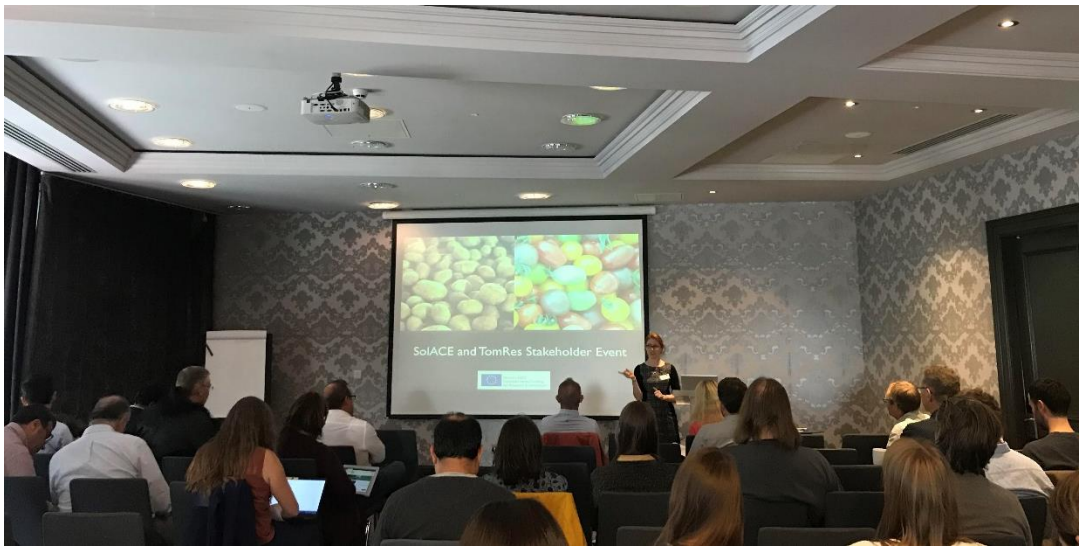
SolACE

Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

# Proceedings of the Third SolACE Stakeholder Event

**Dundee, Scotland**

**October 9, 2019**

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Layout: Laura Kemper, FiBL, Frick, Switzerland

For more information about SolACE visit the SolACE website at www.solace-eu.net and our Twitter account @SolACE_EU_NET

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## The Third SolACE Stakeholder Event

The third Stakeholder Event of SolACE - *Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use*[1] - took place on October 9, 2019, in Dundee, Scotland.[2] The event was held together with SolACE sister project TomRes – *A novel and integrated approach to increase multiple and combined stress tolerance in plants using tomato as a model*[3] – and was hosted by the James Hutton Institute (JHI). The event took place as part of the SolACE and TomRes annual project meetings, providing an opportunity for exchange between the two projects.

During the Stakeholder Event, SolACE and TomRes project partners presented innovations that are being tested in the projects with the aim to receive feedback and comments. The "Dragon's Den" approach, which was successful at the second Stakeholder event in Foggia (Italy), was used: SolACE and TomRes partners presented their innovations for the stakeholders (the "dragons"), who, in turn, asked critical questions. The stakeholders that were present were very interested in the innovations and had a lot of questions for the presenters.

The following innovations were presented and discussed:

- Adapted tillage practices and wheat genotypes to reduce external inputs into agriculture
- Water and nutrient stress stress-resilient tomato genotypes
- Humble Potato Hidden Treasure Unlocked
- Biostimulants in tomato under stress
- Field application of microbial inoculants using DCM's MINIGRAN® technology
- A powerful and cheap molecular tool to obtain the varietal composition of durum (or any species) mixtures (and some other applications)

For these proceedings, we have included the presentations as well as the questions and answers from stakeholders and presenters, respectively.

## Programme

- Welcome and introduction to the event and the 'Dragon's Den' approach
  *Niki Rust, Newcastle University, UnK (SolACE)*
- Adapted tillage practices and wheat genotypes to reduce external inputs into agriculture
  *Sarah Symanczik, Research Institute of Organic Agriculture, Switzerland (SolACE)*
- Water and nutrient stress-resilient tomato genotypes
  *Giorgia Batelli, National Research Council, Italy (TomRes)*
- Humble Potato Hidden Treasure Unlocked
  *Michiel De Vries, Solynta, the Netherlands (SolACE)*

[1] More information about SolACE is available on www.solace-eu.net.

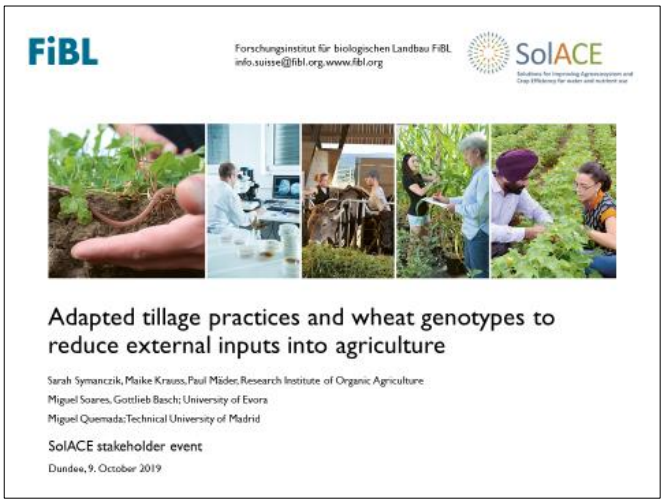
[2] Information on the SolACE stakeholder events is available from https://www.solace-eu.net/service/stakeholder-events.html

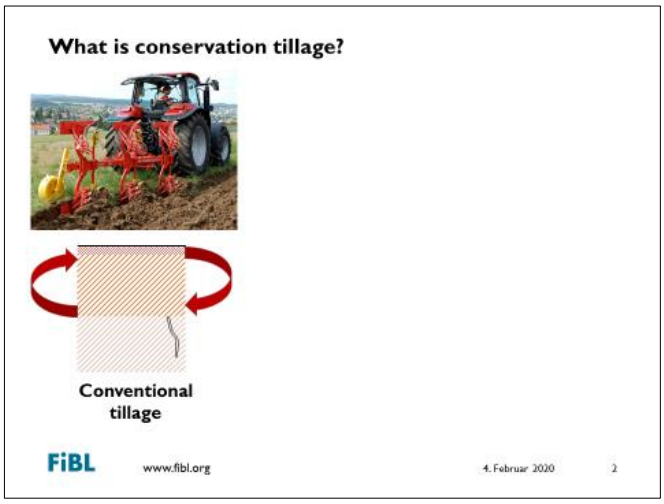
[3] The TomRes project is funded under Horizon 2020, Grant agreement ID: 727929. More information is available at https://cordis.europa.eu/project/id/727929 and www.tomres.eu.

