Working group meeting of the ad hoc group for grain legumes

8 February 2018, Alnarp

Participants:
Country representatives: Matti Leino, WG chair (ML), Nordiska Museet, Sweden; Pertti Pärsinen (PP), Boreal, Finland; Ingunn M. Vågen (IV), NIBIO, Norway; Georg Carlsson (GC), SLU, Sweden; Gert Poulsen (GP), Frøsamlerne, Denmark. NordGen: Anna Palmé (AP) and Ulrika Carlson-Nilsson (UCN).

In addition, participants in the project “Arctic Peas”: Søren Kjærsgaard Rasmussen (SKR), KU, Denmark; Ari Rajala (AR), Luke, Finland; Karolina Aloisi (KA), NordGen,

A. Welcome
ML welcomed everybody to the meeting and all meeting participants introduced themselves.

B. Appointing a secretary
AP was appointed as secretary.

C. Comments on the agenda of this session
No comments on the agenda.

D. Arctic Peas (see separate agenda)

1. *First project year 2017*
   UCN and KA presented the progress of the Arctic Pea project during 2017. See appendix 1.

2. *New application for 2018 (Nordregio)*
   An application will be sent in to Nordregio for continuation of the project (year 2). The deadline is 1 March. UCN and KA will adapt and update the last application and circulate a draft to the project members.

3. *How to proceed in 2018*
   Decisions:
   - Include both garden peas and field peas
   - Measure a date when the pods could be harvested green
• Let all the accessions go to maturity the first year (in Tromsø the plants might not reach maturity)
• Use pesticide against insect damage but no treatment for fungus (IV will come back with some recommendations on this after consulting a colleague)

**a. Choice of accessions**

Decisions:

• A total of 50 accessions will be cultivated in each location, the same accessions in each location
• A majority of these accessions will be chosen among the accessions cultivated in Denmark 2017.
• In addition, a few accessions from Norway and Finland will be added since these are underrepresented. IV and PP will suggest not more than 5 suitable accessions each from their country. Preference should be given to accessions that have good background information and a northern origin.
• **UCN will create a google spreadsheet where all project members can comment on what accessions to include or not.**
• The accessions that will be added to the field trials in 2018, but were not regenerated in Denmark in 2017, should perhaps be treated in some way to improve their germination (e.g. rubbing, soaking).

**b. Field design**

Decisions:

• The same field plan/experiment approach will be used in each site the two consecutive years
• In each field site there should be 4 blocks and in each block there should be 20 plants of each accession.
• In addition, if after year one we see that some accessions seem very promising for green consumption, the next year extra plots (or larger plots) will be planted and harvested green. These could be evaluated for protein content at the green stage and potentially for taste.
• The seeds will be sown directly in the field location
• Support used for the plants: different solutions can be used in different locations. Most likely fences will be used in Norway and Denmark and fava bean in Finland.

**c. Traits to evaluate (same traits at all 4 locations?)**

• Sowing time
• Number of plants (early in the season)
• Flowering period
Start: 10 % flowering
- Full: 90% flowering
- End: 90% stopped flowering (90% no flowers)

- Maturation time – days from sowing until the pods are mature
  - Date of first maturity (in 10 % of plants the first peas are mature
    (pod dry, seeds dry and hard)
  - Date of full maturation (in 90% of the plants the seeds are totally
    matured (pod dry, seeds dry and hard)

- Green maturity – swollen pods, seed meets each other. Date recorded
  when 25 % of the plants have pods that have reached this stage.

- Number of pods on all plants
- Height – stem height at full flowering (and make a note if the accession
  continue to grow after full flowering)

- Protein content – mature seeds are sent to Copenhagen University or
  Boreal for measurement

- Yield
  - Seed yield
  - Dry biomass of whole plant

- Diseases
  - Molecular marker(s) for powdery mildew. If additional funding is
    received, more markers for other diseases will be added
  - Field observations on powdery mildew – scored if observed, scale
    1-9. Score in August.

- TGW

- Morphological evaluation will be conducted at by UCN and KA in the field
  location in Denmark. This will not be evaluated in the other locations.

GP suggested that all the accessions evaluated in the field should be checked
in the Weibullsholm database. If there are gaps in this dataset, accessions
with gaps could be evaluated for the missing traits.

