

## Article

# Scientific knowledge dissemination in Danish seed communities of practice

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*ABSTRACT: Danish agriculture and seed science have a history of successful collaboration spanning more than a hundred years. In this study, we interviewed 26 growers, consultants, and scientists from the Danish seed community focusing on their current knowledge status and on their views on improving scientific knowledge communication. Theoretically, we consider these actors participants in different communities of practice relating to the production of seeds (Seed-CoP), and we conclude that strong network collaboration is present among Danish seed-CoP effectuated by the valuable work undertaken by the consultants. We discovered a divergence in knowledge dissemination among the growers – an innovative group of growers with a high demand for new scientific knowledge versus a majority of growers content with the level of knowledge provided by the consultants. ‘Time’ was recognized as an important parameter, as only the innovative growers prioritized time allocation for additional knowledge search. To improve scientific knowledge dissemination and interdisciplinary collaboration among Danish seed-CoP we recommend a combination of face-to-face and online communication processes.*

## Introduction

For more than a hundred years Danish agriculture has had a history and tradition of collaboration in co-operative movements, which also involves the seed industry. Registrations on seed production in Denmark date back to the 18<sup>th</sup> century, but it was not until the late 19<sup>th</sup> century that people started focusing on crop quality and research into seed refinement.<sup>7</sup> In 1876, the Society of Domestic Seed Growing was founded by three scientists, three merchants, and nine growers.<sup>13</sup> One member of the society, P. Nielsen, established experiments to evaluate the economic sustainability of seed production, and in 1886 he was among the founders of Statens Planteavlfsorsøg (the Danish Institute of Plant and Soil Science). Local experimental stations were established with the aim of supporting the development of agriculture at both a national and a local level, and interaction with the local farmers was an important task. Experiments to improve management techniques in seed production were carried out from 1907 until 1920 and published in 1923.<sup>19</sup> Since 1959 seed production research has intensified, and to this day they are carried out in a close collaboration between seed scientists, seed industry, and seed growers.

Three groups of seed actors are studied in this paper: the seed scientists, the seed company consultants, and the seed growers (hereafter referred to as scientists, consultants, and growers). The growers produce seed on a commercial contract with a company, which includes free access to company consultants’ advice on production of this specific seed crop. This is opposed to the traditional agricultural advisers who provide general support on all crops in the crop rotation and are paid by the hour. Therefore, most growers work with consultants in connection with seeds, and advisers in relation to the remaining agricultural aspects.

The objective of this study is to gain a deeper understanding of how various people within a specific field of interest work with and around scientific knowledge. Based on the Danish seed community case, this study aims at investigating the need for and methods of improving science communication that can enhance the knowledge dissemination by shortening the time span from communication to implementation. The study is based on a qualitative interview approach in which we have used Etienne Wenger’s Communities of Practice methodology – defining a community of practice as people “who

share a concern, a set of problems or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis” (p. 4).<sup>30</sup>

## Methods

The study was based on a qualitative interview investigation which was set up in collaboration with the three active herbage seed companies in Denmark, namely DLF-TRIFOLIUM A/S, Hunsballe Frø A/S, and Barenbrug Danmark. Collectively, they represent 50 consultants, with which 4,500 Danish growers produce seeds under contract.

The particular focus of the 26 interviews was to get a better in-depth knowledge about how the consultants and growers work with knowledge. In addition we wanted to see to what extent the advent of the internet has made an impact on how consultants and growers accessed new scientific knowledge.

10 consultants and 13 growers were interviewed together with 3 scientists. To ensure a broad representation in the interviews, selection of the consultants was performed from a geographical, age and experience perspective. By including interviews from a broad geographical perspective, the interviews would potentially reveal if a physical distance to the science center would cause any deviations in peoples' views on science dissemination; the age and experience perspectives would facilitate the investigation of possible patterns in access to new scientific knowledge. The included consultants were asked to select growers from the company that they represented, and from the resulting selection, 13 growers were chosen at random (taking into account the geographical perspective).

The interviews were based on a semi-structured interview guide and were held in an open atmosphere with the option of further elaborative questions as the interviews progressed.<sup>11</sup> The interviewees did not have prior access to the interview guide.