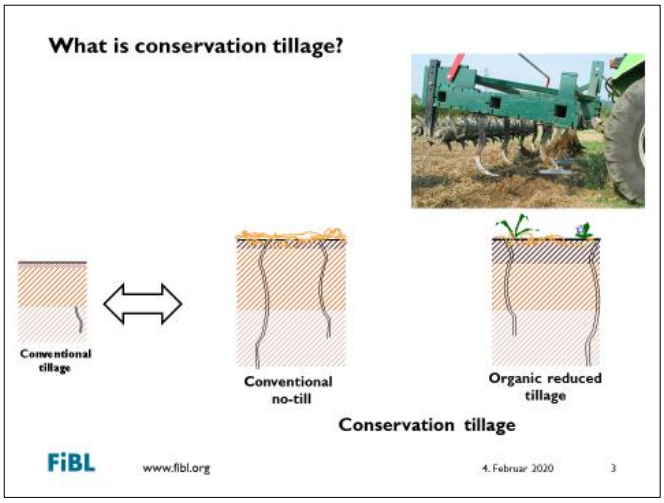
- Biostimulants in tomato under stress
  *Eleonora Deva, Strigolab, Italy (TomRes)*
- Field application of microbial inoculants using DCM's MINIGRAN® technology
  *Hervé Dupré de Boulois, DCM, Belgium (SolACE)*
- A powerful and cheap molecular tool to obtain the varietal composition of durum (or any species) mixtures (and some other applications)
  *Jacques David, Inra-Montpellier SupAgro, France (SolACE)*
- Closing remarks
  *Niki Rust, Newcastle University, UK (SolACE)*

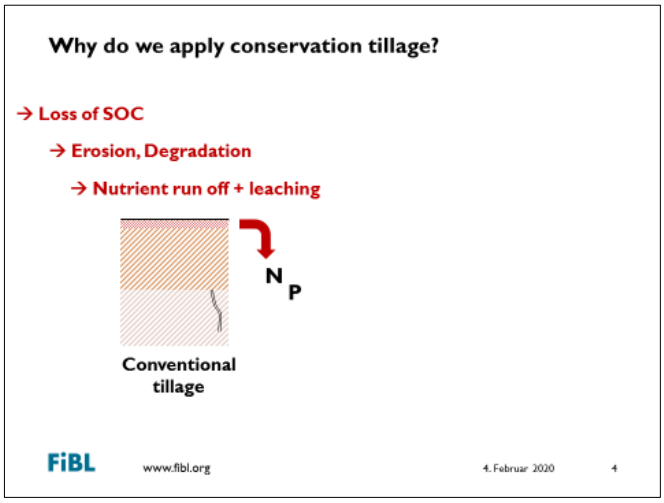
# Adapted tillage practices and wheat genotypes to reduce external inputs into agriculture


## SARAH SYMANCZIK[4]

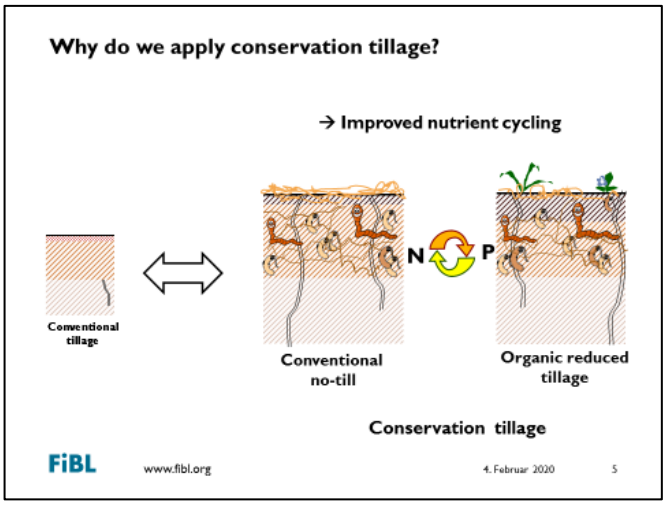



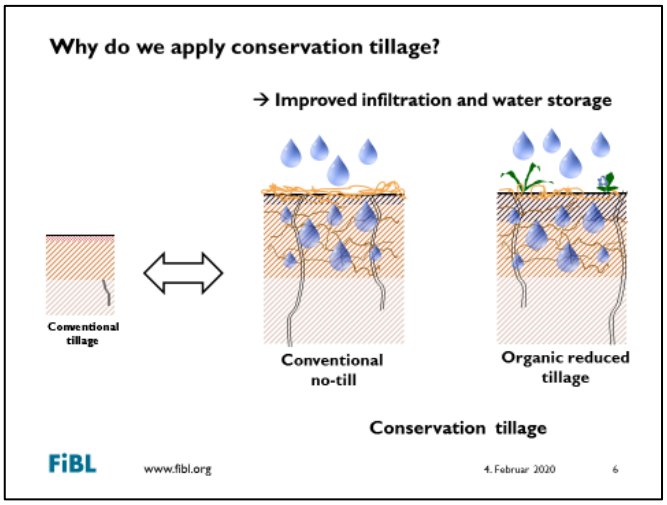



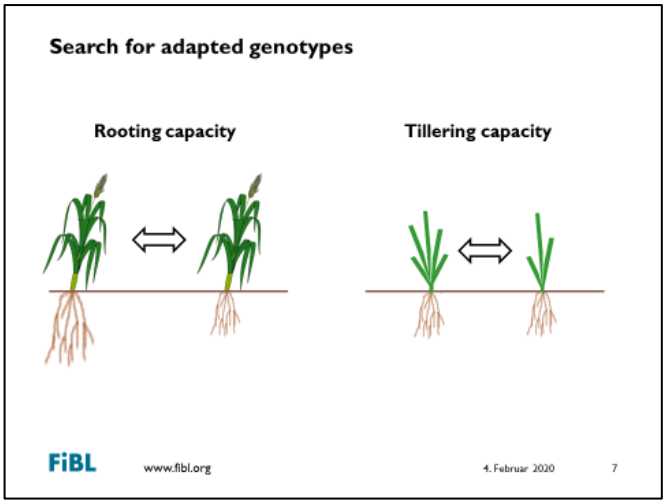



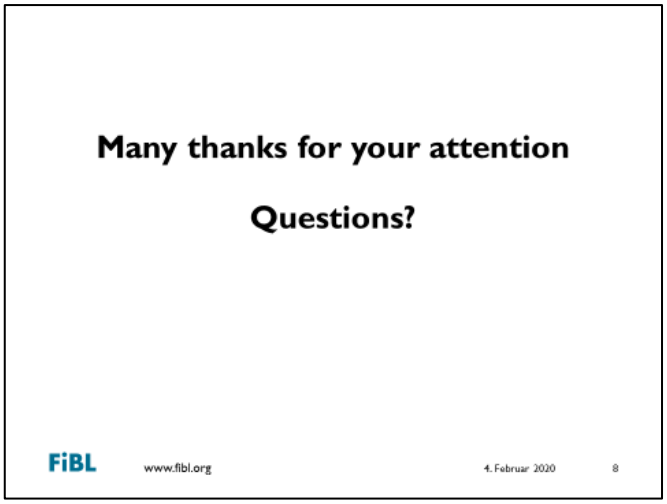




[4] Sarah Symanczik, Research Institute of Organic Agriculture (FiBL), Switzerland, SolACE




## Discussion

**Question: You mentioned tillering capacity. Why is that?**

Answer: It is an interesting wheat trait when dealing with competition with weeds. Some genotypes produce tillers faster in the early stages. This is especially important for reduced tillage in organic agriculture because we don't apply herbicides. So if soil is covered with more tillers at early stages, it is better for competition against the weeds.

