Skema E

Description of the scientific research in the project to be evaluated by Innovation Fund Denmark

(Oplysninger til forskningsfaglig vurdering for ansøgning med forskningsfagligt indhold)

All sections below must be filled in, and in English. Please see the guideline for details on filling it in.

Project:	
E1. Project title and acronym:	**Improved methods of organic seed treatments and propagation** *Behandling og Fremavl af Såsæd Godkendt til Økologisk Jordbrug* (SåGodt) (Max. 10 words)
Applicant:	
E2. Name, title and organisation of main applicant:	Anders Borgen, Ph.D. Agrologica
E3. Start date:	1.1.2017 E4. End date: 31.12.2019
Project description:	
E7. Short project description of the overall project	Previous research has indicated that organic seed has lower vigour and requires more time for emergence than conventional seed, and that this results in lower yield. Also, organic seed is at higher risk of being infected by seed borne pathogens because of lack of control measures. On this background the project will make a survey of the status of organic seed vitality, and perform field trials to identify means to improve seed vigour. The project will develop equipment to treat seed with a combination of steam and ultra sound (SonoSteam), and compare the treatment with a range of other seed treatments consistent with the principles and standards of organic farming. (Max. 1500 Characters)
Scientific research:	
E8. Description of scientific research to be carried out in the project (max. 4 pages)	Background According to the EU seed regulation, cereal seed need to be able to germinate at least 85%, and in Denmark national standards requires a germination of 90-95% depending on the crop species. However, even when seed meets these standards, differences in germination vigour measured as germination speed exist. Pedersen et al (1993) has shown that yield may differ up to 16% caused by differences in seed vigour in winter sown cereals, and also in spring barley it is shown that yield may differ up to 14% in seed lots that still meets the elevated Danish requirements for certified seed under conventional growing conditions (Emmeluth 1990, 1991). Under organic conditions, the effects is likely to be even higher, since especially weed competition is affected by the speed of emergence and early growth rate of the seedlings (Rasmussen and Rasmussen 2000). Müller (2013) has shown that when organic barley seed was used compared with conventional seed, yield was reduced 10-25%. This effect may be caused by many factors such as differenced in protein content caused by lower N-availability, seed size caused by reduced grain filling due to infections of leaf pathogens and infections of seed borne pathogens. Kristensen (2001) has shown that such factors reduces germination speed in organic wheat and barley compared with conventional grown seed, but even when the effect of such known factors were eliminated, yield was still reduced 3% when organic seed is used compared with conventional seed. There is a need for a better understanding of the factors within the cropping system that affect the seed vigour, in order to prevent reduced seed vigour during the propagation of organic seed. Seed vigour is defined as the total effect of the seed on the plants performance. Apart from germination and emergence speed, infection by seed borne pathogens is of crucial importance. In conventional agriculture, seed health is ensured by seed treatments with fungicides. About 90% of all seed is treated with fungicides before sowing in Denmark. In the absence of fungicides, organic seed producers analyse the seed for presence of pathogens and discard infected seed lots. About 25% of all organic seed lots in Denmark are discarded caused by seed pathogens (Nielsen and Kristensen 2001). The methods to control seed pathogens are limited in organic agriculture, but include

thermal treatments and application of certain biological and non toxic agents (EU 2016).

Common bunt in wheat caused by *Tilletia caries* is one of the most devastating diseases in organic cereals (Borgen 2001, Matanguihan 2011). Possible treatments against common bunt include hot water treatment (Jensen 1888, Borgen 2001). This technique however result in wet seed that need post treatment drying. A novel improvement of this is the ThermoSeed technology, where seed is treated in humid air instead of water (Forsberg et al 2005). Electron beaming (E-Ventus) is a technology that can prevent most cereal seed pathogens (Jahn et al 2005, Dressler et al 2008). Both ThermoSeed and Electron beam are only available for industrial scale seed treatment.

For treatment of minor scale seed lots, seed dressings with different agents are possible, including mustard powder (Borgen and Kristensen 2001), acetic acid (Borgen and Nielsen 2001) and treatments with biological agents (Borgen and Davanlou 2000).