The interview guide was based on three main themes:

- Information flow among seed-CoP today: what information sources are used in the interviewee's daily work and what mechanisms help the individual to become motivated and inspired to learn even more about seed production?
- Collaboration with other specialists: uncovering each individual's view on and interest in collaboration. The creation of a mutual understanding of collaboration and knowledge depends on an awareness of collaborating discrepancies, which at the same time clarifies any biases/barriers and strengths/weaknesses.
- Knowledge sharing: how do the involved actors interact with each other? The aim is to investigate the information flow among seed-CoP and to determine to what extent the different communities of practice (CoP) contribute knowledge. This will provide a description of the knowledge flow balance in the Danish seed industry.

The interviews each lasted between 60 and 90 minutes and were all conducted by the same person.

With the permission of the interviewees, all interviews were recorded and transcribed – a total of 35½ hours of interview data. The software program NVIVO9 (QSR International, Australia) was used for transcription and coding.

First, the interview data were explored to get a general sense of the contents. Second, the transcribed text was divided into segments of information which were then labeled with nearly 300 codes. In the third round of analysis the 300 codes were investigated and narrowed down to 20 overall codes reducing overlaps and redundant coding. The transcribed interviews were then reanalyzed using the 20 codes to see if they covered all aspects or not. If successful we continued to collapse the codes into five overall themes, otherwise we reanalyzed the code condensation until we came up with 20 overall codes representing the transcribed interviews. See figure 1 as an example taken from one of the interviews showing how the interview has been transcribed, coded and themed. Theming the codes was carried out similarly to the third round process aggregating the codes into five themes or categories. These five themes would turn out to be topics that were especially discussed among the participants: current setup, seed consultants' mediating role, limited time, knowledge via the Internet, and future ideas.

Codes	Time span	Content	Themes / ideas
Insufficient knowledge // Dialogue with scientist	31:26,0 - 32:39,4	-> Is the knowledge you find satisfactory? <b>It never is. I want to know more!!</b> I cannot get enough knowledge. The problem of the scientific world, is that you can only get funding if you can call it ecology. The trials and scientific results in Danish seed production have suffered from this in many years. Therefore it has been difficult to draw parallels from ecologic seed production to conventional seed production. You may conclude from this that you have access to more scientific knowledge being an organic grower than being a conventional grower.	New knowledge tools
Philanthropist// independent neighbour network	32:38,9 - 33:56,3	-> Experience with other specialists? <b>I am very independent. I do not hire people to do my EU applications - I do them myself. I make my own decisions, and they are not always correct. I do not much collaboration with other growers, but on the other hand many people call me to get my opinion on things.</b>	
Neighbour network Dialogue with scientist Knowledge sharing in small communities Secrecy	33:56,3 - 38:26,4	-> Knowledge sharing <b>[grower's name anonymized] and talk a lot about seeds, and about how we do things. When we meet or when we call each other on the phone, I have some other seed growers whom I call now and then. These growers accept taking risks and try new methods. We know each other very well. We definitely share knowledge. With the scientists the picture is more one-way-traffic with knowledge coming from the scientists to us.</b> Last year we had a couple of trials and earned several visits from the scientist Birte Boelt; We spent 1½ hours with a walk-'n-talk on our premises and discussed how we carried out our work in practice, but not more than that. That calls for more close collaboration. <b>Knowledge sharing occurs when you are a couple of people together, and not when you are among a large crowd; and in the seed production business it is sound if you don't share everything you know.</b> If we are to start up with ecological rye grass, it is of no use if more growers get the same idea. For instance with regards to swathing: let people believe that swathing costs seeds. It serves me well that they believe that. We do not have space for that many ecological seed growers.	Accumulation of knowledge networks
Electronic knowledge sharing Experienced consultants Old consultants especially experienced Knowledge sharing with employees	38:26,4 - 40:17,5	-> Can one share knowledge by using the Internet? <b>I believe this would be difficult.</b> -> Can one share knowledge with the consultant? <b>Yes, I believe you can, but most likely with the most experienced consultants.</b> The young consultants have not experienced enough. For instance, take white clover production: you have growers who produce white clover with great success year after year, and they have something ... perhaps tradition... <b>Heck, it is the old growers who have the knowledge, and not the young. It is experience.</b> -> What about knowledge between you and your employees? Today I have three employees, but this is only during harvest. There is no knowledge sharing with them. <b>I hope one day to get an employee with whom I can share my knowledge.</b>	Strengthen knowledge level over generations

Figure 1. An example on NVIVO9 transcription taken from one of the interviews.

