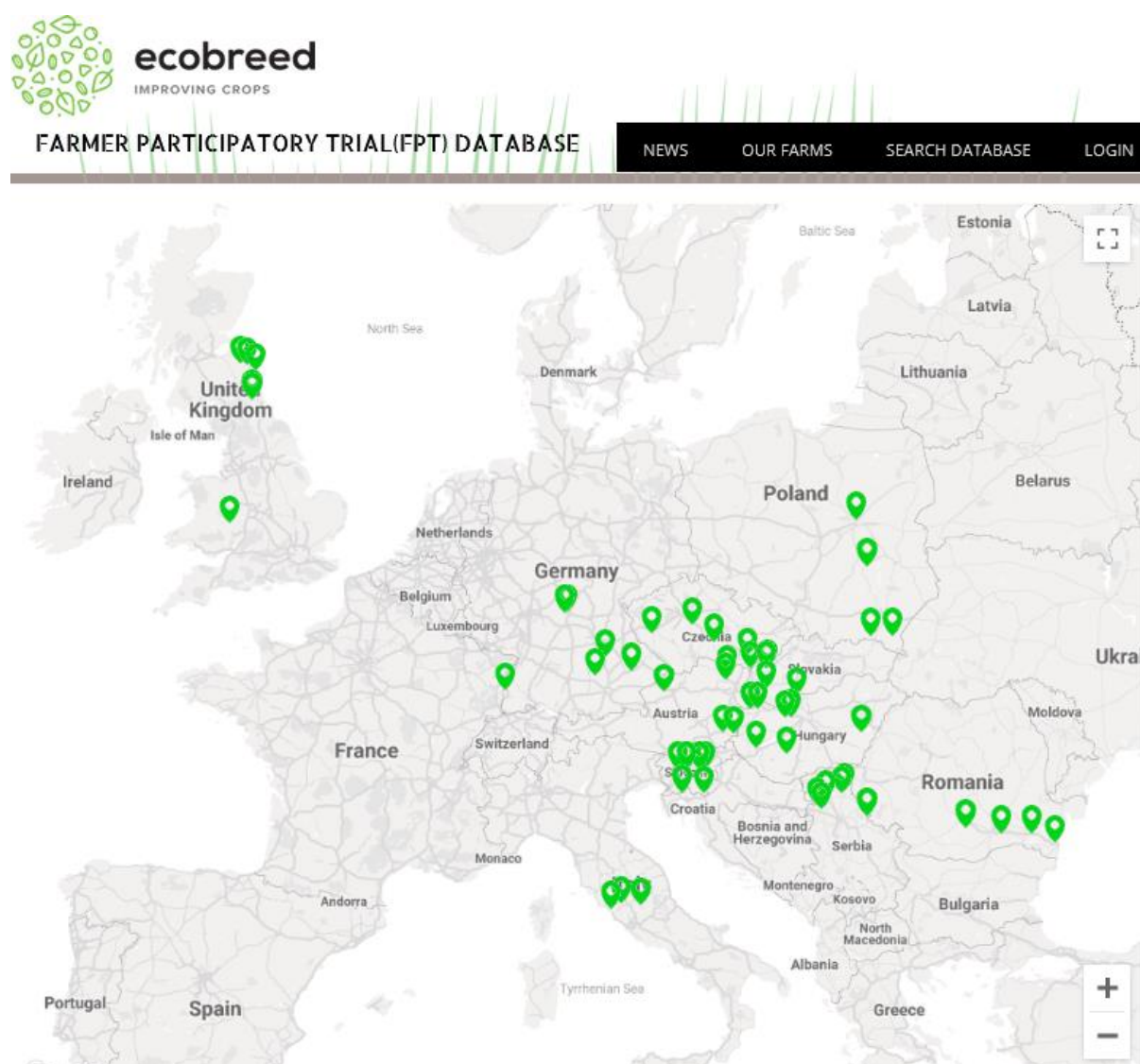


Fig. 1. Map of farms.

Pre-trials 2020

Pre-multiplication of wheat seed 2019-2020

Bulking up of wheat seed for FPT in 2020-21 took place in the 2019-20 season at SMA (UK) and PRO-BIO (CZ).

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ECOBREED farmers participatory field trials 2020 – 2021

Table 1 Total number of farms and genotypes in 2021.

FARMS									
	UK		SI	US	RS		IT	AT	
	UNEW	SMA	KIS	WSU	GS	IFVC	UNITUS	BOKU	NATUR
Wheat		4	1		1	2	3	4	
Buckwheat	4		4	3					
Soybean			2		1	4			2
Potato			4						
Total	4	4	11	3	2	6	3	4	2
FARMS									
	CZ		PL	HU		RO	SK		DE
	PRO-BIO/CRI	IHAR	UP	MTA	NARDI	BIOMILA	NPPC	NATUR	
Wheat				3		3	1		
Buckwheat	5								
Soybean					4			6	
Potato		4	4					1	
Total	5	4	4	3	4	3	1	7	
GENOTYPES									
	UK		SI	US	RS		IT	AT	
	UNEW	SMA	KIS	WSU	GS	IFVC	UNITUS	BOKU	NATUR
Wheat		36	22		9	18	27	40	
Buckwheat	28		32	42					
Soybean			16		6	24			23
Potato			52						
Total	28	36	114	42	15	42	27	40	23
GENOTYPES									
	CZ		PL	HU		RO	SK		DE
	PRO-BIO/CRI	IHAR	UP	MTA	NARDI	BIOMILA	NPPC	NATUR	
Wheat				24		24	8		
Buckwheat	50								
Soybean					35			58	
Potato		44	48					10	
Total	50	44	48	18	35	24	8	68	

- Total number of farms: 62 (7 farms with 2 crops, one farm with 3 crops)
- Total number of trials: 70
- Total number of genotypes: 689

ECOBREED farmers participatory field trials in 2022

Farmers participatory field trials were continued in 2021-2022 according to plan. Only in Romania one trial could not be executed and had to be repeated in 2023. List of varieties was discussed at field days 2021 and meetings and workshops with farmers and stakeholders. The lists of varieties stayed similar enabling two years of results for as many varieties as possible. Although we lost the US farms, we could compensate this with new farms in 2022. The number of genotypes was increased. There were additional trials on wheat in SI, wheat in CZ and potatoes in DE.



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Table 2 Total number of farms and genotypes.

FARMS								
	UK		SI	RS		IT	AT	
	UNEW	SMA	KIS	GS	IFVC	UNITUS	BOKU	NATUR
Wheat		4	1	1	1	3	4	
Buckwheat	4		4					
Soybean			2	1	3			3
Potato			4					
Total	4	4	11	2	5	3	4	3
FARMS								
	CZ	PL	HU	RO	SK		DE	
	PRO-BIO/CRI	IHAR	MATE	NARDI	BIOMILA	NPPC	NATUR	
Wheat	1				3	1		
Buckwheat	4							
Soybean				3			6	
Potato		4	4				2	
Total	5	4	4	3	3	1	8	
GENOTYPES								
	UK		SI	RS		IT	AT	
	UNEW	SMA	KIS	GS	IFVC	UNITUS	BOKU	NATUR
Wheat		40	22		14	30	40	
Buckwheat	28		34					
Soybean			16	10	27			35
Potato			108					
Total	28	40	180	10	41	30	40	35
GENOTYPES								
	CZ	PL	HU	RO	SK		DE	
	PRO-BIO/CRI	IHAR	MATE	NARDI	BIOMILA	NPPC	NATUR	
Wheat	15				24	8		
Buckwheat	49							
Soybean				31			66	
Potato		89	60				22	
Total	64	89	60	31	24	8	88	

- Total number of farms including ATK: 62 (5 farms with 2 crops, one farm with 3 crops)
- Total number of trials: 68
- Total number of genotypes including ATK: 798

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ECOBREED farmers participatory field trials in 2022 – 2023

Many additional Farmers Participatory field trials took place in 2023.