**Q: Do you find yield differences?**

A: In Portugal, after the first year of trials, we didn't find any difference between the two tillage systems – conventional and no-till.

In our trials in Switzerland, where we do reduced tillage in organic agriculture, there are differences between varieties. There was at least one variety that even performed slightly better under reduced tillage than under conventional. So it is up to us to find genotypes that are more adapted to lower soil disturbance than others.

We also want to reduce the inputs we use in agriculture. In the Swiss trials, the conventional system needs a lot of nutrients in order to perform well in terms of yield. In reduced tillage, although the yield is sometimes slightly lower, it is not as dependent on inputs. In some systems, it performed just as well with half of the nutrient inputs.

**Q: You didn't mention some of the problems associated with no-till and leaving residues, like certain diseases. Can you tell us more about that?**

A: There are actually some diseases that might increase under no-till, and if you retain residues, which can be the cause of some fungal diseases. However, if you introduce a well-selected crop rotation, you can also overcome these problems. In addition, some diseases might even decrease, as beneficial soil microbes such as arbuscular mycorrhizal fungi and other plant growth-promoting bacteria and fungi can better proliferate due to the lower disturbance of the soil.

**Q: It's important to emphasise that if we encourage farmers to use reduced tillage, it is absolutely essential to have a breeding programme that provides genotypes that thrive in those systems. It's really obvious that there are differences between the soil conditions in reduced tillage and conventional systems and traits – particularly below-ground traits – will be quite different. So I think that breeding programs for this are absolutely essential.**

A: Yes, that's true. When searching for the varieties we are testing, we wanted to get varieties with contrasting traits so that we can identify the impact of the different traits.

**Q: Some systems can take 7-9 years to transition. There are too many experiments on conservation agriculture going on in systems that have not yet transitioned and are essentially conventional systems. We need to set up platforms, especially for experiments of this nature.**

A: I completely agree. For every system, you have a residual effect from your previous system. You need time to adapt in order to see the real picture. It is really important to have long-term trials to get a realistic picture.

**Q: One of the functions of conventional tillage is to control weed populations. How do you use reduced tillage or conservation agriculture in organic farming, if you can't use herbicides?**

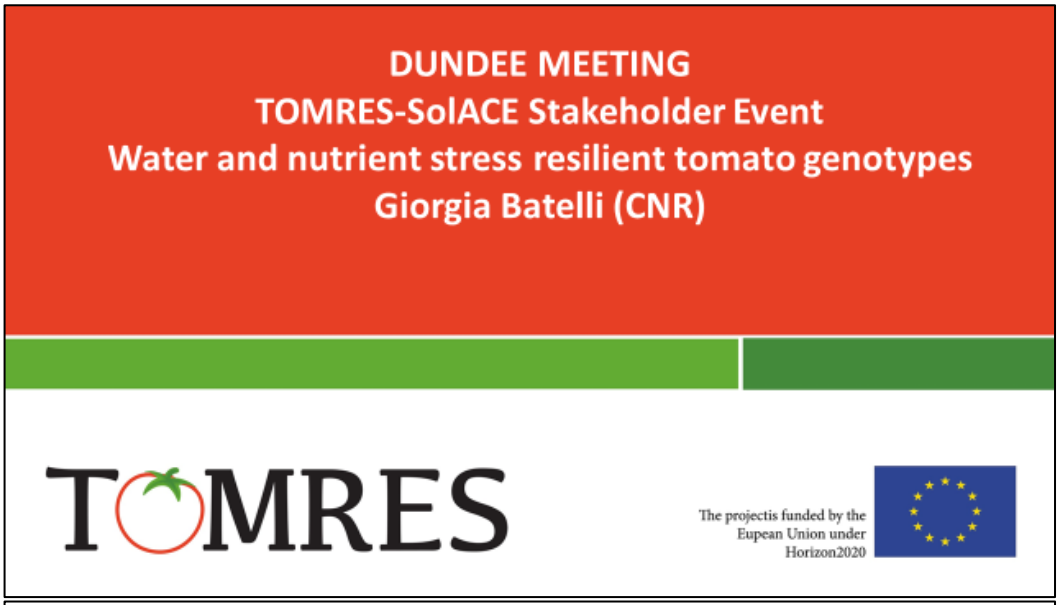
A: Crop rotation is a very important feature for that. For example, alternating winter crops and summer crops can help to reduce weeds quite a lot.

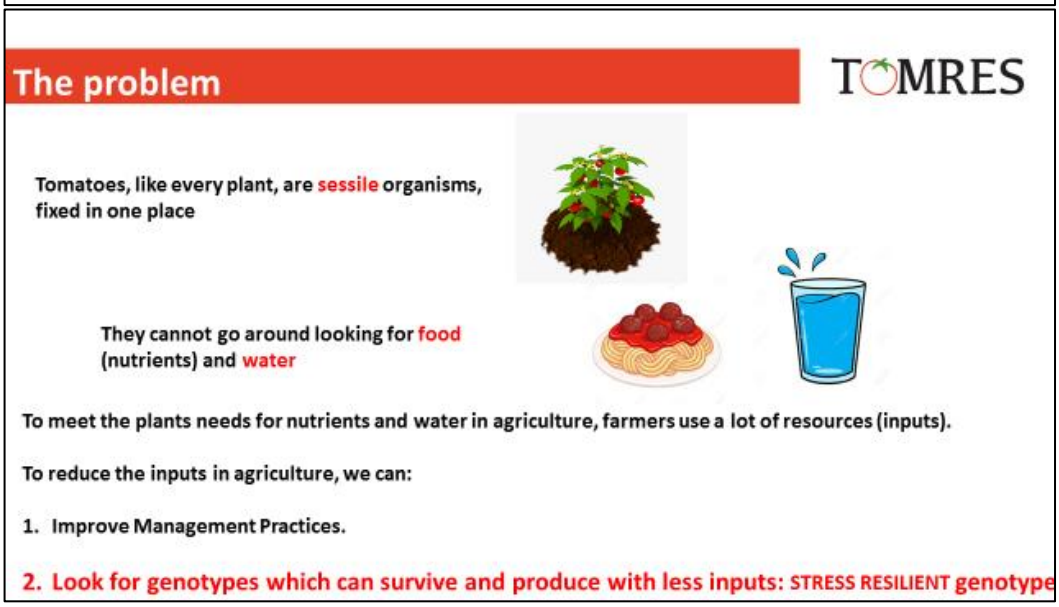
**Q: Did you do economic comparisons as well? Or full cost accounting? Maybe reduced emissions, inputs, etc., can offset lower yield.**

A: Yes, we do life cycle assessments to measure these aspects, but this will only be done after the second year once the field trials have been completed.