As “all research is interpretive and the researcher self-reflects about his or her role in the research, how he or she is interpreting the findings, and his or her personal and political history that shapes his or her interpretation” (p. 266),<sup>2</sup> accurate and credible analyses are of utmost importance. The authors in this article have triangulated the data against their own experiences as communication officers and seed scientists and evaluated the resulting theme findings with external auditors representing seed growers and seed consultants. The latter process was carried out during a seed knowledge workshop in 2010, in which the participants concurred with the findings.

## Results

Five primary factors were derived in relation to dissemination of scientific knowledge.

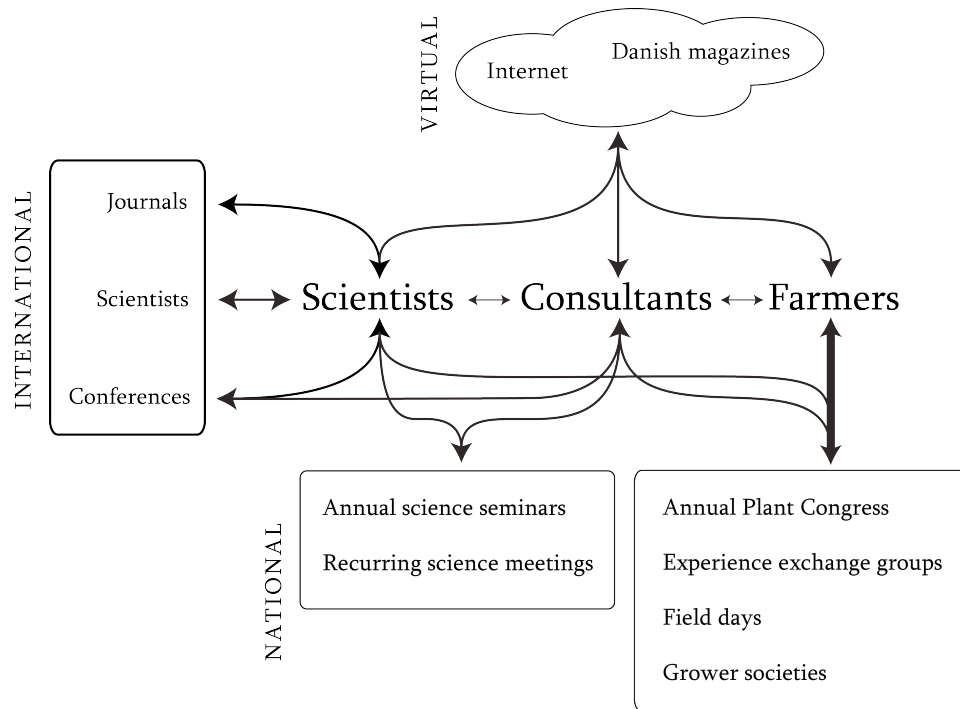
### *The current setup*

The interviews supported the popular consensus about communication flows in the Danish seed industry: that there is a close reciprocal dialogue between growers and consultants, and likewise a close reciprocal dialogue between consultants and scientists. Respondents were generally pleased with the way in which knowledge flows through the network today: from scientists to consultants and from the consultants to the growers (see figure 2). The majority of the respondents expressed contentment with the fact that they felt that their knowledge needs were well covered with the current setup. However, the interviews verified that there is practically no mutual dialogue between growers and scientists.