Table 3 Total number of farms and genotypes in 2023.

FARMS								
	UK		SI	RS		IT	AT	
	UNEW	SMA	KIS	GS	IFVC	UNITUS	BOKU	NATUR
Wheat	1	4	1		1	1	3	
Buckwheat	2		3					
Soybean			2	1	2			1
Potato			4					
Total	3	4	10	1	3	1	3	1
FARMS								
	CZ	PL	HU		RO	SK		DE
	PRO-BIO/CRI	IHAR	UP	MTA	NARDI	BIOMILA	NPPC	NATUR
Wheat				6		3	2	
Buckwheat	3							
Soybean					3			5
Potato		3	3					
Total	3	3	6	6	3	3	2	5
GENOTYPES								
	UK		SI	RS		IT	AT	
	UNEW	SMA	KIS	GS	IFVC	UNITUS	BOKU	NATUR
Wheat		65	22		1	10	42	
Buckwheat	12		6					
Soybean			10	4	5			16
Potato			66					
Total	12	65	104	4	6	10	42	16
GENOTYPES								
	CZ	PL	HU		RO	SK		DE
	PRO-BIO/CRI	IHAR	UP	MTA	NARDI	BIOMILA	NPPC	NATUR
Wheat				48		24	38	
Buckwheat	10							
Soybean					28			34
Potato		30	18					
Total	10	30	18	48	28	24	38	34

- Total number of farms: 52 (4 farms with 2 crops, one farm with 3 crops)
- Total number of trials: 57
- Total number of genotypes (including populations) 489



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Task 6.3. Participatory Plant Breeding

The ECOBREED consortium was able to mobilise 68 farmers in 12 countries to carry out Farmer Participatory trials. The FPTs gave the base to spread know-how to other farmers and stakeholders, increase awareness on organic breeding and increase use of organic seed, organic varieties and organic heterogenous material. This was done by field visits, training events, demonstration events, other meetings, publications and presentations.

At 62 farms populations or breeding lines were evaluated or selected. With the distribution of CCPs (composite cross populations) and breeding lines ECOBREED gave farmers the chance to identify future possibilities for activities on their farms both in seed multiplication and breeding.

Participatory Plant Breeding in 2020 - 2021

Participatory plant breeding on wheat started in 2021 according to plan. Distribution of soybean and buckwheat CCP's had to be postponed until 2022 to have enough seed for several trials. In Poland the first two evaluation trials on farms could start. Wheat CCPs could be distributed to farms and were sown in most wheat FPTs.

Table 4 Number of wheat farms and CCPs in 2021.

	SMA	GS	IFVC	BOKU	MTA	BIOMILA	NPPC
Farms	4	1	2	4	3	3	1
CCPs	6	1	2	6	6	3	1

- Total number of farms that have sown CCPs: 18
- Total number of CCPs: 25
- The CCPs that were sown were: Wakelyns: 4 (UK); Liocharls: 3 (UK, AT); 1109: 1 (UK); Mv elit CCP: 14 (AT, SK, HU, RS); Mv Bio2020: 3 (HU)

Potatoes: In Poland 15 selected breeding lines were evaluated on two farms.

Participatory Plant Breeding in 2021-2022

Participatory plant breeding on wheat was continued according to plan. A new CCP (NS Obi) was sown in one trial in Serbia. Early breeding lines of potatoes were distributed to four farms in Poland, three farms in Slovenia and two farms in Hungary. There were delays and problems with the shipment of buckwheat and soybean so the full amount of PPB trials can be reached in 2023. **MS24** (formation and distribution of CCP to farmers) was reached on 28th September 2022.



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Wheat: Wheat CCPs were distributed to farms and were sown in most wheat FPTs.

Table 5 Number of wheat farms and CCPs in 2022.

	SMA	IFVC/GS	BOKU	MTA	BIOMILA	NPPC	IFVC	UNITUS	PRO-BIO
Farms	4	1	3	5	3	1	1	3	1
CCPs	6	1	4	7	3	1	2	3	2

- Total number of farms that have sown wheat CCPs: 22
- Total number of wheat CCPs: 29
- The CCPs that were sown were: Wakelyn's: 2 (UK); Liocharls: 7 (UK, AT, CZ); Mv elite CCP: 11 (AT, SK, HU, RS, CZ); Mv Bio2020: 2 (HU); NS Obi: 1 (RS); Mix population: 3 (IT)

Soybean: There were a few problems with distribution of soybean CCP. Shipment from Serbia to Slovenia was held up by customs and partially lost by the courier. The back-up sample was transported to the general assembly meeting (30-31. 5. 2022) in Hungary and brought by KIS staff to Slovenia. Due to late arrival, CCP was sown only at the farm PUCIHAR. The amount of seeds was too small for farmers in Romania so they could only sow one trial for further multiplication. SZG has sown three additional CCPs at Jugovits farm in Austria.

Table 6 Number of soybean farms and CCPs in 2022.

	NAT D	NAT/SZG AT	IFVC	KIS	NARDI
Farms	3	1	4	1	1
CCPs	3	4	4	1	1

Buckwheat: Buckwheat CCP was distributed too late by RGA. It could only be sown in two trials in Slovenia and at CRI in Czech Republic. Seeds for UK were transferred at EB meeting in Prague 28 September 2022.

Table 7 Number of buckwheat farms and CCPs in 2022.

	KIS	PRO-BIO	SMA
Farms	3	1	-
CCPs	3	1	-

Potatoes: Early potato lines were tested on four farms in Poland, three farms in Slovenia and two farms in Hungary.

Table 8 Number of potato farmers and early lines in 2022.

	KIS	IHAR	MATE
Farms	3	4	2
Breeding lines	42	60	12



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Participatory Plant Breeding in 2022-2023

Wheat: Some more wheat populations were distributed and sown on some farms. Trials with variety mixtures started in the UK.

Table 9 Number of wheat farms and CCPs in 2023.

	SMA	IFVC/GS	BOKU	MTA	BIOMILA	KIS	IFVC	UNITUS
Farms	5	1	3	6	1	1	1	1
CCPs	5	1	12	21	22	1	1	1

- Total number of farms that have sown wheat CCPs: 19
- Total number of wheat CCPs plots: 64
- The CCPs sown: Wakelyn's: 5 (UK); Liocharls: 2 (SI); Mv elite CCP: 8 (AT, HU); Mv Bio2020: 2 (HU); NS Obi: 1 (RS); Mix population: 1 (IT)
- New wheat populations 2023: SK 1 farm with 22 different populations (BOKU OHM); AT 1 farm with 8 different populations (BOKU OHM); HU 2 farms with 8 populations (sub 1-8)
- New: variety mixtures in UK; 5 farms with 4 different mixtures (total 10 plots).

Soybean: Some more populations were developed and tested. The amount of seeds was again too small for farmers in Romania.

Table 10 Number of soybean farms and CCPs in 2023.

	NAT D	NAT/SZG AT	IFVC	KIS	NARDI
Farms	3	1	3	2	1
CCPs	3	6	3	2	1

- Total number of farms that have sown soybean CCPs: 10
- Total number of soybean CCPs plots: 15
- New populations 2023: SZG has sown 2 more CCPs at Güssing farm in Austria.
- New variety mixtures in RO: 3 farms with 3 different mixtures in total. 9 plots

Buckwheat:

Table 11 Number of buckwheat farms and CCPs in 2023.

