PPP Annual Report 2019
PPP projects which are under supervision of the "Topsectoren" must report annually on the scientific content and financial progress. This form is used to report the progress of the content of the project. PPP projects that finish in 2019 should make use of a different form: "PPP-final report."
The annual report will be published on the TKI / topsector website. Therefore, please ensure that there is no confidential information in the annual report.
Please, submit the report before 15 February 2020 to Hans van der Kolk

General information	
PPP-number	**T&U 18009**
Title	**Prediction of seed vigour and storability**
Theme	**High Tech & Digitale Transformatie**
Implementing institute	**Wageningen Research**
Project leader research (name + e-mail address)	**Nicole Koenderink (nicole.koenderink@wur.nl)**
Coordinator (on behalf of private partners)	**Corine de Groot (Bejo Zaden)**
Project-website address	**https://topsectortu.nl/nl/prediction-seed-vigour-and-storability**
Start date	**1 February 2019**
Final date	**31 January 2023**

Approval by the coordinator of the consortium The annual report must be discussed with the coordinator of the consortium. The "TKI's" appreciate additional comments concerning the annual report.	
Assessment of the report by the coordinator on behalf of the consortium:	x Approved □ Not approved
Additional comments concerning the annual report:	De jaarrapportage geeft een helder overzicht van waar we staan.

Summary of the project	
Problem definition	Seeds are an unequivocal part of crop and food production for human consumption. Seed vigour is both a critical aspect and complex trait to the successful establishment of crops in the field or greenhouse, thereby indirectly linked to crops yields and food security. Seed vigour is a complex trait but can be quickly defined as the potency of seed to establish quickly into a healthy seedling across a diverse set of environmental conditions. Seed vigour will decline during storage which can adversely affect seedling establishment in the field or greenhouse and lead to reduced storability of seed lots. Currently, seed companies cannot predict which seed lots, or which seeds in the population will deteriorate faster or slower during storage. Neither can they distinguish between individual high or low vigour seeds from a stored seed lot. Apart from the aspects of crops yields and food security, also resource use efficiency is affected by poor or declining seed vigour: Seed lots may be discarded or available field or greenhouse surface cannot be used most efficiently in times where good yields are a constant challenge. Furthermore climate change may challenge seed

	vigour by the overall rise in temperature or by more extreme environmental conditions in the field.
Project goals	- Use state of the art spectroscopy and imaging techniques in combination with artificial intelligence and 3D phenotyping of seedlings, to predict the seed vigour deterioration during storage. The ultimate goal is by non-destructively detecting single seed vigour to establish the sorting of seed lots into vigour classes, thereby producing seed lots with optimal overall and more uniform seed vigour and the prevention of discarding whole seed lots due to overall vigour. - Use a systems biology approach to measure and predict the physiological ageing state and storability potential of seed lots, by combining metabolomic approaches with spectroscopy and imaging techniques in combination with artificial intelligence and 3D phenotyping of seedlings.

Results	
Planned results 2019	1.1 Develop a prototype for VIS-NIR spectroscopy and hyperspectral measurements – hardware. 1.2 Develop a prototype for VIS-NIR spectroscopy and hyperspectral measurements – software. 1.3 Optimise GC-MS method for key species 1.4 Prepare EPPO setups 1.5 Write detailed experimental design 2.1 EPPO ageing of batches
Achieved results 2019	**Prototypes, hardware and software setups for measuring seeds based on hyperspectral imaging and near infrared spectroscopy.** This deliverable has been achieved by using the Datacollector system developed by project partner SeQSo. The Datacollector analyses individual seeds on Visual and hyper spectral properties, plus X-ray and chlorophyll fluorescence. Analysed seeds can individually be sorted in microtiter plates, with a link to their spectral data. **Optimized headspace GC-MS protocols for seed batches of the target species.** The project team has decided to postpone metabolomic analyses to later in the project and prioritise first on establishing the ageing treatments, which will take a few years, and optimising the logistics for analysis of individual seeds, seedlings and integration of the data. The stored samples are input for the metabolomics (GC-MS method) analyses in the last stage of the process. **EPPO setups and protocols for seed batches of the target species.** The EPPO system has been applied to 30 Brassica seed lots. It was found that about half of the seed lots were sensitive to the pressure itself. All seed lots showed more ageing symptoms the longer the duration of the EPPO treatment, which indicates that the EPPO ageing treatment is useful to mimic the seed ageing process. **Detailed experimental design for experiments in year 2** The project team has discussed the main experiment of measuring, ageing and assessing many seeds in order to reach the objectives. We expect that approximately 10,000 seeds will be processed and analysed and have identified the logistical bottlenecks in performing this

	experiment. A pilot experiment has been agreed upon which will take place in Q1 of 2020.
Planned results 2020	**Start of natural ageing and EPPO ageing of selected batches under various natural conditions** - Out of the 30 seed lots to which EPPO ageing and control treatments have been applied, six will be selected for more detailed analyses of their sensitivity to ageing and the EPPO treatment. - From these three seed lots will be selected to start a large scale storage experiments under EPPO and natural ageing conditions. - Samples from EPPO stored seeds will be analysed for seedling performance to select a prepare sample for the main experiment, including metabolomics analyses in the third year. - It will be tested if seeds can be individually followed during EPPO treatments using microtiter plate strips. **Database containing all collected data corresponding to the seeds and seedlings** - A pre-pilot will be performed with around 750 seeds to test the logistics and methods for data gathering the spectral data of individual seeds, the images of corresponding seedlings - Besides the Datacollector system for VIS-NIR spectroscopy and hyperspectral measurements, a 3D MARVIN computer vision system for seedling analysis will be used. The current system will be adapted in such a way that data packages can be generated for deep learning analysis of the whole process. - It will be explored if a module for Raman spectroscopy would be valuable in identifying the seed vigour. - It will be explored if 2D chlorophyll fluorescence imaging would be valuable in assessing seedling quality in the cotyledon stage. - All gathered data in the pre-pilot will be combined to understand the requirements for the deep learning process. - The database will be checked on its completeness

Deliverables/products in 2019 (provide the titles and /or a brief description of the products/deliverables or a link to a website.
Scientific articles: -
External reports: -
Articles in professional journals/magazines: -
(Poster) presentations at workshops, seminars, or symposia. -
TV/ radio / social media / newspaper: -
Remaining deliverables (techniques, devices, methods, etc.): For the deliverables in 2019, please see the section on achieved results of 2019.

https://topsectortu.nl/nl/prediction-seed-vigour-and-storability