4. Additional applications for funding 2018
Attempts may be made to apply for additional funds from the following
foundations:
- Ekhagastiftelsen – a Swedish fund with strong focus on organic farming
  and health benefits of food. Deadline in May.
- KSLA (reapply)
- Nilsson Ehle – a good place to apply for consumables to extend the
  molecular studies
- Erik Philip-Sörensens – could apply to extend the molecular studies

E. Propagation and characterization of old pea varieties for modern agriculture
SKR presented the work on pea evaluation that he and his colleagues has conducted at Copenhagen University. Focus has been on accessions from the Weibullsholm Pisum collection. The initial step has been multiplication of seeds from single seeds producing 350 lines (start 2015). Genotyping with DArTseq was conducted 2017. Multiplication and field evaluation will be done during 2018.

(F. Lunch)

G. Follow up on the minutes from last meeting
- ML: regeneration of the fava bean Brottby is ongoing
- PP has sent evaluation data on soy beans to NordGen. The next step is to format it and upload it to the data base at NordGen or EURISCO.
- GP has contacted Jens Christen Nørgaard Knudsen regarding the material from Toft Plant Breeding. GP will pursue this issue further.
- ML brought a historic seed collection to the meeting for donation to NordGen. The collection was found in a house south of Stockholm and contain 33 well labelled jars with peas. ML judge the seeds to be from the 1940s or possibly 1950s. This collection could form the basis of an interesting scientific project combining germination tests with DNA studies. GP has developed a method to test germination in old seeds that could be used for this purpose. ML will send the documentation to AP and AP will register the collection as part of NordGen’s historic seed collection.
- The EUROLEGUME handbook was circulated by IV before the meeting. IV will let NordGen know when it is published on a homepage and AP will publish something on this on NordGen’s homepage. It is still unclear if the raw data will be available but IV will investigate this.
- We could consider to make a similar handbook for the accessions evaluated in the Arctic Pea project

H. Updates from NordGen (including info on Reduction of NordGen’s collection)
UCN and AP gave updates on the work at NordGen, see appendix 1.

I. Information on activities in the countries
a) Finland (PP)
There is a continued interest in protein crops in Finland. A new fava bean variety named Vire has been released by Boreal in Finland. It has low vicine and convicine content. Boreal continue to breed for low vicine and convicine content in fava bean.

b) Denmark (GP)
Nothing to report since the last meeting

c) Norway (IV)
- IV has sent in an application to Landbruksdirektoratet in Norway for their call reading funds for genetic resources. The application is for additional funds for the field trials in Tromsø in the Arctic Pea project.
- There is an increasing focus on legume cultivation in Norway.
- A new PhD student has been hired at NIBIO to work on legume production
• (IV has been included in an informal soy bean network for northern Europe. They are discussing writing an EU application for funds and perhaps also to include fava bean in the focus of the application.)

**d) Sweden**

**GC:**
A Swedish competence centre for plant breeding will be initiated during 2018. SLU will be the host but the aim is a network of different partners working together on breeding and pre-breeding in Sweden. Different focus groups will be created within the competence centre. One such focus group will be on protein crops and they will have a first workshop in March 2018.

Also in Sweden there is an increasing interest in legumes, both in research and in the rest of the society.

**ML:**
The Axfoundation contacted ML and want to develop new food products from grain legumes. They are interested in using lupines and other grain legumes in “vego-mince”.

Örebro University contacted ML and they are also interested in new types of food and in tasting experiments. If we have enough seeds left from the fava bean trial we could contact them and ask them if they would be interested in conducting tasting experiments on the beans. IV, GC and PP will make an inventory of leftover seeds and ML will thereafter contact Örebro University. They could also be a potential cooperation partner for tasting experiments within the Arctic Pea project.

**J. Fava bean evaluation**

**Presentation of results**

• PP presented the results in a power point presentation (see appendix 2). The 2017 evaluation was successfully conducted and all traits were evaluated in all accessions.

• IV presented the preliminary results in a power point presentation (see appendix 3). Protein data are not ready yet. The 2017 evaluation was successfully conducted according to plan. The weather conditions substantially delayed the harvest compared to 2016.