## Water and nutrient stress resilient tomato genotypes

GIORGIA BATELLI[5]




[5] Giorgia Batelli, National Research Council, Italy, TomRes

## The gold mine

TOMRES

There's thousands of tomato genotypes



Produced by

breeders/scientists

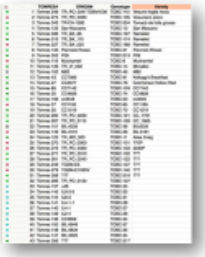


Selected by farmers

for local environments

## Which genotypes can work with less inputs?

TOMRES



The TOMRES tools to answer this question:

Different environments, setups, tools to verify tolerance

NDVI Thermography *In vivo* leaf gas exchange, including iWUE

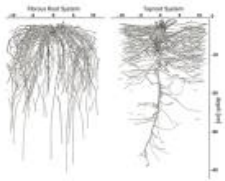
GAUTIER Semences



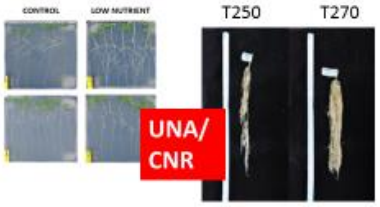

***Genotypes are characterized for different traits, and environments. Selected lines outperform others in several experiments***

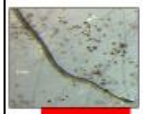
## Which traits promote resilience?

TOMRES



Root system architecture traits.




Lines where improved W/NUE when associated with AMF-root colonization

Gene variations; Hormone Responses etc


***Resilience promoting traits identified***

## Discussion

**Question: You didn't mention quality. How important is quality for the production of drought and nutrient deficient varieties?**

Answer: One of the partners is assessing quality under stress conditions. In some of the genotypes, quality is virtually unchanged in the tolerant genotypes. What can change is the yield. We are looking into that.

**Q: Are you looking for drought stress-resilient genotypes for field cultivation or also for greenhouse cultivation?**

A: We have different types of tomatoes. We have tomatoes in the open field, but we also have cherry tomatoes grown in greenhouses.

**Q: In the greenhouse, you also need to have stress tolerance?**

A: Well, you can always reduce the inputs. We are most interested in the combined stress of drought – water deficit and nutrient stress. But really, the aim is to reduce inputs, even in the greenhouse.

**Q: Do you have first results about root traits? Can you say something about what kind of root has been better for plant stress?**

A: We don't have final results. What we have observed is that some of the adapted varieties have longer root systems, but this is not yet finalised.

**Q: For the traits, are they assessed in artificial conditions, platforms or real conditions?**

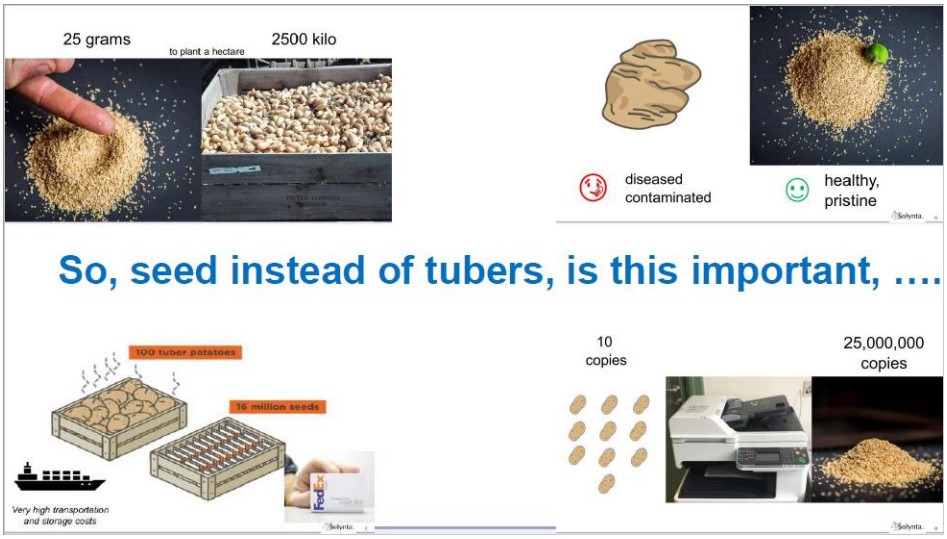
A: They are not tested in real soil, but we have different systems. For example, in Naples, we are using sand. In Nottingham, we are using a field soil-sand mix.

## Humble Potato Hidden Treasure Unlocked

### MICHIEL DE VRIES[6]



[6] Michiel De Vries, Solynta, the Netherlands, SolACE


25 grams
to plant a hectare
2500 kilo
diseased
contaminated
healthy,
pristine
So, seed instead of tubers, is this important, ….
100 tuber potatoes
16 million seeds
Very high transportation
and storage costs
10
copies
25,000,000
copies


35
30
25
20
15
10
5
0
experimental trials
yield / ha
local average
Solynta
4


Solynta
5



## Discussion

**Question: Seeds are not automatically free of diseases. I understand your point because you compare it to a tuber, but they are not automatically free of disease.**

Answer: Within the European Union, there are no diseases known for potato seed. This doesn't mean that they do not exist. But outside the EU, there are three viroids that are seed transmittable.

**Question: When you provide the seed to the farmer, I guess he needs to produce the seedlings before planting them in the field. Or can you plant the seed directly in the field?**

A: That is an option, but there are quite a lot of crops, where the farmer is supplied with seedlings by nurseries, rather than just receiving the seeds.

**Q: In your business model, are you going to sell to the farmer directly or to the nurseries or to both?**

A: Both. It depends on the local economic conditions. It can be too expensive to do that whereas in other cases it can be a very good option.

**Q: Is there any change in the crop cycles when you sow it from the seed?**

A: If you have the same genotype in true seed and in the seed tuber, the cropping cycle is longer in a true seed than a tuber by about two to four weeks.

**Q: Compared to the classical tubers, do you think another variety would be faster?**

Yes

**Q: How do you register your variety?**

A: We are in the registration process in several countries. It depends on the regulations of the different countries, whether they have to adapt the registration protocol or whether they can take an existing one. In the EU, we are working with several companies that are working on this type of starting material to have a European registration protocol.