	KIS	PRO-BIO	SMA
Farms	3	3	2
CCPs	3	6	6

- Total number of farms that have sown buckwheat CCPs: 8
- Total number of buckwheat CCPs plots: 15
- New populations in 2023: 6 CCPs/Snys sown in UK and CZ (Syn 21, Syn 22.1, Syn 22.2., Syn 22.3, CCP 4, CCP 8)



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Potato: Early potato lines were tested on 3 farms in Poland, 3 farms in Slovenia and 3 farms in Hungary.

Table 12 Number of potato farms and early lines in 2023.

	KIS	IHAR	MATE
Farms	3	3	3
Breeding lines	40	29	9

- Total number of farms that have sown potato early lines: 9
- Total number of potato early line plots: 78

Partner conclusions

UNITUS

- The results of WP6 activities together with the ones run under WP2 was useful to identify an accession which was presented at the Italian Ministry of Agriculture to be registered as an Organic Variety. Dissemination was done within WP8, UNITUS prepared many posts on social media.
- The farmers enjoy the participation in the trials and interesting discussions were conducted.
- The variety developed and registered for Organic agriculture will have economic value due to the shortage of varieties devoted for organic agriculture.

IFVC

Results of Farmer Participatory field trials were disseminated at 72nd Conference "Plant Breeding for the Green Deal" held on 22-24 November 2021, Agricultural conference in Zlatibor 30 January to 3 February 2023 and World Soybean Research Conference, 18 to 23 June 2023.



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Demo events and trainings:



Fig. 2. Training at Rimski šančevi in 2022.



Fig. 3. Training at Šuljam in 2022.

Trial results have big variations within countries and specific locations (different variety responses). Farmer participatory trials are a crucial milestone to define local criteria for variety selection and for increased adoption of new and improved soybean varieties to low-input and organic production.

Farmer Participatory Trials (FPTs) have significant socio-economic impact. Farmers are empowered to share their expertise and preferences through direct participation in



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experiments. FPTs promote cooperation and knowledge exchange between farmers and researchers in specific agro-climatic conditions. Farmers take an active role in the decision-making process about selection of plant varieties, which helps to test and disseminate innovations in organic production.

IHAR

Since potato cultivars suitable for organic farming should have a slightly different set of 'mandatory characteristics' than conventional ones, breeding of such cultivars differ from conventional breeding. It is believed that selection of cultivars destined for organic farming could be strongly improved by active participation of farmers (Participatory Breeding). The vision for organic plant breeding is based on the cyclic interaction between plant and environment, and between farmer (the rest of the production chain) and breeder. Therefore, in the ECOBREED project conduction of a series of field trials in contrasting soil and climate zones were planned. Selection of cultivars destined to organic farming should be improved by active participation of farmers (Participatory Breeding). Environment (L × Y), genotype (G) and interaction (G × E) were main effects, which significantly affected tuber yield. Cvs. Twister, Alouette, KIS Kokra and Levante were the most stable cultivars in tuber yield in all 12 environments and can be considered as highly adaptable to a wide range of environments. A different response of potato cultivars to environmental factors suggests that is a need to select genotypes in the multi environment trials (METs). Depth of eyes was significantly affected by environment (L × Y), genotype (G) and the G × E interaction, while regularity of tuber shape was affected by genotype (G) and G × E interaction. Genotype (G) and localisation (L) were main effects, which significantly affected values obtained for taste and on non-darkening of flesh tubers both raw and cooked. Cooking type was very variable and depended on genotype, year and location.

The results from WP6 were presented on field days and demonstration events. Cultivars suitable for organic farming were popularised among local farmers. Potato cultivars and breeding lines from the ECOBREED project were presented during training and demonstration events.

There is a need for more breeding efforts aimed at new potato varieties suitable for organic conditions. There is a need to breed potato varieties suitable for specific local conditions. Close collaboration with organic farmers is justified. The results obtained show that it is necessary to evaluate cultivars for organic farming in multiple and multi-year trials.

The identification of organic cultivars plays a key role in improving the management system for organically produced potatoes, which is still far from being optimised. Research efforts and policies should converge to develop farming systems that can



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benefit from cultivars able to express their organoleptic, nutritional and agronomic potential under low-input farming conditions, with adequate pyramiding resistance and nutrient use. Especially for species that require long-term breeding to release new varieties, such as potatoes, this effect can only be achieved through cooperation with organic farmers (FPT) and proper communication with the public.

NPPC/BIOMILA

The project aimed to increase the availability and quality of organic seeds and varieties, and to enhance the performance and resilience of organic crops. The project also aimed to disseminate and transfer the knowledge and innovations generated by the project to the stakeholders and end-users, such as researchers, breeders, farmers, processors, retailers, consumers, and policymakers.

NPPC, BIOMILA and partners collaborated and coordinated their activities and efforts to achieve the objectives and impacts of the project. Some of the main activities and results of the project in Slovakia were:

- Conducting field trials and evaluations of organic wheat varieties and populations and identifying the best performing and most suitable ones for organic and low-input conditions in Slovakia.
- Organising several demonstration events, presentations, and conferences to showcase the project and its outcomes, and to engage and interact with the target audiences, where the project partners and the farmers presented and discussed the results of the field trials and the advantages of the organic varieties and populations.
- Presentations at the Slovak Agriculture University in Nitra, where we shared and exchanged our knowledge and expertise on organic plant breeding and organic agriculture.
- Conferences, where we and the experts from different fields and sectors discussed and debated the challenges and opportunities of organic plant breeding and organic agriculture in Slovakia.

The project had a positive and significant impact on the organic sector in Slovakia and contributed to its development and promotion. The project brought together many organic farmers and other actors involved in organic agriculture and created a network and a platform for collaboration and communication. The project also raised awareness and interest among the public and the policymakers about the importance and benefits of organic plant breeding and organic agriculture.

PROBIO

Exploitation and dissemination activities:



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- Farmers bulletin 2021, 2022 and 2023 – An overview of 19 different buckwheat varieties tested over 3 years on organic farms in the Czech Republic.
- Practice abstract 19 - Buckwheat and how to grow it.
- Practice abstract 20 - Harvesting and storage of buckwheat.
- Presentation - “Buckwheat, a special chance for Eastern Europe?” – practically aimed presentation for farmers. Presentation includes practical tips what to avoid when growing buckwheat and how to deal with high risk of this crop.
- Presentation “ECOBREED results on buckwheat” at Naturland farmers conference on 24 January 2023 at Würzburg.
- Overview table qualitative assays - Winter wheat additional farmers participatory trial (FPT) in 2022.
- Articles about growing buckwheat in green mulch – published at Zemědělec, Živé zemědělství and Ekolist.
- The results were presented at ECOBREED demonstrational events under Task 8.4., which PROBIO has held 3 during the project. PROBIO has actively cooperated with CRI – the genebank team and Adam Brezáni was a guest speaker at their demonstrational event and 2 farmers training events. Those were the main channels of results exploitation and dissemination.
- Presentation with practical tips for buckwheat growing, evaluation of different buckwheat varieties and selected varieties for grain and varieties suitable for cover cropping. The presentation was held at Demonstrational event of NPPC in Borovce on 17.6.2022, Demeter conference in Lumpėnai, Lithuania on 2.7.2023 and 26.9.2023 at Day of organic farming in Bojnice, Slovakia.

Buckwheat is a niche crop. Only about 1,000 ha of organic buckwheat is grown for grain production in Czech Republic annually. Since only few farmers grow buckwheat the knowledge about available varieties in Europe is very limited and the offer of seed companies is very limited in this manner. Winter wheat is one of the most grown crops in organic farming in the Czech Republic. Many farmers aim for food grade quality wheat, but the knowledge about suitable varieties is also limited.



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Fig. 4. A demonstration event in Okrouhlice in 2022. (Photo: Petra Hlásná Čepková).