In particular, the consultants praised the two yearly science seminars where consultants meet scientists for one day. One seminar day in the summer, where scientists present the actual scientific research and experiments that are taking place in the research fields, followed by a winter seminar, where the scientists present in-depth data resulting from the last 12 months of research. The growers valued the consultants' work in converting the scientific results into more comprehensible formats before they were disseminated to the growers, and the scientists favored the current setup in which they are in close contact with consultants, who have a broad insight into the current status in all seed crop fields. One scientist summed it all up during the interview:

*“The consultants play an important role in conveying the experience and results from scientific experiments to practice in farmers' fields and to the specific species and variety grown by the specific farmer. My premise for this is that the growers have confidence and 'trust' in the*

consultants. This also becomes the drawback because the grower does not have access to the same results - and if a consultant misinterprets the results, it puts the scientific results into a misleading perspective. However, my overall impression is that growers have great confidence in their designated consultants, and if not, they have the possibility to contact another consultant – perhaps from another seed company. One could say that the consultants are our spokespersons, and it is my impression that they are all very serious and do not misinterpret our results! Would rather wait for the results of one more year than use results we are not sure of.” (Respondent D, scientist, female, 50s)



**Figure 2.** Knowledge flow among Danish seed-CoP. The figure, which is based on interview data, illustrates how the consultant has a mediating role between the scientist and the grower. Virtual knowledge forums, into which people can enter individually and find new knowledge, are placed above, while physical forums, where people physically meet other people, are placed to the left and below.

### Seed consultants' mediating role

The consultants were nominated by all interviewees as the main knowledge carrier from the scientists to the growers; they convey transformed validated scientific knowledge from the scientists to the growers and in return carry vital observations from practice back to the scientists.

How the consultant acts as an intermediary in the transfer of scientific information between the scientist and the grower depends on what kind of grower the consultant is visiting. A minority group among the growers (in this paper described as “the innovative growers”) prioritized time for self-acquisition of new knowledge by searching the Internet and reading national as well as international agricultural magazines. In addition, they carried out their own field tests and primarily used the consultants to verify ready-made conclusions. This minority group was in contrast to the majority of the growers who de-emphasized the self-acquisition of new knowledge, but instead regarded the consultant as the most important source of scientific knowledge.

*“My mind is totally blank when it comes to experience with seed production as I am fairly new in the seed business. Therefore I depend on my consultant’s advice.” (Respondent G, grower, male, 40s)*

*“I am very pleased with the consultant I have. His knowledge and experience in the field is great and indisputable.” (Respondent R, grower, male, 30s)*

Other growers preferred asking the consultants for advice as a form of verification of their own conclusions on a specific problem that had arisen.

*"I form my own views. I have an idea of how and in what way. Then I call my consultant, and through the conversation with him my view is either confirmed or rejected and replaced with another usable solution." (Respondent O, grower, male, 50s)*

#### *Limited time*

The way in which disseminated knowledge about seed production is handled by different communities of practice was a novel finding in this study, and this may explain people's interest in seeking new knowledge. Of particular interest is the way the individual growers availed themselves of accessible knowledge sources by various means. The time factor played a crucial role in the respondents' answers on how they were exposed to new knowledge.

Some growers did not feel that they had enough time to search for new knowledge on their own (due to either workload or lack of experience with finding and interpreting seed production knowledge) and often preferred to call their consultants if/when they were in doubt. By making a phone call to their consultants, they were able to obtain answers within minutes in comparison to trying to find the information either online or in printed reports, statements, journals, etc. Furthermore, in several cases the growers had found possible solutions to their problems, but just wanted a second opinion from their consultants.

*"I am too busy to look up information in various farmer newspapers and websites, and therefore simply do not use them. ... You can look up everything in books, but it took me less than 10 minutes to make a phone call to my consultant and get an answer I could use." (Respondent I, grower, male, 30s)*

Farmers' magazines and newspapers were mentioned as available knowledge resources for the farmers, but time constraints prevented many from using these sources.