• GC informed the group that the evaluation was successfully conducted and most traits were evaluated according to plan.

**Plans for analysis and publications**

Enough data has been collected during the evaluations in 2016 and 2017 to do an interesting analysis and to publish in a scientific journal.

Plans:
1. Agree on a common data format. **PP will send a suggestion for format.**
2. Collect all data. (Protein data will be evaluated at Boreal 2018. IVs seeds are in the post and GC will send seeds later)
3. **IV will do the initial data analysis of the data**
4. We will later decide on further analysis and writing of a paper.
K. Sending of EUROLEGUME data to NordGen
See comments on minutes from the last meeting (item G)

L. Future plans
The WG funding will be used for the Arctic Pea project in 2018 and 2019
In addition, analysis of the fava bean evaluation data will be conducted and additional funding for the Arctic Pea project will be applied for.

M. Next meeting
- Arctic Pea Skype meeting in June. **UCN will send out a doodle**
- Skype meeting in the autumn in October/November. **AP will send out a doodle.**
- The next real meeting will take place in one of the field location of the Arctic Pea project. Potential times could be end of June or July. Tromsø was suggested as the first alternative, Umeå as the second.

*Topics to address in upcoming meetings:*
- Weibullsholm Collection
  - Transfer of data from Stig Blixts old dBase-files to SESTO
  - Should we check info that is printed on the seed bags from the first batches?
- Arctic Peas
  - Discuss if we should make a handbook or other presentation of the accessions evaluated in the Arctic Pea project
- Fava bean evaluation
  - Fava bean tasting experiment with leftover seeds from the evaluation?
  - Publication

N. Other issues
No other issues.

O. Closing of the meeting
ML closed the meeting
Working group meeting of the *ad hoc* group for grain legumes

Alnarp 8 February 2018
Arctic Peas

Ärtor – en genetisk resurs för hållbar proteinproduktion i Arktis

Peas – a genetic resource for sustainable production in the Arctic
2017

**Multiplication at Taastrup (Copenhagen University)**

90 accessions chosen based on available documentation (cultivation history, origin)

25\(^{th}\) April - sowing of 15,000 seeds in Jiffy pots
2017

8\textsuperscript{th} May – 100 plants per accession were planted out in the field

Only one accession (Gronninghoved) did not germinate.
2017

• General inspection, photo documentation
• Flowering period (10%, 90%)
• Height (low, medium, high)
• Yield
• TGW
• grm %
2017

Marker studies

Literature

29th May - collection of leaves for DNA extraction (all plants)

58 accessions chosen for preliminary studies
Information used for selection of accessions

1. Geographic origin (when available in SESTO, not WBH accessions)
2. Winter hardiness (data from old files, only WBH accessions)
3. DTF (data from old files, only WBH accessions)
4. Days to 90% flowering (Danish field trial 2017, all accessions)
5. Type of material, landraces preferred (according to SESTO, all accessions)
2018 and 2019

Choice of accessions

• Number of accessions (50?)

• Garden peas/field peas?

• All from multiplication at Taastrup 2017?

• Additional? Need for one more year of multiplication...
2018 and 2019

Field design

• 4 localities (Tromsö, Umeå, Jokioinen, Taastrup)

• Randomized block design (4 blocks x 20 plants/acc)?

• Same accessions at all 4 locations?
2018 and 2019
Traits to evaluate (same on all 4 locations?)

Focus on:

✓ Sowing time
✓ Number of plants (early in the season)
✓ Flowering period
  ✓ Start 10% flowering
  ✓ Full 90% flowering
  ✓ End 90% stopped flowering (no flowers)
✓ Maturation time – days from sowing until the pods are mature
  ✓ Date of first maturity (in 10% of plants the first peas are mature (pod dry, seeds dry and hard)
  ✓ Date of full maturation
✓ Green maturity – swollen pods, seed meets each other (date recorded). Measured in the first pod reaching this stage. 25% of plants reached this stage.
✓ Number of pods on all plants
✓ Height – stem height at full flowering (and make a note if it continue flowering)
✓ Protein content (Copenhagen University) – mature seeds sent to Copenhagen Uni. or Boreal.
✓ Yield
  ✓ Seed yield
  ✓ Dry biomass
✓ Diseases
  ✓ Molecular marker
  ✓ Field observations on powdery mildew – scored if observed, scale 1-9. Score in august.
✓ TGW
2018 and 2019