In 2021 and 2022, 20 different buckwheat varieties, 4 different populations of buckwheat were tested on 5 farms. 14 different varieties of winter wheat, including 2 populations in 2022 were tested at one farm. It was important to exploit the results within other farmers in an effective manner. A field day or a demonstrational event was organised at every farm involved in participatory farm trials in 2022. Farmers involved in FPTs invited neighbouring farmers or contacted local agricultural office to contact the farmers from the neighbourhood. A small workshop, which lasted about 2 hours was held directly in the field. This way the farmers did not need to travel very far. They could see the varieties in the environment that they are familiar with. Some of the farmers knew each other. A very lively discussion was always held at such events. In 2023 a final demonstration event was held with total attendance of 700 people. Selected perspective varieties for Eastern Europe and populations from Slovenian partner RGA were presented.

Further development of organic farming has been highlighted as one of the important tasks in the new European Common Agricultural Policy. Development of organic farming will help to deliver EU environmental objectives. These efforts should also result in development of arable organic farming in the Czech Republic. Since the 1st of January 2022 a farm can run conventional and organic units/activities under the same enterprise in Czech Republic. This can make organic farming more accessible. Farmers do need relevant and easy to access information to help them to develop their organic farming.





Fig. 5. Demonstration event in Soběkury in 2022 (Photo: Petra Hlásná Čepková).

Suitable varieties for organic farming play a crucial role in these efforts. Buckwheat is usually viewed by farmers as a semi-wild crop and relatively risky crop to include in their rotation. On the other hand, buckwheat doesn't have major pest or disease issues and has relatively short vegetation period. Making it perfect as a substitution crop or a second harvest crop. During the FPTs varieties with shorter vegetation period, shorter plant length and even maturity were selected to satisfy the above-mentioned requirements. Thanks to this knowledge a farmer, who was included in FPTs has increased acreage of buckwheat to 100 ha in 2022 and 60 ha in 2023. Information collected during the 3 years of FPTs will need to be exploited helping to promote growing buckwheat to farmers with suitable conditions. This can help them to create more resilient and robust crop rotations.

Many organic farmers aim to produce wheat with high quality for the food market with the potential for higher grain prices. A combination of suitable variety and production technique e.g. good pre-crop can have positive results in achieving this. During the demonstration event the effect of both was evaluated. Two CCP populations were presented. The Liocharls population is meant to be used by a farmer for several years, which can result in reduced cost from the annual purchase of certified seed.



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KIS

Establishment of a farmer group and knowledge of the farms: Farmer group as central elements in FPT and PPB

First step was the construction of a farmer group and clear the roles of farmer and institute in achieving results.



Fig. 6. Preparation of trial plots, Pucihar Farm, FTP 2021.

The trials were successfully carried out by farmers. In Slovenia, out of 38 trials started via FPT and PPB, only 3 trials were abandoned due to weather or wildlife damage and 4 trials were recorded manually. Farmers collected and evaluated some data and observed development stages. KIS visited the trials to evaluate certain parameters, photograph the trials and talk to the farmers about certain diseases/pests, climatic conditions and difficulties with different stresses factors, etc. In case of damage or stress, we decided whether the trial could continue or not. Most of the data was successfully collected by the farmers and KIS. Some of the observations and evaluations were carried out with varying degrees of ease. Questions about technical means and material resources were discussed in advance, which facilitated the set-up and follow-up of the trials.





Fig. 7. Harvest of buckwheat samples at Zagorc Farm, FPT 2021.

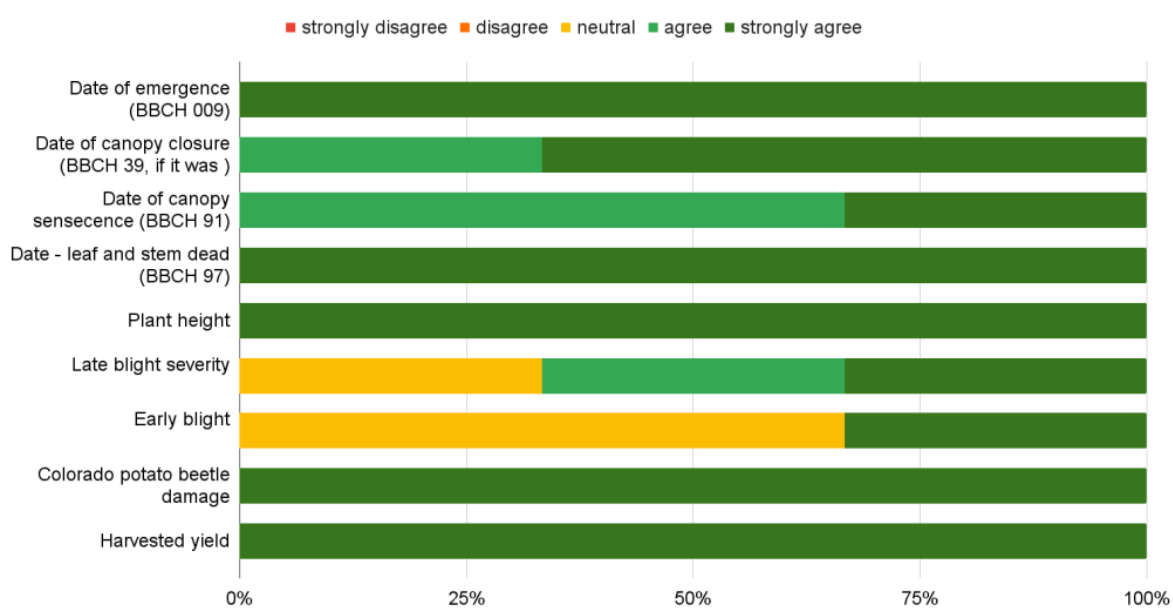


Fig. 8. Composition of farmer response concerning the ease of assessing potato characteristics in FPT 2020/2021.

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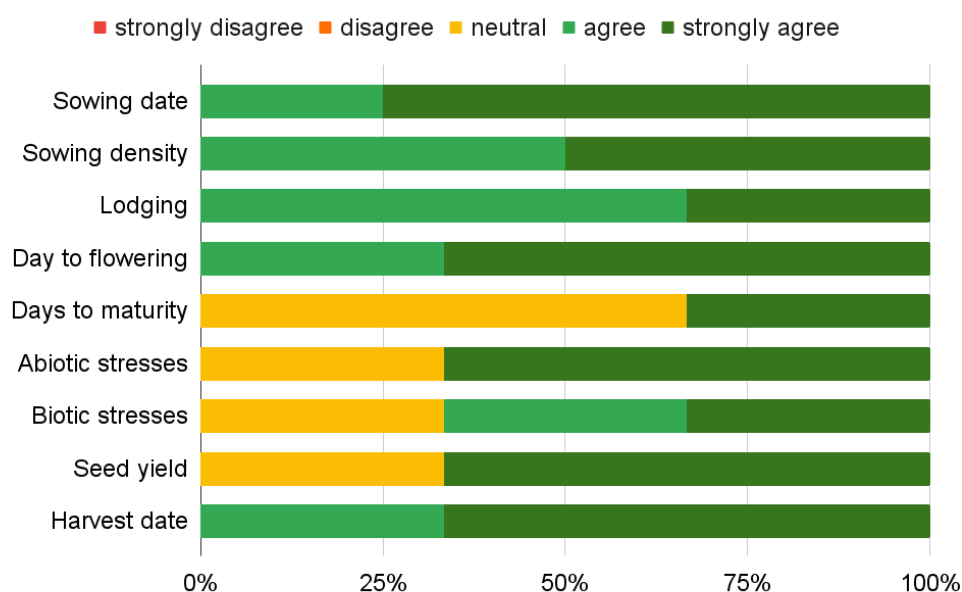


Fig. 9. Composition of farmer responses regarding the ease of evaluation of buckwheat traits in the FPT 2020/2021.