*"I subscribe to many farmer newspapers and magazines, many which I do not have time to read. I simply do not get to the end of them all. It is a question of when I have the time to sit down and read things through. [...] Often time is a scarce resource, and then it is both much easier and safer to call a consultant and get exact information on what you are to do in the given situation." (Respondent U, grower, male, 40s).*

At the other end of the "available time scale", the "innovative growers" were found, who had firm control over their seed production – this in turn facilitated them with time to prioritize their own search for knowledge. These growers were characterized by the fact that they often possessed a level of knowledge about seed production equal to that of their consultants and thus they could no longer benefit from the consultants' high knowledge base other than their consultants' confirmation of conclusions. This enabled them to seek answers elsewhere.

*"For me knowledge is never satisfactory. I want to know more. I cannot get enough knowledge. What I read in bed is about seed production. I am a grower 24/7." (Respondent N, grower, male, 50s)*

#### *Knowledge via the Internet*

Respondents' opinions were divided when asked about how they viewed the Internet's significance for knowledge dissemination in the Danish seed industry. Some respondents did not believe that it was time to introduce knowledge sharing to the growers in the industry.

*"Personally, I do not believe we are there yet. Instead I believe we should try to improve the good old dialogue: to communicate knowledge in an effective and comprehensive manner. If you fail in communicating to other people in less technical ways, you will definitely fail communicating using the Internet." (Respondent C, consultant, male, 50s)*

Slow local internet connections were mentioned as another factor which could hinder the dissemination of scientific knowledge on the web.

*"Where I live, the Internet is slow, and I therefore spend a lot of time trying to search for the information that I need. This 'time consumer' conflicts with my interest in being together with my family when I come home from the fields." (Respondent F, grower, male, 40s).*

In addition, the age issue was raised arguing that the different age groups acted differently when being introduced to new forms of information media.

*"The old growers will begin to use it, but the younger generation of growers will eventually use the Internet if they are not already using it." (Respondent T, consultant, male, 50s).*

It is time consuming to search for knowledge about seed production on the Internet, and it requires many years of experience as to where to find the information you are searching for. Not all growers can cope with this time consumption.

*"One must set aside time to find the information one needs because searching for knowledge on seed production is not easy. I know that it can be difficult to wrap so much knowledge into something that it is easy to search for, but perhaps it could be done somewhat smarter with new technologies." (Respondent J, grower, male, 40s)*

The seed knowledge available on the Internet is very limited. Firstly, the seed companies' own web sites provide up-to-date cultivation guidelines together with news alerts on pests and diseases. In addition, the Knowledge Centre for Agriculture (a partnership made up of 31 local advisory centers) assists growers with useful online databases on pesticide use, results from local trials, etc. Furthermore, the seed scientists launched a three-year pilot cluster project in 2003 where they presented their results on a website which is still active today despite the fact that it primarily only includes historic data. Last but not least, there is the remaining vast Internet space, where growers can search for useful information either domestically or abroad.

#### *Future ideas*

When the respondents were asked to come up with suggestions about how the scientists could strengthen their scientific communication to professionals in the Danish seed industry, the answers were generally grouped into two segments:

- Personal dialogue and contact
- Electronic dissemination of knowledge

The respondents suggested that it would be of benefit to the industry if the scientists spent more time with the growers.

*"It would be a dream come true if there was a receptiveness for a direct dialogue between the various parties guided by interest. This would make it legitimate and clear where to attain the knowledge one requires." (Respondent F, grower, male, 40s)*

At the same time a personal meeting between scientists and growers would create contact between them, and thus aid future communication between the two.

*"In my opinion, you need to have an established contact with the scientist before you call him with a specific problem. Some of the knowledge sharing could take place virtually at a later stage, but you need to have created some kind of relationship with the scientist before you go any further." (Respondent J, grower, male, 40s)*

The growers had high expectations of the scientists' form of communication with the growers. It needs to be more specific, manageable, and in a form that the grower can comprehend.

*"We growers are quite busy and do not have several hours available to read up on matters. They need to cut down the amount of information so that we can read it in time." (Respondent I, grower, male, 30s)*

Consultants and growers were surprised to learn that Danish scientists did not use the Internet as a source of knowledge sharing.