Harvest/post harvest

• When/what? (mature, not mature)

• Protein analysis - total protein, amino acid profiles, how many years?
<table>
<thead>
<tr>
<th>Trait</th>
<th>Description/comment</th>
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<tbody>
<tr>
<td>Sowing date</td>
<td></td>
</tr>
<tr>
<td><strong>Flowering time: beginning</strong></td>
<td>beginning of flowering (10% of the individuals have started to flower)</td>
</tr>
<tr>
<td><strong>Flowering time: end</strong></td>
<td>end of flowering (90% of the individuals have stopped flowering)</td>
</tr>
<tr>
<td>Height</td>
<td>Measured at first maturity. The whole plant will be measured for 5 plants per accession.</td>
</tr>
<tr>
<td>Disease</td>
<td>Scale 1-9 (UPOV). Always noted when scoring other traits.</td>
</tr>
<tr>
<td>Lodging</td>
<td>Standing ability/erectness. Scale 1-9.</td>
</tr>
<tr>
<td>Nodulation</td>
<td>Development of nodules. Qualitative scoring scale.</td>
</tr>
<tr>
<td>Date of first maturity</td>
<td>In 10% of plants the first peas are mature (pod dry, seeds dry and hard)</td>
</tr>
<tr>
<td>Date of full maturation</td>
<td>In 90% of the plants the seeds are totally matured (pod dry, seeds dry and hard).</td>
</tr>
<tr>
<td>Yield</td>
<td>Total yield per accession (count number of plants)</td>
</tr>
</tbody>
</table>
Additional funding applied for:

*KSLA* (2018)  
(marker studies, mildew)

*COP 21*, Nordiska ministerrådet (whole project, 2018)

Both rejected… 😞
Updates from NordGen

— Quality assurance: goal to increase the number of approved QA documents (from 38 to 65 %)

— IT evaluation at NordGen
  • Desktop
  • Servers
  • SESTO

SESTO is a genebank management tool developed by NordGen. The application has gradually been adopted for management and presentation of data from progress.

The main idea of SESTO is to browse instead of searching for [taxon] [culton] [accession] [dataset] in the forms available for a more traditional search by key (the right below the banner) will provide a quick [advanced search form here] and a new [new]

Please also try the very [simple search form] below.

Some EXAMPLES of what you may
Staff changes

Seed lab:
Turn over of staff
Training of new employees

Field/greenhouse:
Further training of present employee (focus on knowledge in fertilization and plant protection)
Working Procedures of NordGen’s Working Groups

Comments from
- NordGen’s board
- Working Groups
- Nordic national coordinators

Final draft produced

NordGen director will decide if it should circulate once more or be approved
Reduction of the collection

- Ongoing evaluation regarding NordGen’s legal obligations in connection with potential reductions of the collection.
- 16 March – NordGen’s Board discuss if future reductions are in compliance with national and international obligations
- March/April - documents on the principles for reduction of the collection circulated to NordGen’s working Groups and to the Nordic national coordinators.
Current status of NordGen’s collection - updating the Long Term Management Plan (LTMP)

- Update key numbers in the LTMP to evaluate status of the collection and progress
- Input for NordGen’s Board meeting 16 March
- Status
  - improved status: need for germination tests and regeneration reduced
  - new and more efficient algorithm
  - focus on germination testing and regeneration

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2018</th>
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<tbody>
<tr>
<td>Total number of accessions (ACC+PEN)</td>
<td>29 660</td>
<td>28 034</td>
</tr>
<tr>
<td>Accessions that need regeneration</td>
<td>14 763 (50%)</td>
<td>5 832 (21%)</td>
</tr>
<tr>
<td>Accessions that need germination test</td>
<td>5 009 (17%)</td>
<td>814 (3%)</td>
</tr>
<tr>
<td>Packing</td>
<td>3 902 (13%)</td>
<td>5 338 (19%)</td>
</tr>
<tr>
<td>Check/Reject</td>
<td>na</td>
<td>2390 (9%)</td>
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</table>
Current status of NordGen’s collection - updating the Long Term Management Plan (LTMP)