The means of communication used varied according to the habits and preferences of the farmers: paper documents, emails, phone calls, messages or exchanges in a private group via an application. Visits to the farms also enabled an exchange of information on site.

Three types of dissemination were carried out: Bulletins for farmers, demonstration events and articles in professional journals. The 2021 and 2022 bulletins were produced for farmers to inform them about the results of all trials in Slovenia. Bulletin 2023 is in preparation. KIS and farmers organised demonstration days at the institute or on farms participating in the ECOBREED project. The aim was to share the results of the trials, discuss the challenges of organic farming with farmers and breeding experts and obtain more information on the development of organic seed supply and demand with the help of a questionnaire. After each event, event reports were prepared with the evaluation of the questionnaire. The articles were published in the Slovenian agricultural magazine. The final event for farmers will take place in 2024 to present a summary of the results for Slovenia.

The FTPs were used to analyse the potential of the varieties in different environments on organic farms.

Opportunities for cooperation with contacts and various means of communication

Crop monitoring documents were provided, which included a summary of the ECOBREED project, data on WP6, technical information on the crops and varieties tested, photos and visual aids to assess disease and pest monitoring and a table to record information. All in a single, easy-to-use medium for the farmer. In addition, the suggestion to vary the



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media was validated and desired during initial conversations with the farmers. As the partner farmers were comfortable with e-mail or written communication. A Viber group was set up to exchange photos and brief information.

Demonstration events: the key events for the project's local impact

The demonstration events held as part of the trials brought together participants from different regions and professional groups. These events provided an opportunity to discuss initial results and the challenges facing the sector in Slovenia.

Partial heterogeneity of the farmer group

The group of farmers consisted of 5 farms in which the main actors were men aged between 30 and 60 years, 3 were pure farmers and 3 were farmers with a complementary activity. In each case there was family and/or inter-generational support for farm work to some degree +/- strong.

Participant to events: Participants attending demonstrations events were not exclusively organic farmers and stakeholders but also advisers, teachers, researchers, etc (Fig 10).

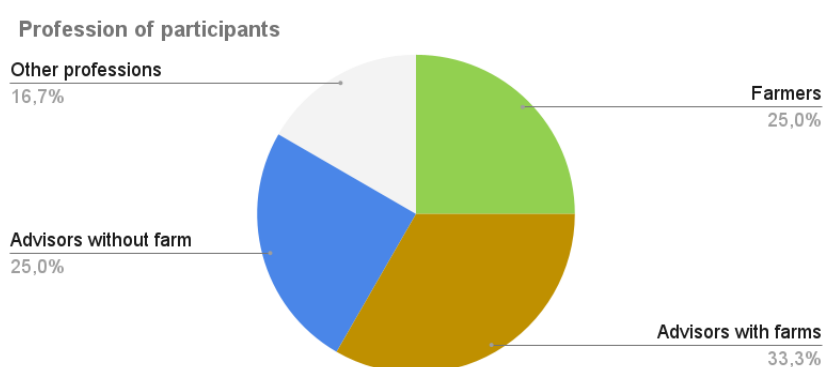


Fig. 10. Professions of participants at the demonstration event at Pucihar Farm, September 9, 2021.

FTP and PPB: a first step towards establishing PPB in an organic potato breeding programme. The farmers who participated in the FPT were also volunteers for PPB. The collaboration between farmers and KIS will continue at least for the potato PPB in coming seasons (from 2023/2024) as part of the newly organised participatory plant breeding of the organic potato breeding programme at KIS.



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NATUR

There were critics in the beginning from research institutes that the farmers participatory are not “scientific” compared to official variety testing with replications. But the official trials are always sited at locations with very good soils for a better chance to have good crop performance. With the farmer participatory trials, we could cover different regions but with a potentially lower yield level. The farmers loved to see different varieties under “real-life” conditions. The demo farmers wanted to continue the trials in 2023 although this was not obligatory.

At all six farms in Germany and two farms in Austria demonstration events and field visits took place during the project duration. There was communication with farmers, advisers, seed traders, processors and researchers. As soybean production has its centre in the South of Germany only stakeholders from there could be reached by the *in-situ* demonstration events.

Results of farmers participatory trials were published in organic farmers magazines and were presented in seminars.

The ECOBREED farmer participatory field trials had influence on the breeding activities in Germany, e.g. Bavarian State Research Institute.

For the first time a soybean population could be shown to farmers and public. As the maturity of NS CCP is later than usual in Germany we do not expect that farmers in Germany will start to grow it. But an adaptation seems to have happened from first to the second year of growing. We will try to continue growing NS CCP in the warm region in the South west of Germany in official trials.

The farmers enjoyed participating in the trials and there were interesting discussions with them. With farmer participatory trials, regions and local conditions could be reached that are not covered by official organic testing nets.

In soybean, there are so many varieties on the market that farmers were happy to get some guidance from the trials on their choice of varieties. Farmers were able to see that some of the very popular varieties were not as good as they had expected in their regional conditions.

A soybean population could be shown for the first time, but this was only a first step to develop improved populations in the future.

Saatzucht Gleisdorf had the chance to show all their varieties in German organic trials, so they have clear visibility as a soybean breeder. Their variety GL Melanie got quite popular and reached a stable level of production. IFVC varieties generally produced poor results.



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Choice of variety is one of the few parameters that an organic farmer can influence. Therefore, organic farmers were interested in visiting the trials because choice of variety is crucial for their success.

Buckwheat is a niche crop, but the European organic market has developed well during recent years. ECOBREED project came at the right time for buckwheat helping to gain and develop a lot of basic knowledge for the production of organic buckwheat in the European Union to make the production more profitable and reduce imports.

MATE

The Potato Research Centre of MATE along with four organic potato growing farms co-operated on characterisation of 12 selected potato varieties (Farmer Participatory Trials) and evaluation of several potato breeding lines and variety candidates (Participatory Breeding) for four years. The goals of the common activities were to identify varieties and select new candidates best suited to local circumstances and the needs of local growers/consumers.

During the experimental years both the growers and researchers have gained a lot of valuable experience. The growers were able to familiarise themselves with the varieties and new variety candidates most recommended by the breeders for organic cultivation. They gained experience on what kind of traits and how to take them into account when choosing the varieties to grow.

One of the main results of the co-operation is that it was proven that resistance to viruses, especially to PVY, under Hungarian ecological conditions is a pre-requisite trait for a variety to be successful in profitable production. Without PVY resistance, susceptible varieties lose their productivity in just 1-2 years of replanting, and because of this, they need constant seed potato renewal, which greatly impairs the economics of their production. This is the reason why varieties from the Slovenian and Hungarian resistance breeding programmes can be recommended to Hungarian organic potato growers more than Western European varieties, which are otherwise competitive based on their other properties (resistance to late blight, quality etc.).

Another important experience of the trials is that, in connection with climate change, profitable cultivation of organic potatoes under Hungarian ecological conditions can only be realised under irrigated conditions. In connection with the regular summer drought conditions, we could also establish that early-ripening varieties with a short growing season have an advantage over those having longer and later maturity.

The third concrete result of the co-operation with growers is that, partly based on their opinion and considering the joint experimental results, a candidate variety called Balatoni



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sárga from the breeding program of the MATE Potato Research Centre was entered into official variety registration trials.

CRI

In co-operation with PROBIO, CRI conducted field trials on several farms during the project. These trials aimed to sensitise organic farmers to buckwheat cultivation, to show them the possibilities of cultivation and the available varieties and, by raising awareness, to expand the range of crops grown on organic fields. Buckwheat is known in the Czech Republic primarily as a crop to produce achenes, which are used as food. However, buckwheat is rarely cultivated as a pollinator crop or as a catch crop. This was the first time that such trials had been carried out, allowing organic farmers to familiarise themselves with multiple varieties grown in a single field. Visitors to the different events greatly appreciated the comparison of the different varieties, as well as the comparison of some quality parameters. Furthermore, the discussion with experts and individual participants was also highly appreciated.