**Q: Has anyone tried direct drilling?**

A: Yes, we did it to show that it didn't work, but we were surprised. Sometimes you get 20-30 tons if you direct sow. I can foresee in the distant future that we may direct drill potato in some cases.

**Q: Why doesn't it work now?**

A: Early growth is slow, so you miss an important part of the season. Breeding frost tolerance would be something that is needed to make that happen.

**Q: In Africa, one of the obstacles to adoption of tubers by farmers is the lack of mechanisation. Do you see an improvement through seeds rather than tubers?**

A: Yes, it is easier for dissemination and adoption. In Africa, storage of seed tubers is a very big issue.

**Q: Why didn't these farmers adopt tubers in the past?**

A: They are using tubers, but they are affected by diseases. That is one of the main reasons why their yields are so low.

**Q: Cost of seed compared to tubers?**

A: It depends on the added value. If we can supply a variety that saves 500 euros per hectare in spraying costs, we can find ways to split the added value.

**Q: But how much does it cost? I guess it should be more complicated to produce the seeds.**

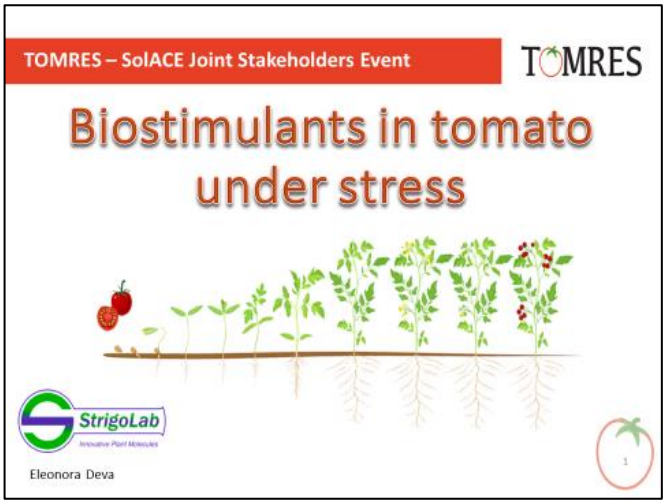
A: Not necessarily. But today there is a potato market, so we should be competitive on price and quality in today's market. Also, seed tubers have a wide range in terms of price. So I cannot give a general answer.

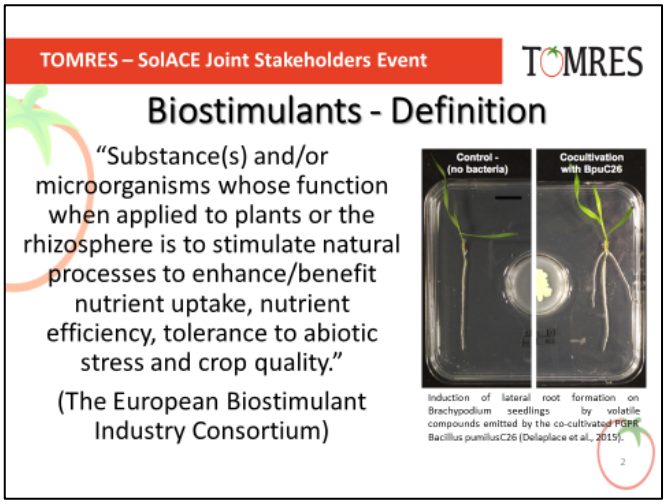
**Q: Does the longer cycle exclude that you have alternative cycles? Is it just for a normal cycle?**

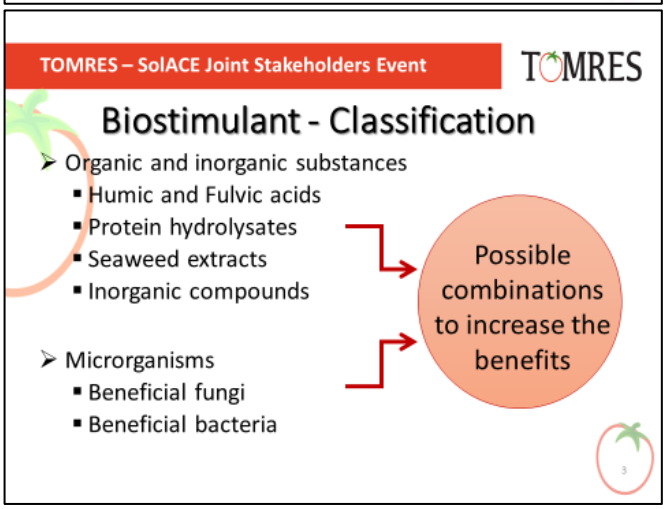
A: We see a big variation in cycle length. Not only in the time that the crop is amassing, but also in the time that the crop tends to tuberise. So with these two traits, you can play and breed one that fits the cropping cycle of the farmer. In the Mediterranean areas, we still need to optimise the crop cycle and hybrid to each other.