<table>
<thead>
<tr>
<th>Genus</th>
<th>Total number of accessions (PEN, ACC)</th>
<th>Regen. need</th>
<th>Regen. 2018</th>
<th>Regen. 2019</th>
<th>Remaining (2020 – 2024)</th>
<th>Additional regen. need per year (2 %)</th>
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<tbody>
<tr>
<td>Glycine max</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Phaseolus</td>
<td>137</td>
<td>46</td>
<td>6</td>
<td>11</td>
<td>29</td>
<td>2</td>
</tr>
<tr>
<td>Pisum</td>
<td>1967</td>
<td>712</td>
<td>60</td>
<td>100</td>
<td>552</td>
<td>25</td>
</tr>
<tr>
<td>Vicia faba</td>
<td>81</td>
<td>48</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>
Regeneration 2017
<table>
<thead>
<tr>
<th>Species</th>
<th>Acc. name</th>
<th>Yield (g)</th>
<th>Grm%</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. vulgaris var. vulgaris</td>
<td>Hartley Jepsons bruna bönor (SWE)</td>
<td>1287</td>
<td>92</td>
</tr>
<tr>
<td>P. vulgaris var. vulgaris</td>
<td>Prinsesse (DK)</td>
<td>4854</td>
<td>100</td>
</tr>
<tr>
<td>P. vulgaris var. vulgaris</td>
<td>Prinsesse fra Mariager (DK)</td>
<td>3900</td>
<td>96</td>
</tr>
<tr>
<td>P. vulgaris var. vulgaris</td>
<td>Garda 2 (SWE)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>P. vulgaris var. vulgaris</td>
<td>Litago (NOR)</td>
<td>3990</td>
<td>92</td>
</tr>
<tr>
<td>V. faba var. equina</td>
<td>Sving (SWE)</td>
<td>2850</td>
<td>100</td>
</tr>
<tr>
<td>V. faba</td>
<td>Gubbestad (SWE)</td>
<td>1053</td>
<td>96</td>
</tr>
<tr>
<td>V. faba var. faba</td>
<td>Högtomt (SWE)</td>
<td>153</td>
<td></td>
</tr>
<tr>
<td>V. faba var. faba</td>
<td>Sigvard (SWE)</td>
<td>1203</td>
<td>96</td>
</tr>
<tr>
<td>G. max</td>
<td>Fiskeby III (SWE)</td>
<td>273</td>
<td>100</td>
</tr>
<tr>
<td>G. max</td>
<td>Altona gård (SWE)</td>
<td>173</td>
<td>82</td>
</tr>
<tr>
<td>G. max</td>
<td>Ugra soya (SWE)</td>
<td>118</td>
<td>96</td>
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## Regeneration 2017 (external)

<table>
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<tr>
<th>Species</th>
<th>Acc. name</th>
<th>Yield (g)</th>
<th>Grm %</th>
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</thead>
<tbody>
<tr>
<td>P. vulgaris var. vulgaris (TL)</td>
<td>Resista (SWE)</td>
<td>750</td>
<td>94</td>
</tr>
<tr>
<td>P. vulgaris var. vulgaris (TL)</td>
<td>Morbrors gröna (SWE)</td>
<td>3423</td>
<td>94</td>
</tr>
<tr>
<td>P. vulgaris var. vulgaris (OJ)</td>
<td>Brun böna (SWE)</td>
<td>1571</td>
<td>80</td>
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<tr>
<td>P. vulgaris var. vulgaris (AB)</td>
<td>Dvergbønne (NOR)</td>
<td>708</td>
<td>98</td>
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<tr>
<td>V. faba var. faba (AB)</td>
<td>Evert (SWE)</td>
<td>822</td>
<td></td>
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<tr>
<td>V. faba (OJ)</td>
<td>Lövånger (SWE)</td>
<td>2268</td>
<td>74</td>
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<tr>
<td>V. faba var. faba (TL)</td>
<td>Edsbro (SWE)</td>
<td>1955</td>
<td>96</td>
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</tbody>
</table>
Plan for 2018 (Alnarp + external)

Phaseolus – 6 acc

Vicia faba – 8 acc

Pisum – 60 acc
One way ANOVA, significance of differences between accession means