*"I would prefer that scientists used better functional websites, and in particular the Danish scientists. They need to create a new website where one can look up all communicated research from 20 years ago until today, and they do not have to limit the knowledge to Danish research alone – I would appreciate it if other international research was also gathered in the same website. This would make it much easier for us – that we only had to search on one single website." (Respondent H, consultant, male, 50s).*

### Discussion

Overall the interviews revealed seed communities of practice with a well-working face-to-face knowledge disseminating network (see figure 2). From the results we were able to detect a divergence in knowledge dissemination among the growers – a major group with sufficient knowledge about seed production and a minor innovative group of growers with a great demand for additional scientific discoveries. Our findings indicate that growers living in remote areas were less likely to disseminate seed knowledge to their neighboring growers; however, this could not be demonstrated when reviewing a putative association between answers and overall geographical distribution of the growers. Moreover, we found that young growers have increased contact with consultants compared to older, more experienced growers, which is likely due to their relative inexperience. Another explanation is that younger people today are overall better educated and familiarized with means of electronic communication and thus are accustomed to gathering information and receiving answers in a shorter time span.

Wenger and Lave's concept of CoP is a good starting point when one looks at the learning mechanisms concerning the Danish seed industry, as they state that learning is acquired through participation in CoP.<sup>1,12,32,33</sup> Wenger defines CoP as "groups of people who share a concern, a set of problems or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (p. 4).<sup>30</sup>

CoP are viewed by many scholars as a means to capturing tacit knowledge, or the know-how that is not easily articulated. According to Davenport and Prusak<sup>3</sup> managers get two-thirds of their information and knowledge from face-to-face meetings or phone conversations stressing the importance of networked learning. Duguid<sup>4</sup> refer to the works of Ryle<sup>24</sup> and Polanyi<sup>20</sup> who both describe tacit and explicit knowledge as 'knowing how' versus 'knowing that' – arguing that the two aspects of knowing are complementary in that 'knowing how' helps to make 'knowing that' more easily comprehensible, but not substitutable. Duguid continues "Accumulation of knowledge that does not lead to knowing how. Know *that*, we acquire in the form of explicit, codified information. By contrast, we learn *how* by practice." (p. 111).<sup>4</sup>

Nonaka defines the two types of knowledge as objective and rational (explicit) knowledge versus subjective and experiential (tacit) knowledge.<sup>14-17</sup>

*"Knowledge that is more or less explicit can be embedded in procedures or represented in documents and databases and transferred with reasonable accuracy. Tacit knowledge transfer generally requires extensive personal contact. The "transfer relationship" may be a partnership, mentoring, or an apprenticeship, but some kind of working relationship is usually essential" (p. 95).<sup>3</sup>*

According to Nonaka, explicit knowledge is always grounded in tacit knowledge.<sup>15</sup> In addition, knowledge cannot be put into work unless the explicable knowledge corresponds with the tacit knowledge, and tacit knowledge cannot be made explicable unless it is part of a social process.<sup>16</sup>

While there are only a few critiques on the CoP theory, primarily focusing on neglecting or inappropriately addressing issues of power<sup>5</sup> and innovation,<sup>28,29</sup> most CoP users appreciate the novel view of what constitutes a group, and how it interacts with knowledge, thereby explaining how the informal and tacit aspects of knowledge creation and sharing as well as the more explicit aspects can be addressed.

### *The Danish seed community - a learning society*

Viewing the Danish seed community from a CoP point of view, the industry can be described as a web of CoP interweaving between one another. Scientists constitute one CoP, consultants another, and growers a third. In addition, the network dialogue between scientists and consultants can also be seen as a CoP together with the growers' experience exchange groups constituting another.

However, despite this interweaving web of CoP, only scarce amounts of scientific knowledge were disseminated directly between the scientists and the growers (as depicted in figure 2). Primarily, this fact builds on tradition more than it builds on actual limitations in terms of communication possibilities. Secondly, the interviewed scientists were concerned about the time-consuming prospect of giving all 4,500 growers free communication access to the 12 Danish researchers involved in seed production. Thirdly, what particularly separates the two professions is the way in which they work with knowledge – “experiential (or tacit) knowledge is typically less formalized or systematically organized compared to scientific knowledge” (p. 654).<sup>18</sup>

Therefore, tacit and explicit knowledge are inherently inseparable and it is imperative that knowledge is built around a dialogue between tacit and explicit knowledge, and in respect with the Danish seed industry, this is where the consultants' CoP comes into play.