Agents containing saponines is known to be fungi-static, and common corn-cockle seed (*Agrostemma githago*) can be used as a seed treatment against common bunt (Borgen 2001). However, corn-cockle seed is not commercially available, and the treatment therefore expensive. Extracts of sisal (*Agave sisalana*) also contains saponines and has also effect on common bunt, but the potential is not developed (Borgen and Lund 2014).

Many seed weed products contains fungi-static or fungi-toxic compounds, including saponines and fucoidan. The highest content of bioactive metabolites is expected to be found in *Fucus vesiculosus* and *Ascophyllum nodosun* which are found in abundance along the shores of Denmark, but the effect as seed treatments are unexploited. However, this could be relevant compounds to use because of the slimy textures of some alginates which could be used as an additive in a seed dressing, eventually in combination with other products.

Most alternative seed dressings need application mixed with water in quantities of some 20 ml/kg which makes the treatments less suitable for industrial seed treatments as drying is needed afterwards. So far, most of the seed dressing mentioned have not been allowed in organic farming since they were not listed in Annex II in the organic regulation (EU 2008). However, the regulation has changed in 2016 (EU 2016), and a range of non toxic seed dressings are now available for organic farmers.

Brush cleaning can remove most of the fungal spores on the seed surface, and the effect on control of common bunt is demonstrated (Borgen 2005a 2005b).

One of the most promising methods of seed treatment against common bunt is the SonoSteam technology based on thermal ultrasound (Borgen et al 2005). The ultrasound significantly improves the thermal effect of the steam, making the treatment targeted to the entire seed surface. However, equipment for thermal ultrasound treatment able to treat seed has only been available for small scale tests, and has therefore not been used in practice.

Based on this, the project will:

- investigate the seed vigour in organic and conventional seed, and identify factors in the organic cropping system affecting the seed vigour
- Develop equipment to treat seed with thermal ultrasound to control seed pathogens
- Test the effect of thermal Ultrasound and a range of other seed treatments to compare the effect of common bunt and other seed borne pathogens on cereals

Work package 1: Seed vigour.

The project will collect samples of certified conventional and organic seed lots, and test the germination speed to conclude the present status of the organic seed in practice. If differences in early seed vigour are demonstrated, the effect on grain yield will be tested in field trial under both organic and conventional conditions.

In field trials, the project will grow seed of different origin at different plant densities, nutrient levels and with differences in resistance to leaf diseases under organic and conventional conditions to test which factors most significantly affect seed vigour of the harvested grain.

Field trials and vigour tests will be done at Agrologica and Nordic Seed.

The project will develop a guideline for propagation of organic seed for optimal seed vigour.

Work package 2: SonoSteam

The project will develop a seed treatment equipment able to treat 0-4 tons seed/hour with thermal ultrasound, and adjustable in duration and intensity of the treatment.

Work package 3:
The project will test the effect of different seed treatments on the control of seed borne pathogens and seed vigour in wheat and barley. The treatment will include:

- SonoSteam treatment developed in the project WP2
- E-Ventus
- ThermoSeed
- Brush cleaning
- Vinegar
- Mustard powder
- Tillecur
- Seed weed *Fucus vesiculosus*
- Seed Weed *Ascophyllum nodosun*
- Sisal extract
- Conventional fungicide seed treatments

Seed infected with seed borne pathogens will be sent to Germany or Sweden for treatment with E-Ventus or ThermoSeed. Reference seed treatment with conventional fungicide seed treatment will be done at Nordic Seed, and the rest of the treatments will be done at Agrologica.

Treatments will be tested for the effect of seed infected with common wheat bunt (*Tilletia tritici*), fusarium spp, Barley net blotch (*Pyranophora teres*), barley leaf stripe (*Pyranophora graminea*), wheat glume blotch (*Stangonospora nodorum*), ramularia leaf spot (*Ramularia collo-cygn)* and common root rot (*Bipolaris sorokiniana*).

The effect on common bunt will for all treatments be tested in field trials at the disease nursery at Agrologica to avoid spread of the disease. For the rest of the diseases, the effect of the heat/energy treatments the effect will be tested by blotter test according to ISTA guidelines (Keitreiber 1984). For the seed dressings, the effect will assessed in field trials at Agrologica and Nordic Seed, recording seed germination speed, early vigour, disease symptoms and grain yield.

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CVs:	
E9. CVs for relevant persons in connection to the scientific research (max 1 page pr. person)	