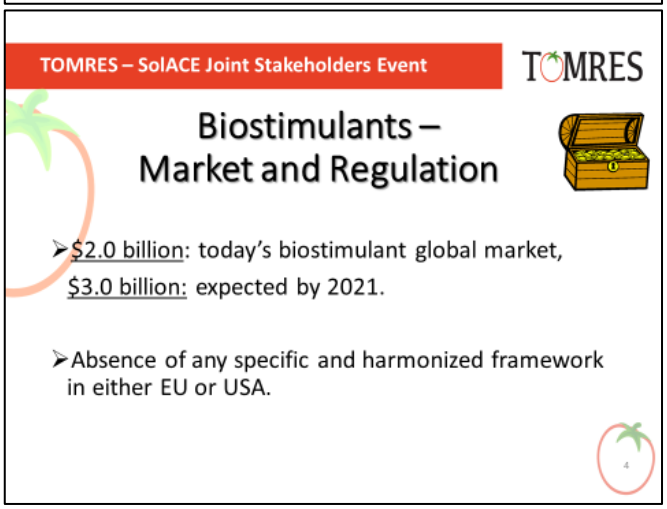
# Biostimulants in tomato under stress


## ELEONORA DEVA[7]

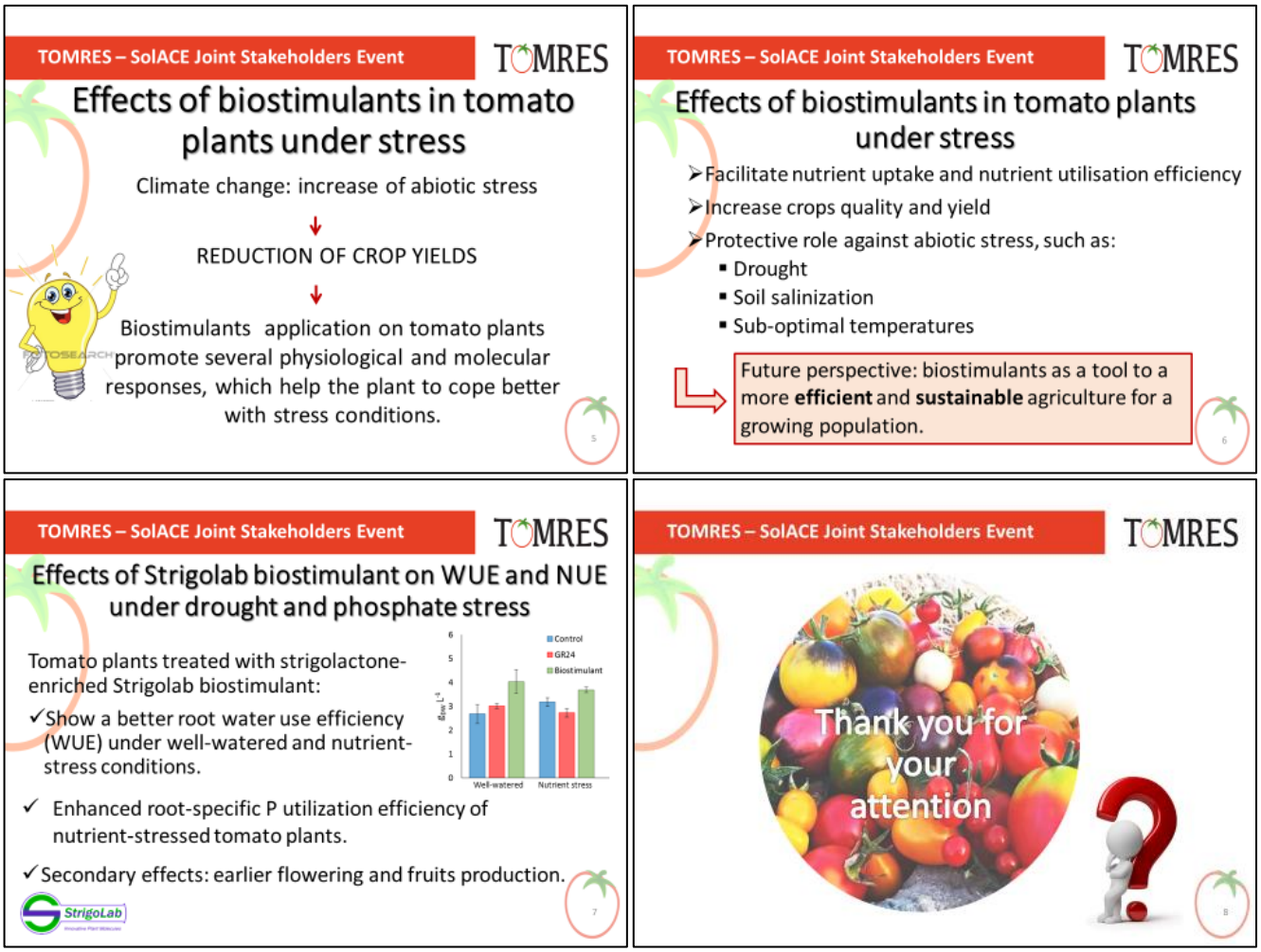




[7] Eleonora Deva, StrigoLab, Italy, TomRes




## Discussion

**Question: If you have a plant hormone that you apply, it doesn't fall under the biostimulant registration. It should fall under the plant protection regulation**

Answer: We are not applying a plant hormone. Our biostimulant is derived from the root of tomato. So we did some chemical research on the composition, and we found out that it is naturally enriched. So we didn't apply a synthetic hormone.

**Q: Do you know what the mode of action is? Obviously, it makes bigger root systems, but what is it changing?**

A: Until now, we just saw that the dry weight per litre of water was higher. We don't know the physiological response yet.

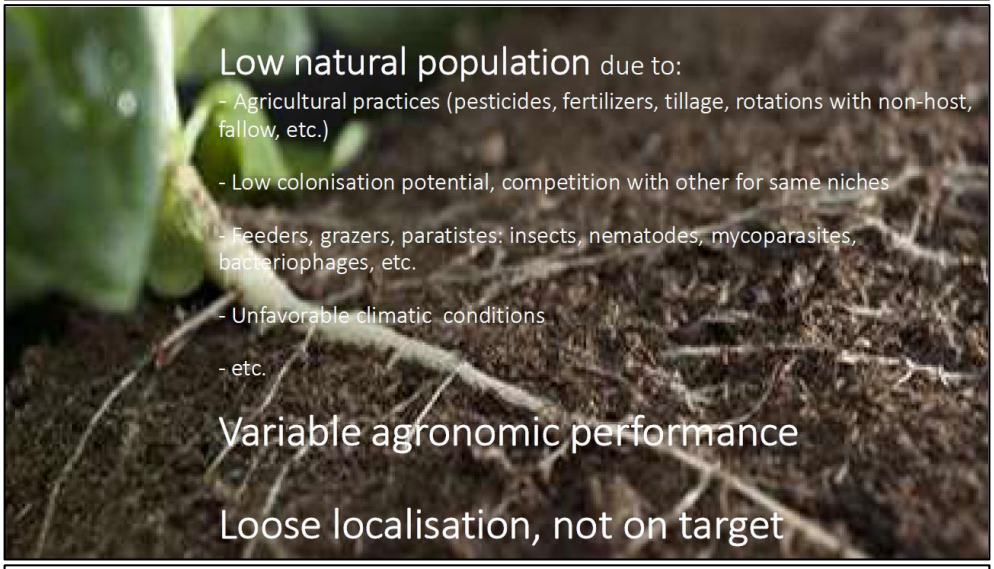
## Field application of microbial inoculants using DCM's MINIGRAN® technology