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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<td>rust * entry</td>
<td>20.4</td>
<td>19</td>
<td>1.074</td>
<td>0.976</td>
<td>0.519</td>
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<td>choc. spot * entry</td>
<td>14.275</td>
<td>19</td>
<td>0.751</td>
<td>1.307</td>
<td>0.279</td>
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<td>heightcm * entry</td>
<td>7415</td>
<td>19</td>
<td>390.263</td>
<td>1.01</td>
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<td>tillersperplant * entry</td>
<td>2,114</td>
<td>19</td>
<td>0.111</td>
<td>1.141</td>
<td>0.385</td>
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<td>plantsperplot * entry</td>
<td>297</td>
<td>19</td>
<td>15.632</td>
<td>1.226</td>
<td>0.327</td>
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<td>tillersperplot * entry</td>
<td>1978.475</td>
<td>19</td>
<td>104.13</td>
<td>1.411</td>
<td>0.225</td>
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<td>yieldperplot * entry</td>
<td>0.361</td>
<td>19</td>
<td>0.019</td>
<td>2.268</td>
<td>0.038</td>
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<td>19</td>
<td>1900405</td>
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<td>0.038</td>
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<td>19</td>
<td>82.604</td>
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<tr>
<td>podsperplant2 * entry</td>
<td>1096.6</td>
<td>19</td>
<td>57.716</td>
<td>3.365</td>
<td>0.005</td>
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<tr>
<td>podsperplant2 * entry</td>
<td>189.6</td>
<td>19</td>
<td>9.979</td>
<td>3.564</td>
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<td>9.435</td>
<td>19</td>
<td>0.497</td>
<td>5.929</td>
<td>0.000</td>
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<td>seedspertsiller2 * entry</td>
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<td>19</td>
<td>170.005</td>
<td>15.247</td>
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<td>19</td>
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<td>19</td>
<td>456963.7</td>
<td>5.524</td>
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<td>50817.15</td>
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<td>protein * entry</td>
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Relationship of yield and seed size 2017
Relationship of earliness and seed size 2017

Days to maturity and tsw g

R² = 0.4691
Relationship of yield and earliness 2017
Appendix 3
Faba bean field trial in Norway 2017

Cultivar trial as part of NordGen’s ad hoc working group for grain legumes

Preliminary results

Ingunn M. Vågen, NIBIO Landvik
## Accessions for evaluation

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Trial setup

Coarse sandy soil
(10% silt, 3% clay, ~5% SOM)

Sowing:

10.05.2016 / 19.05.2017

30 faba bean seeds m\(^{-2}\)

6 rows per plot

20 cm between rows

Plot length 1m

Harvest period:

2016: 14. sept – 19. sept
2017: 12. oct – 30. oct
Climate conditions

2016

2017

NIBIO
Grain legumes working group meeting, Ingunn Vågen, Alnarp 8. February 2018
Germination

Faba bean seeds germinated in Norway 2017

Germination, %

Sairala me0503
AP8308100101
Suontakainen me0301
Sairala me0401
Seikanlampi
Ranta me1001
Imatra me0101
Kokkoskylä
Tyrjä me0202
Saari
Lemi me0702
Korkeamäki
Lovanger
Römfortuna
Gerd
Gubbestad
Göteryd
Horshult
Kontu
Fuego

Grain legumes working group meeting, Ingunn Vågen, Alnarp 8. February 2018
Flowering Days from sowing
Start: First open flower on at least 2 plants

Start of flowering in faba bean Norway 2017

Grain legumes working group meeting, Ingunn Vågen, Alnarp 8. February 2018
Maturity Days from sowing

Beginning: Dry mature pod on at least 2 plants
Full: All plants have dry pods with hard dry seeds

Grain legumes working group meeting, Ingunn Vågen, Alnarp 8. February 2018
Yields
kg ha\(^{-1}\)

Actual and adjusted faba yields in Norway 2017
Disease incidence

scored 1-9

Main pests in faba bean Norway 2017
Some notable correlations

Yield

- Beginning maturity (0.83)
- Full maturity (0.60)
- Number of pods (0.27)
- Height (0.69)
- Aphids (-0.36)
- Chocolate spot (-0.35)

Aphids

- Number of pods (-0.52)