### *The mediating role of the consultants*

One of the essential strengths in the way knowledge is disseminated from scientists to growers in the current study arises from the role of the consultants. They have the recurring contact with the growers, and thus they are good at understanding individual knowledge needs for each grower; they have a continuous contact with the science center where they are updated with the latest scientific developments; and they all work in seed companies with good internal knowledge sharing. In other words the consultants have become walking ‘knowledge-pedias’ taking into account information from the growers and the scientists. Schön and Paine et al. conclude that consultants draw on combinations of scientific and experiential knowledge to perform in practice.<sup>18,26</sup>

The consultants are positioned as a mediators or brokers between the scientists' CoP and the growers' CoP in the knowledge flow. One may describe their function as “boundary spanners”<sup>6,9,35</sup> or “brokers”<sup>8,10,33,34,36</sup> as they carry with them knowledge from one CoP to another – they aid the growers with up-to-date knowledge while at the same time aiding the scientists by being their observing eyes and ears when walking in the growers' fields. Wenger describes it in the following way:

“The job of brokering is complex. It involves processes of translation, coordination and alignment between perspectives. It requires enough legitimacy to influence the development of a practice ... it also requires the ability to link practices by facilitating transactions between them and to cause learning by introducing into a practice, elements of another.” (p. 109).<sup>33</sup>

In many ways they act as ‘mediating change agents’ in that they build their expertise on their long-term communication experience with the scientists and mediate this knowledge to their growers in just time when problems occur. Rogers<sup>21</sup> defines “change agents” as being able to develop a need for change in his targeted CoP. The “change agent” can diagnose problems and motivate interest in an innovation. In addition, s/he can create an intention for change in the target group and can translate intention into action by virtue of putting the innovation into operation.

It is evident that the consultant performs an important role in that s/he is involved in all aspects of the knowledge creation from when a grower calls about a problem in his field to the formulation of the observation to other consultants and scientists, to the knowledge yield from new scientific work, and finally to the resulting dissemination of the new knowledge.

### *Time to learn*

According to the interviewees, one of the greatest impediments to independent acquisition of knowledge was time scarcity. Very often, the growers did not feel that they had enough time available for literature searches in magazines and on the Internet. If a consultant or a grower wanted an answer to a specific



problem, they preferred to call a contact for a quick reply; in the consultant's case this was often to an already familiar scientist, and in the case of the grower it was frequently a phone call to his/her designated consultant.

Time-consuming knowledge searching could be one explanation as to why several growers were more passive than others in their reflection on applied knowledge; if the consultant suggested application of a specific procedure, the grower would follow this advice without questioning why. Other growers were less dependent on their consultant's advice and instead used it as form of confirmation of their own assumptions based on personal experience prior to contacting their consultants. These growers acquired their knowledge from their own experience in addition to whatever time they had had with local "experience exchange groups" and information searches.

In opposition were the innovative growers, who in many respects were on the leading edge of development. The innovative growers did their own field tests and were constantly searching for new literature on their work (using both national and international knowledge sources). Their needs for knowledge were unappeasable – they were never completely satisfied with the data they had and were in a constant search of more knowledge. One of the knowledge challenges for these growers who spend a significant amount of time searching for new seed knowledge is the fact that the scientists' scientific results are often not easily accessible – this is often caused by the fact that Danish scientists do not use the Internet as a relevant knowledge source.

Based on empirical data – ranging from hybrid seed corn to modern mathematics, to the snowmobile, and to antibiotic drugs for HIV/AIDS prevention<sup>21</sup> – it turns out that for most people in a CoP successful spreads of innovation are formed by the time it takes people to make the innovation decision. Some individuals decide early when presented with an innovation being a new idea and other people decide later; some individuals need more information than others; some individuals are more open to change than others.<sup>11,17</sup> All individual members contribute to a collaborative learning curve in the system while at the same time complementing each other's learning skills.