On 16th September 2023, an important event took place at EKOFARMA PROBIO s.r.o. in Velké Hostěrádky, organised by PROBIO in co-operation with CRI and attended by around 700 people. Experts Dr Dagmar Janovská (CRI) and Adam Brezáni (PROBIO) gave a presentation in the field on different buckwheat varieties and gave practical recommendations to farmers.

The trials provided information on optimal sowing densities and crop rotation strategies. They emphasised the role of buckwheat as a versatile, heat-tolerant crop suitable for different agricultural contexts in the EU.

Varieties such as Devyatka, Drushina and Kora were identified as suitable for food production, while others such as La Harpe and Čebelica excelled as cover crops.

Analysing the TGW (thousand-grain weight) and yield potential showed the economic viability of certain varieties for grain production and helped to identify the potential market demand for buckwheat products in the EU.

SMA

During the project, we have grown wheat trials for four years and buckwheat for two years at SMA. We have also grown wheat trials at three FPT sites for three consecutive years.

Over the four years at SMA (Thornton Farm), we have grown 21 different varieties of wheat, 1 wheat CCP and 4 varietal mixtures.

We did not see a benefit to varietal mixtures in the trial, however by the very nature of a trial, there is already some variation in the field.



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We saw that the CCP grown, Wakelyn's YQ population was significantly taller. This meant that it outperformed others in trials where there was a high weedpressure. It was however more susceptible to lodging and therefore as a result at greater risk of quality loss. It did not show lower disease pressure.

We have used 6 different biostimulant products over the course of the project, both seed treatments and sprays. The product that we have seen the most impact with is Itaka's Fixio product, which is sprayed at the start of stem extension (GS31). This works by making unavailable nitrogen in the soil available to the plant. It works best where there is a source of nitrogen, such as applied manure. Over three years at SMA, we saw an average yield benefit of 1.73t/ha.

With buckwheat, over the two years, we have grown 11 different varieties, 1 varietal mixture and 3 CCPs.

SMA have held four demonstration days over the project, looking at three trials of wheat and two trials of buckwheat. It has been a brilliant platform for organic farmers to get together. We have looked at not only the performance of the different varieties, but also CCPs and varietal mixtures which they were previously unfamiliar with, as well as some of the current biostimulants available on the market. We have also looked at other issues within organic farming, such as trying minimum tillage and maximising clover leys, also linking up with the HORIZON Liveseeding Project.

We have had around 35 different visitors to the trials, including farmers, traders, agronomists and researchers with many repeat visitors across the years.

In the first year of the trials, we were unable to host a demonstration day due to COVID-19 restrictions, so we made a short video instead. This has been viewed 135 times.

The project and demonstration days have had a significant impact on both the participatory farmers and the demonstration day participants. It has noticeably encouraged farmers to try new ideas on their own farms, shown them the benefits of CCPs and possibly benefits with the role of biostimulants. Several participants commented that they had gained an enormous amount of useful information and hoped that the demonstration days could be continued after the end of the project.

RGA

RGA developed experimental synthetic buckwheat varieties for the ECOBREED project. During the years 2022 and 2023 they were tested at more locations (Slovenia, Czech and UK). Considering the complexity of the development of synthetic buckwheat varieties and the lower heterosis compared to F1 hybrids (due the apomixis, presence of parental components), the practical value of synthetic buckwheat varieties is limited. We see a higher future potential in conversion of self-incompatible buckwheat accessions into self-



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compatible accessions using inter-specific crosses between *F. esculentum* and *F. homotropicum*. During the ECOBREED project we introduced also breeding material (crosses F. Hom. (Acc. 2) × Alaya 846 and F. Hom. (Acc. 2) × Pul. II) which enables good fertility restoration in the above-mentioned kind of buckwheat inter-specific cross. we could conclude that the concept based on combining several different genomes into one genotype is more promising than the development of varieties based on the multi-genotype concept (e.g. synthetic varieties).

To understand such kind of genetics in practice we organised field day in Krog near Murska Sobota on 23rd October 2023. Beside the demonstration field we visited also the greenhouse at Cornus company where the single components of buckwheat synthetics were represented.

ECOBREED project gave an insight into the harnessing of buckwheat (*Fagopyrum* sp.) germplasm with two different breeding concepts. We assume that the development of synthetic buckwheat varieties is less favourable in comparison with the use of buckwheat wide crosses which relate to the development of self-compatible varieties. Gene pool of inter-specific crosses was created but for the introduction of advanced buckwheat self-compatible breeding lines into common agriculture practices additional breeding work is necessary.

SZG

In the framework of WP6 SZG organised and looked after organic farmer participatory trials and breeding in Austria for soybean. In Güssing (at Fachschule Güssing in Burgenland, a province in the South-east of Austria; an important soybean growing area with Illyric-pannonic climatic influence) and in Kalsdorf bei Ilz (Steiermark, a province also in the South-east of Austria; an important soybean growing area with mainly Illyric climatic influence; trials were organised in cooperation with BioAustria) variety trials with already registered Austrian and Serbian varieties were performed to figure out the best performing varieties for these locations. Dissemination of farmer participatory variety trials was performed in the framework of field visits and demonstration events with stakeholders, farmers and students.

Additionally, six segregation populations were grown at organic farmers fields in Schachendorf (Burgenland) 2022 and Güssing 2023. The populations were chosen from SZGs and IFVC´ breeding programmes. According to their genetic background and performance of their parents in this region, the segregating populations should bear suitable progenies for this environment. During these two growing seasons the populations were harvested selectively in creating elite-SSDs: Seeds were only harvested from good and best performing plants. This process will be continued until homozygosity and until new variety candidates can be selected.



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Results and activities of WP6 were presented at the “Unser Lagerhaus Feldtag – Das Festival der Landwirtschaft in Kalsdorf bei Ilz, Steiermark” in June 2023 and at several excursions and visits at SZG, at which SZG activities were presented.

Working directly with farmers and at farmer field sites was a very valuable experience for SZG as a breeder. SZG will continue the activity after the project, especially with the segregating populations and elite selection lines.

The good collaboration with farmers and project partners was also fruitful through the establishment of very valuable contacts, which could be used in the future development of organic varieties. Through the direct exchange with farmers and cultivation on their fields, we as breeders get valuable and practical input of their needs. So, we can incorporate the information sustainable into variety development, resulting (hopefully) in new organic ECOBREED™ varieties in near future.

ATK

The Hungarian on-farm organic wheat trials started in autumn 2020. Winter wheat varieties and two populations (Mv Elit CCP, Mv Bio2020 Pop) were sent to organic farmers with the aim of starting participatory testing (PVS: participatory variety selection) and breeding (PPB: participatory plant breeding) on their farms. Trials were run on 3 farms in 2021 complemented with 2 additional farms for the following years, thus, besides the two Hungarian and one Slovakian locations (Szár, Füzesgyarmat and Zselíz), two other Hungarian farms at Kömlő and Tornyiszentmiklós (Organic Valley) were involved in the experiment (Fig. 11). All farms are part of the on-farm trial network of ÖMKi (Hungarian Research Institute of Organic Agriculture), the research partner of ATK (Centre for Agricultural Research).

PVS: Cultivars (registered varieties of ATK + Mv Elit CCP + Mv Bio2020 Pop) were evaluated by farmers during the trial years (Participatory Variety Selection: PVS). PVS activity of the farmers was strong resulting in the involvement of a couple of new registered varieties in each new season, while – at the same time – several underperforming cultivars were dismissed (especially after the very dry year of 2022, when the testing of 7 varieties was finished).