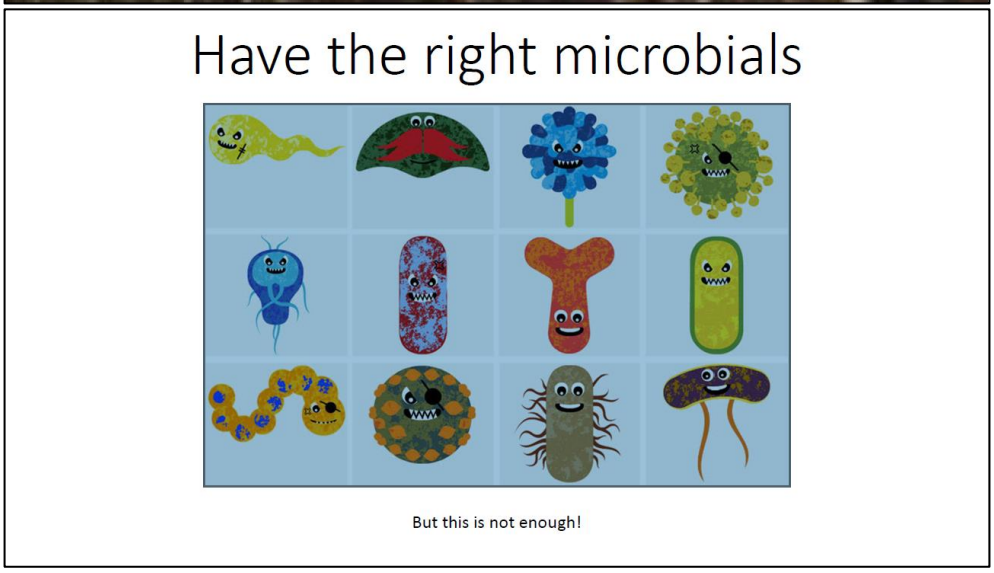
HERVÉ DUPRÉ DE BOULOIS[8]



[8] Hervé Dupré de Boulois, DCM, Belgium, SolACE


If beneficial microbes are naturally present in soils, why should I add more?


Low natural population due to:
- Agricultural practices (pesticides, fertilizers, tillage, rotations with non-host, fallow, etc.)
- Low colonisation potential, competition with other for same niches
- Feeders, grazers, paratistes: insects, nematodes, mycoparasites, bacteriophages, etc.
- Unfavorable climatic conditions
- etc.
Variable agronomic performance
Loose localisation, not on target


Have the right microbials
But this is not enough!

Is it allowed to use them ?

Can they be mass-produced ?

Minimum shelf-life?

How to deliver them to the plant ?

Can they be used with current cultural practices ?

Cost ?

Etc.


SolACE
Solutions for improving Agroecosystem and Crop Efficiency for water and nutrient use

Design single inoculum units to bring consortia of beneficial microorganisms to the field

**Microbials ingredients consisted of:**

- Mycorrhiza root fragments
- Wettable powders for
  - Bacteria
  - Trichoderma

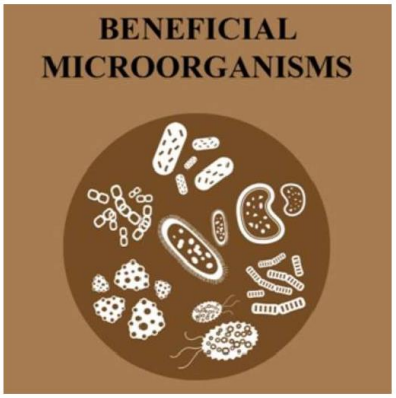
**Possible formulations:**

Pellets

**Granules**

Capsules using entrapment technologies

???

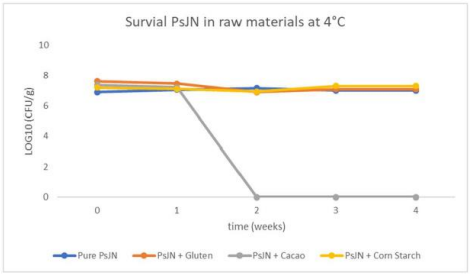



Minigran®

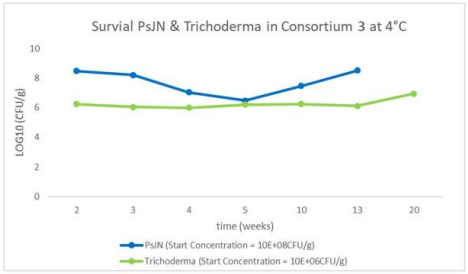
- Organic ingredients blend into granules
- Flexible composition, size and density
- Compatible with machinery
- Suitable for organic farming

## Designing Minigran® as microbial carrier

From choosing the right raw materials for each microbial ...




... to choosing the right combination of raw materials for each consortium

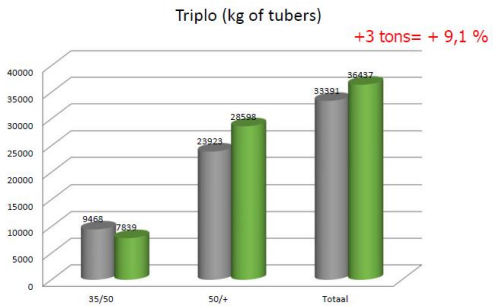



## 1 adaptative inoculation unit: Minigran®

## 4 microbial consortia formulated in Minigran® for SOLACE

## Excellent survival over time

## Minigran®
## as a microbial carrier




Precise application of 30 kg Minigran® with *Bacillus* sp.

## Discussion

**Question: I'm interested in the cost. Do you have numbers to compare one unit of nitrogen or phosphorus? How much more expensive is it?**

Answer: This is an example of a commercial product that we have had on the market now for a few years. The price per hectare is 40 euros. If you have three extra tons of potatoes, you are probably profiting. The objective of biostimulants such as those developed with the minigran® technology is not to replace nitrogen or phosphorus fertilisers, but to use them better.

**Q: AMF survives quite well in a dry product. Do you think your bacteria in your product could be compromised in a dry state? So you might be losing some viability.**

A: It depends on what type of bacteria you have to start with. If you have a spore-forming bacteria, no problem. If you are working with gram-negative bacteria, most of the time, their stability in either a liquid or dry formulation will be complicated. The preliminary results that I showed on gram-negative bacteria were with granules kept at four degrees, for instance. At other temperatures, viability could drop faster. The results we obtained are, however, very encouraging.

**Q: There haven't been a lot of studies on the effect of these inoculants on the soil microbial community at all. We assume it's ok, but we've not checked.**

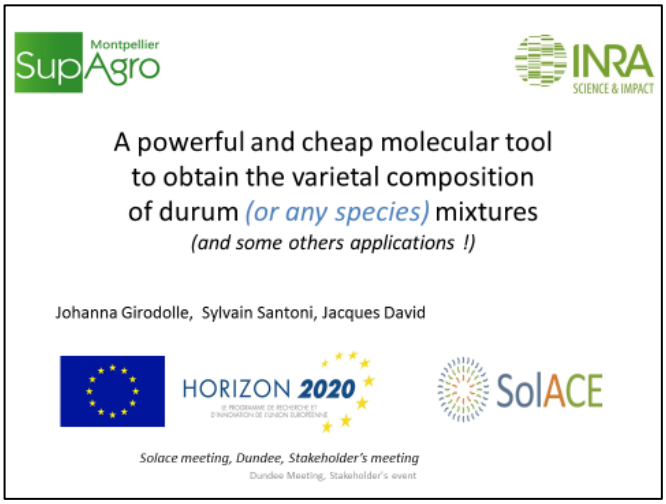
A: Anything you do on your field will impact the natural soil microbial community. This is true whether it's a plant, a chemical or a microbial inoculant that you add to your system. So whether you use a strain from Japan, India or Europe, there will be a perturbation of the natural soil microbial community. What may be relevant is the persistence of an introduced microorganism and its spreading to natural ecosystems. In this respect, it might be better to work with local strains than exotic ones.