Even so, fast decision making is not a prerequisite for the best decision making. Fast innovative decision people are often characterized as cosmopolitan and willing to take risks, whereas opinion leaders are more likely to take considerable time to decide.<sup>21,23</sup> If one takes a good look at successful seed growers – being those growers capable of continuous profound yields in seed production – there is no clear message of what makes these seed growers able to maintain high yields. Some growers base their knowledge on generation long traditions and "own common sense", whereas other growers base their knowledge on the information they acquire from available up-to-date knowledge sources together with their own experience, and it is in particularly this latter group of growers who claim they see time as a limiting factor to acquiring new up-to-date scientific knowledge on seed production.

### *Electronic knowledge sharing*

Today, one of the best known knowledge tools aiding rapid action decisions is the use of electronic knowledge portals.<sup>22,25,27,31</sup> However, it is not an easy task to use the Internet as a dissemination medium, and especially not when dissemination works well through face-to-face dialogue from scientist to consultant to grower. There are several parameters to be considered when one uses the Internet as a medium of knowledge dissemination.

Each individual's choice of knowledge source depends on the situation of the individual: what knowledge need is required, and what types of knowledge access are available.

- Immediate needs, where one requires a fast response to a problem or
- Educational needs, where one via problem clarification seeks an answer.

Fast responses are often solved either by a simple phone call or by a face-to-face meeting with an acquaintance from one's network or alternatively using online searches in electronic databases. Fast solutions often give one-sided answers: 'use this amount of nitrogen in your field', 'use that crop in your establishment', and 'harvest now' without going into detail about the reasons for the specific answers given. If one wants to go more in depth into the problem and include more nuances, then it becomes a time-consuming task. You need to search for answers and reasoning in articles, scientific literature, and databases together with possible expert discussions.

According to Rogers<sup>21,23</sup> individuals act differently with regard to new innovation. If you are the inquiring kind, you want to use more time searching for new knowledge, regardless of the format. If you are more reluctant towards additional innovation, you prefer to benefit from personal networks and see how other individuals have applied the idea. If you still hesitate about how the results may be interpreted, you can always have your assumption confirmed or disproved with a quick phone call to your immediate network members.

Today, the Danish seed companies are beginning to see the advantages of using new communication media when communicating news to their growers. They are slowly phasing out their printed newsletters and are instead introducing 'smart' electronic newsletters – smart in the sense that the growers will be able to filter out information in the newsletters that is not relevant for his production – together with SMS alerts with recommendations and warnings about “today’s action plan”. These new communication initiatives have been well received by growers of all ages and are very cost effective. However, both of these technologies only support individual reflections of knowledge and one should therefore try to look at other technologies supporting the community as a whole in which knowledge about dissemination of knowledge could be collected and recycled into the community.

## Conclusion

In conclusion, face-to-face knowledge dissemination works well in Danish seed communities of practice between growers and consultants and between consultants and scientists. The interviews revealed that the majority of Danish growers’ demand for knowledge on seed production is well covered and one of the reasons for this success can be attributed to the current knowledge setup between growers, consultants, and scientists, where consultants act as mediating change agents who quickly respond to the growers’ requests.

In addition the interviews revealed that the majority of growers believe they are not capable of allocating additional time to search for scientific knowledge. When in doubt regarding an immediate problem, they prefer to make a simple phone call to their consultants for information to solve their immediate problems. This is in contrast to a marginal group of innovative growers who prioritize additional time spent on knowledge sharing with scientists. The latter prefer research material to be available on the Internet in such details that conclusions could be readily available.

Returning to the aim of improving science dissemination in Danish seed communities of practice by means of implementing new communication technologies, our interviews clearly state that it is essential for the industry that scientific results are communicated in both oral form during face-to-face events and also by sharing scientific knowledge online in order to facilitate interdisciplinary collaboration. As a next step in improving online scientific knowledge dissemination we have held an innovation workshop involving growers, consultants, and scientists with the aim of shaping the layout of a future electronic knowledge tool together with the participants’ views on user segmentation across communities of practice.

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