Our participatory plant breeding (PPB) programme started based on the two populations (Mv Elit CCP and Mv Bio2020 Pop) sown by farmers. Mv Elit CCP was developed in 2007 and no selection has been performed on this population since then. Mv Bio2020 Pop was made in 2020, as a mixture of segregating winter wheat F2 populations which parents were formerly selected in the ECOBREED project as appropriate cultivars for organic farming. Positive selection of spikes was performed on both populations by 3 farmers in 2021 (Fig. 11). Selected spikes were sent to ATK and threshed into 6 bulks resulting in 6 new sub-populations (based on the population and farm of origin).





Fig. 11. Farmer selecting his own spikes as a first step of participatory plant breeding (Szár, 2021).



Fig. 12. Organic field days at Szár in 2022.

Based on one year of replicated trial, some patterns could be found regarding farmer preference and diversity-dependent adaptability of the populations. Although results were so promising to enable continuation of the trial after the end of the ECOBREED project, the material had to be destroyed because of severe bunt contamination.

The participatory trials of ATK were presented at national and international plant breeding conferences during the last three years. In addition, trial results and the ECOBREED project were presented every June between 2021 and 2023 at the Hungarian Organic Field Day at Szár, which is a demonstration event co-organized by ÖMKi and ATK (Fig. 12). At the same time, detailed results were disseminated in the form of a bulletin, which covers all ECOBREED participatory trials from all partners involved in WP6, thus all



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details and results of ATK's participatory trials summarised above can be found in these ECOBREED Bulletins.

All results from ATK's participatory trials have helped organic farmers to gain more information on variety performance at organic sites resulting in the selection and organic seed sale of Mv Pántlika (conventional) winter wheat variety. This success has also boosted organic breeding activity at ATK, who will be able to offer organic varieties for organic farmers in the future, because now only conventional varieties are available for farmers cultivating Mv varieties. This work of ATK is the integrative continuation of the activities carried out in the project LIVESEED, the sister project of ECOBREED. In addition, the outstanding quality (and quality stability) of the populations has caught the attention of several organic farmers who have become more familiar with organic heterogeneous material (OHM), and some of them have already started to test Mv Elit CCP at larger sites. During the ECOBREED project, a very fruitful collaboration had been built up with the sub-contractor of ATK, ÖMKi and their on-farm trial network, who will be able to help ATK's future organic breeding and research activities. All Hungarian organic farmers involved in these participatory trials have decided to continue the testing of ATK's populations in the coming years and try to get the best for their sites out of them. Additionally, all of them are also open to test new varieties found to be suitable for organic agriculture on small plots, and some of them are also open to host small plot performance trials for the examination of future organic breeding lines originating from ATK's organic breeding programme.

GS

GS (SME) participated in FPTs in Serbia during 2021 and 2022 (variety donators IFVC and SZG), also 3 varieties were tested during 2023 as a sub-set and results were submitted by IFVC. After two years of trials some varieties were selected as candidates for further production under GS pedo-climatic conditions. In addition, CCPs were tested, and this is quite important for us since evaluation of material together with experts from IFVC. Results varied through three years, but some varieties showed good stability which is crucial for future sustainable production.

Dissemination and knowledge exchange was performed through the organisation of two demonstration events in 2023 (related to WP8). These events were central places for discussion and to share know how in organic production with different stakeholders. Bulletins were published in the local language.



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BOKU

Farmer participatory trials (FPT) with winter wheat (*Triticum aestivum* L.) were carried out from 2021 to 2023 on organic farms in different agro-ecological zones of Austria, i.e. the production areas (i) "Seewinkel" (47.7284, 16.9370), (ii) "Hollabrunn-Mistelbacher Gebiet" (48.5667, 16.0833), (iii) "Herzogenburg-, Tulln-, Stockerauer Gebiet" (48.4303, 16.0306), (iv) "Grieskirchen-Kremsmünster Gebiet" (48.1495, 13.7254), and (v) "Marchfeld" (48.2466, 16.5653). With exception of (iv) all other production areas are located in the North-eastern hills and lowlands which is a traditional production area of high protein quality wheat. In total, trials were carried out in 13 environments (location by year) with 40 genotypes (i.e. 31 cultivars and 9 populations). Eight cultivars (i.e. 'Alessio', 'Aristaro', 'Arminius', 'Arnold', 'Aurelius', 'Capo', 'Edelmann', 'Wendelin') and two populations (i.e. 'Liocharls Population', 'Mv Elit CCP') were tested in 6 to 11 environments. Due to the diverse origin of the germplasm a great variability in grain yield was observed ranging from 2526 to 10061 kg/ha. Generally, the lowest grain yields were recorded in the Seewinkel region with an average yield of 4108 kg/ha, whereas the highest yields were recorded for the Tulln (6720 kg/ha) and Hollabrunn (6396 kg/ha) area. Results for a reduced number of 10 genotypes which were grown in the majority of environments are shown (Table 10). It is obvious that differences between locations were more important than differences between years. Considering genotypes, only 'Arnold' fulfilled in all environments the Austrian market limits for organic baking wheat, i.e. 78 kg/hl test weight and at least 11% grain protein content (GPC). Failure in market criteria were mainly caused by too low GPC values. The two populations 'Liocharls Population' and 'Mv Elit CCP' were not competitive in grain yield with the most popular cultivars 'Capo' and 'Aurelius', with respect to market criteria 'Liocharls population' performed well, whereas 'Mv Elit CCP' missed the criteria in each of the four environments.

Besides the FPTs a field experiment with two different seed treatments/biostimulants was carried out in 2022 and 2023 at the test site in the Marchfeld production area. Seeds of cultivars 'Capo' and 'Aristaro' were treated with RhizoVital® 42 F (*Bacillus velezensis* FZB42) or T-Gro Easy-Flow® (*Trichoderma asperellum*) immediately before sowing. Statistical analysis across the two years revealed no significant effect on grain yield, grain weight, test weight or protein content.



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Table 13 Mean values of grain yield, test weight and protein content for genotypes, locations and years. Values for genotypes are best linear unbiased estimators (BLUEs), values for locations and years are best linear unbiased predictors (BLUPs).

Genotype	Grain yield (kg/ha)	Test weight (kg/ hl)	Protein content (%)	Market criteria fails (%)
Alessio	5154	83.3	12.2	14.3
Aristaro	5102	81.7	12.7	16.7
Arminius	5500	82.9	12.1	7.1
Arnold	5575	83.3	12.8	0.0
Aurelius	5885	82.5	12.0	16.7
Capo	5472	83.5	11.7	18.2
Edelmann	5506	82.5	11.3	22.2
Liocharls Population	4938	81.4	11.6	11.1
Mv Elit CCP	5346	81.6	10.6	25.0
Wendelin	5339	81.6	12.7	16.7
Year				
2021	5516	81.3	12.6	
2022	5305	82.1	12.2	
2023	5324	83.9	11.1	
Location				
Aspersdorf (ii)	5855	84.0	12.2	
Gaspoltshofen (iv)	5540	81.9	11.4	
Raasdorf (v)	4891	80.4	13.2	
Starnwörth (iii)	6361	85.0	11.5	
Wallern (i)	4261	80.8	11.5	

Table 14 Mean values of grain yield, grain weight, test weight and protein content for genotypes and biostimulant treatments. Mean values are best linear unbiased estimators (BLUEs) and based on a two year's (2022 & 2023) trial in Raasdorf, Austria.