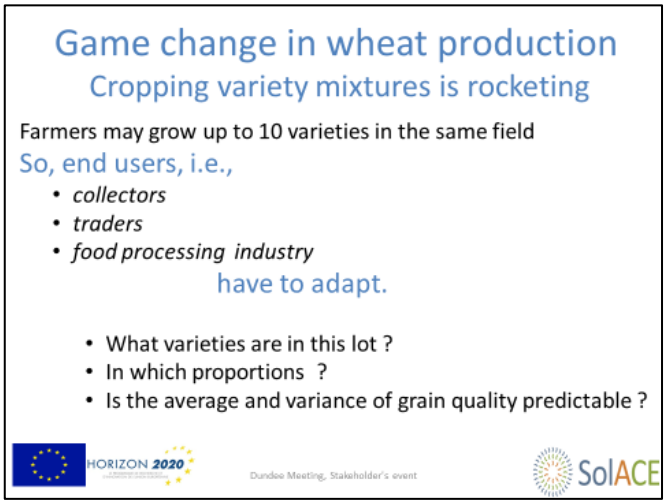
**Q: Is the product capable of carrying trophic assemblages that might work together?**

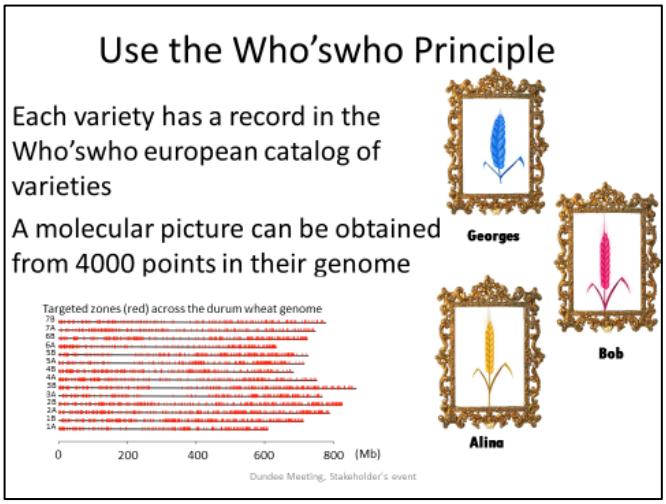
A: Yes, but the more you add things, the more the costs will rise. This can make costs unviable for farmers.

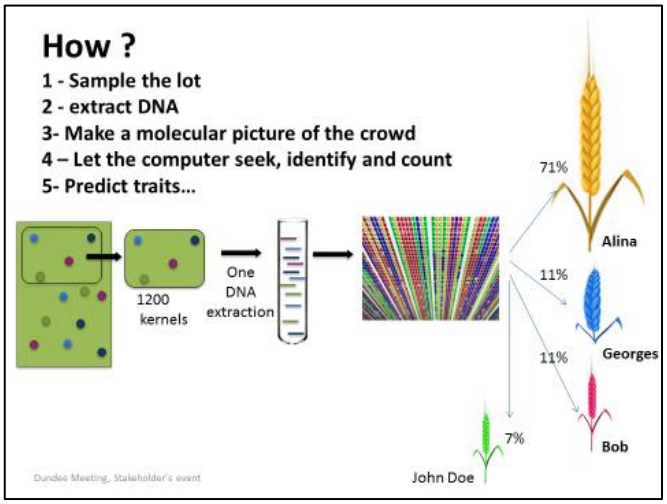
# A powerful and cheap molecular tool to obtain the varietal composition of durum (or any species) mixtures (and some other applications)

JACQUES DAVID[9]

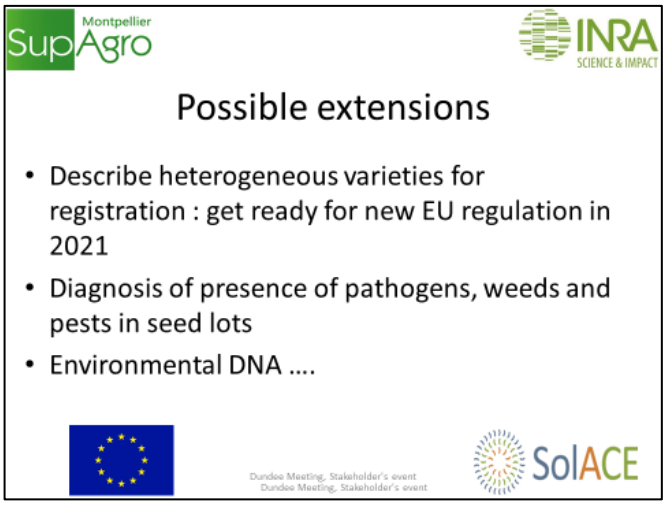



[9] Jacques David, Inra-SupAgro, France, SolACE




## Discussion

**Question: What is the degree of confidence?**

Answer: Very good. In SolACE, we will have a number of tests, and we will use that in a routine way on our populations. We have a much higher number of pixels than what is needed to identify the few components of a simple mix. If you only have recorded varieties, the error level is very low because we have so much information.

**Q: What is the cost of one analysis?**

A: The lab costs, without salary, are about 30 euros.

**Q: Will you calibrate the seed samples?**

A: Yes, this still needs to be done. We have to verify how much DNA one additional seed could provide. At the moment we consider it equal. But we don't know yet, where the DNA is in the sequence.

**Q: Is it possible to apply this to below-ground?**

A: Yes. If you want to do this below ground, you can. You take a sample of something and then you can identify who is who. Very simple.

**Q: Do you think if there are more mixtures, the notion of variety will become less important?**

A: When we first discussed this with bread makers or pasta makers, they were horrified that it would be blended. After a while, they found that the mixtures also had nice properties for them sometimes, for example, good textures. So the debate is currently open. Most of the French farmers that I know use mixtures for their cattle. And for the part that goes to the market, it is unclear. However, some French bakeries started to design mixtures by themselves in order to be the first to promote the mixture to the farmers and control the quality.

**Q: What are the main drivers that make farmers want to cultivate mixtures?**

A: Facility. There is a trend of saying to farmers that they have to diversify. But if you want to have diversity and sell products that aren't in mixtures, then it's very difficult to have more than two or three varieties. It is also

difficult for them to get seeds and then split them according to variety. So it is much easier to mix. There are also a lot of other possible benefits.

**Q: I would like to know more about the method. What do you sequence?**

A: We use a capture method to sequence only targeted zones in the genome. Because the wheat genome is huge, we can't sequence everything. From that, we get sequence reads, and with those, we can use the software to estimate the frequency of each component.