Genotype	Grain yield (kg/ha)	1000 grain weight (g)	Test weight (kg/ hl)	Protein content (%)
Aristaro	6970	44.1	81.3	12.4
Capo	6648	42.0	83.1	11.5
Treatment				
Control	6785	43.0	82.1	11.9
RhizoVital®	6805	43.0	82.2	11.9
T-Gro Easy-Flow®	6837	43.1	82.2	12.0

The project's aim, individual FPTs and specific issues of organic plant breeding were shown and communicated to stakeholders (i.e. organic farmers, extension service of agricultural chambers, seed companies, processors, policy makers etc.) at a total of eight field events. Together with Bio Austria Burgenland and the BioNet network each year the trial in Seewinkel was visited and specific topics were discussed intensively with the audience, e.g. OHM in 2022 and common bunt in 2023. Together with the seed savior network Arche Noah and organic farm Grand Garten a workshop on OHM was organised and examples of wheat OHMs were shown in the field. Another field event and



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presentation of OHM, as well as presentations from the national authorities AGES and BML was organised together with Saatgut Austria in 2023.

The project's FPTs showed that mainly cultivars originating from the domestic conventional and organic breeding programmes performed well with respect to both grain yield and end-use quality criteria required by processors. Surprisingly elite varieties from Hungary and Slovakia performed inferior despite the fact that they were developed under similar climatic conditions. Most elite varieties from Germany were medium yielding but showed shortcomings in test weight and protein content, especially at sites in eastern Austria. The two populations (OHMs) did not show superior performance compared to the varieties most popular in organic farming, however, it has to be mentioned that both OHMs were developed under different climate conditions. Seed treatment with biostimulants showed no effect on grain yield or end-use quality and their benefit may be questionable under the current conditions, i.e. organic field with per se high bacterial and fungal diversity.

The project's FPTs had three main impacts: (i) communication and activities between stakeholders was strengthened; (ii) the at the beginning negative attitude of farmers and seed companies towards OHMs weakened over the three years: some organic farmers showed interest in growing such plant material; some breeding companies don't see any more a big competition by OHMs to their variety portfolio, especially as their continuously developed material is superior in grain yield; (iii) problems with common bunt in organic wheat production in 2022 and 2023 raised awareness to this disease and differences in the resistance level of cultivars significantly; consequently multiplication area and seed sales of the organic wheat cultivar 'Aristaro' from Germany which is still highly resistant to common bunt has increased significantly since 2021. This is a direct impact of the ECOBREED project as results from common bunt infection trials were communicated already at the beginning of the FPTs and the variety was included in almost all FPTs.

UNEW

Wheat: Wheat FPT varieties evaluated included organic varieties from across Europe identified by the ECOBREED project as having greatest potential for organic production in comparison to farmer grown varieties initially Revelation in the first years (2020 and 2021) but then progressing to KWS Extase, Theodore, KWS Dawsum etc. in later years. The farmer grown own varieties were popular conventional varieties from the UK Recommended List. In terms of yield it was the UK conventional varieties that outperformed the European Organic varieties (either bred or selected under organic management) in generally all trials. However, the organic variety Wendelin that is very popular in southern Germany always showed high resistance to foliar disease in the field but this was not reflected in its grain yield but it did have high grain quality. The organic



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varieties from Europe particularly Roderik, Barranco, Purino and Alessio were very susceptible to yellow rust which was at high levels particularly in the 2020 and 2021 seasons.

The CCP Wakelyn's YQ population was grown in all years and produced an average yield across the varieties/treatments with the exception of 2023 where severe lodging at Thornton Farm, Nafferton, Nesbit Hill and Gilchesters resulted in a very low grain yield for this tall CCP. Only having the Wakelyn's CCP in the UK limited the potential for comparison of the performance of CCPs against pure line varieties.

A number of seed dressings (i.e. Tiros, Sikulo, DK-20, AminoA Staart and Newton) were evaluated across the trials together with the foliar applied biostimulant Fixio. The seed dressings used had no effect on grain yield and/or grain quality. However, the biostimulant Fixio had a clear effect on grain yield with an increase of 1.04 t/ha at Thornton Farm in 2021, 0.45 t/ha at Thornton Farm in 2022, 2.73 t/ha at Thornton Farm in 2023 and 1.47 t/ha at Nesbit Hill in 2023 when averaged across all varieties/treatments. There was no clear effect of Fixio on grain yield at Gilchesters (2021, 2022 and 2023) and Nesbit Hill (2022).

A number of varietal mixtures were evaluated in 2023 (generally a 3 way blend but also a 10 variety blend) but with no clear benefit to grain yield, foliar disease or grain quality when compared with the pure line varieties.

Buckwheat: Buckwheat grain yields in the FPT were very variable in the UK with lost trials and low grain yields due to severe weed competition being a key problem. The exception was at Gilchester's where relatively high grain yields were observed in 2022 with 2.92 t/ha for the variety Kora followed by 2.86 t/ha for La harpe and 2.78 t/ha for Zoe. For other trials grain yields were generally low at or just below 1t/ha which limits the potential value for this crop in organic production systems. Successful establishment is key to this crop and even in some cases like Nafferton Farm in 2021 and 2023 where crop establishment was even and competition with weeds was successful grain yields were still low. The small seed size and asynchronous ripening of buckwheat pose key challenges for the future success of buckwheat as a commercial crop in the UK although in many cases it is used in cover crop mixes which are increasing in their adoption especially in regenerative farming systems.

NARDI

NARDI Fundulea participated in the Farming Participatory trials and breeding (FPT) to establish an efficient system for farmer-participatory-selection of new soybean varieties. This objective was achieved by testing, during 2021, 2022 and 2023, in 2 pedoclimatic zones/regions of Romania – South-Muntenia and South-east and in organic farming



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system, of 9 – 11 soybean varieties of most maturity groups (000, 00, 0, I, II) created in Austria, Romania, Serbia and the US.

After three years of trials, some soybean varieties were identified as suitable for organic farming, in terms of stability and quality of production in a period with strong and frequent droughts, accentuated by weed infestation, including on irrigated DEMO farms. The CCPs and varietal mixture were tested during the last two years. The yields and quality of these was modest compared with the parent varieties, mainly in case of the varietal mixtures because, maybe, of incompatibility of those. In Romanian FPTs, the soybean had many other enemies from sowing to harvest i.e. wild and domestic pigeons, European hare, *Agriotes* sp., *Tetranychus urticae*, *Etiella zinckenella*, *Septoria glycinea* etc.

Dissemination and knowledge exchange were performed through the organisation of one Demonstration event on 5th August 2022 at NARDI Fundulea and ECO-FRUCT farms, Călărași county, with 60 participants from all agriculture sectors: research-innovation, farmers, businessmen and other stakeholders. This event was focused on Q&A, discussions and sharing know how regarding soybean organic technology from seed and sowing to harvesting and storage. Also, at the end of each growing season (2021, 2022 and 2023) FPT Bulletins were posted in Romanian and English on the INCDA Fundulea website: e.g. <https://www.incda-fundulea.ro/cercet/ecobreed/T6.2.2022R.pdf>.

Conclusions:

- Except for the production years of 2020 and 2021, the last 2 years were the warmest and the driest of the last 60 years in Romania.
- The agriculture technologies, excepting soybean varieties, are specific for each FPT, depending on endowment with equipment, soil characteristics and experience in organic farming.
- Soybean inoculation with a mixture of Bradyrhizobium strains was very efficient, but in the case of organic fertilisation then less so.
- The sowing density has to be higher by about 40 % than in conventional agriculture for reducing competition with weeds during and after emergence.
- The soybean yield and TGV is according to genetic potential of the variety and soil water supply on all vegetation periods.

Impact: the cultivation by the ECO-FRUCT Ștefan cel Mare, county Călărași in 2022 of the Mercury variety on 60 ha and Fabiana F on 30 ha and by the ADAFLOR Zebil, Tulcea county in 2023 of the Florina F on 40 ha.



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