Available online at www.centmapress.org

Proceedings in
System Dynamics and Innovation in Food Networks 2017

INTERNATIONAL JOURNAL ON FOOD SYSTEM DYNAMICS

Embedded Competence: A Study of Farmers' Relation to Competence and Knowledge

Jostein Vik and Egil Petter Stræte

Centre for Rural Research, Trondheim

jostein.vik@rural.no; egil.p.strate@rural.no

ABSTRACT

The aim of this paper is to explore the diversity of farmers' relationship to the networks that make up the knowledge and innovation systems. We approach farmer's knowledge diversity through the development of a typology based on a principal component analysis (PCA) of Norwegian farmers. The analysis indicates a preliminary typology of farmers where the main types are: 1) the self-confident farmers; 2) the knowledge-seeking farmers; 3) the knowledge-purchasing farmers; 4) the experienced farmers; 5) the collective-knowledge farmers; and, 6) the well-educated farmers. We discuss how extension service may improve communication, knowledge services, and knowledge networks.

***Keywords**: Knowledge, Principal component analysis, typology, farmers, agriculture*

Introduction[1]

The knowledge and innovation challenges in agriculture are substantial. Reaching for the twin goals of both increasing global food production and adapting to climate changes (FAO - High-Level Expert Forum, 2009; Godfray et al., 2010), even though they are contested (Maye & Kirwan, 2013; Tomlinson, 2013) implies high expectations to the agricultural knowledge systems. For the farmers, there is a need for relevant and accessible knowledge on best practices in agriculture in order to produce food in a sustainable manner, and consequently, for the knowledge system in general, there is a need for improved knowledge on how transfer and adoption of knowledge can be achieved. How is knowledge selected, adapted and turned into practical action in the interaction between farmers and knowledge operators like the advisory services?

New agricultural innovation system perspectives stress that interaction and communication are of major importance; farmers are no longer the only focus of advisory services. The principal objective is the promotion of innovation processes involving a multitude of actors (Faure, Desjeux, and Gasselin, 2012). In this perspective, farmers' competence and knowledge rests not only with the farmers themselves and their practice, but within the whole knowledge and innovation system in agriculture. This system may be described as a stable actor network which support agricultural innovation and learning, comprising, for example, researchers and advisory services and farmers (EU SCAR 2013; Engel 1995). Farmers are still key actors in these networks though, and we

[1] This study is related to the project "Competent farmer: Improving farmers' competence by more efficient interaction between farmers, advisory services and research". The project is funded by Norwegian Research Funding for Agriculture and Food Industry, county governors in Møre and Romsdal, Sør-Trøndelag and Nord-Trøndelag, and the business partners and cooperatives TINE, Nortura, Felleskjøpet Agri, Norwegian Agricultural Extension Service, and Mid-Norway Board of cooperation in agriculture.

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

know that farmers differ, both regarding their competence and their relation to knowledge and other knowledge actors within the wider knowledge network.

The aim of this paper is to explore the diversity of farmers' knowledge and their relation to the networks that make up the knowledge and innovation systems they are part of. Knowledge about how farmers' competencies and knowledge are embedded in farming practices, social and cultural beliefs, motivations, and structural factors, is necessary in order to improve innovation systems, and extension and advisory services for farmers. In addition, several policy discourses (e.g. on competence certification requirements for farmers) call for new research on the diversity of agricultural knowledge systems and practices.

In this paper we ask how we can describe the diversity of farmers' relation to knowledge and competence through the development of a typology, and what the implications can be for advisory services and policy formulation.

To approach farmers "knowledge diversity", we develop a typology based on a principal component analysis (PCA). We do this with Norwegian agriculture and farmers as case. The data comes from the survey "Trends in Norwegian agriculture – 2016". This is a dataset on the answers from 1869 Norwegian farmers. The PCA calculates latent variables in a dataset that include farm level variables such as size, production type, economic results, debt; personal variables as age, education and experience as farmer; variables on attitudes; and various variables on the farmers' own competencies and their relation to sources of knowledge. Based on the PCA and our interpretations of this we have developed a typology of farmers where we have labelled the main types as: i) the self-confident farmer; ii) the knowledge-seeking farmer; iii) the experienced farmer; iv) the collective-knowledge farmer; v) the knowledge-purchasing farmer, and finally; vi) the educated farmer. We discuss and describe the types, and we relate our empirical typology in relation to theoretical knowledge dimensions discussed in the literature (e.g. Amin and Cohendet 2004). Furthermore, we address how extension services can use such a typology in their work to improve and tailor communication, knowledge services, and knowledge networks. Finally, we explore and discuss some policy implications.

Conceptual framework

Knowledge is to know or to have insight into something. This is an example of a term used in everyday speech and at same time a concept that is being challenged, theorized and applied in many professional contexts. Knowledge has practical and economic consequences but also implications for power and distribution (e.g. Bryson et al. 2000; Vik, 2006). Consequently, there are no shortage of general knowledge typologies and dimensions. Following the works of e.g. Polanyi (1967), and Nonaka and Takeuchi (1995) it has become common to understand knowledge according to the basic dimensions tacit-explicit (codified/formal), and individual-collective (social) (e.g. Amin and Cohendet 2004). Both are highly relevant in a farming context (Curry & Kirwan, 2014; Dolinska & d'Aquino, 2016; Goulet, 2013), and theapplications are many.. It is also argued that co-produced knowledge, for example, between farmer and advisor, is a new form of knowledge that combines scientific evidence and coaching, technical information, experience-based knowledge, information about the goals and interests of the farm household, farmers' tacit knowledge etc. (Labarthe & Laurent, 2013). This indicates that agricultural extension services are characterized by diversity and complexity (Prager, Creaney, & Lorenzo-Arribas, 2017). It is therefore argued that it is necessary to combine different extension methods for enhancing knowledge transfer and improve learning in agriculture (Labarthe & Laurent, 2013. See also Prager, Labarthe, Caggiano, & Lorenzo-Arribas, 2016).

Competence has often been regarded as the sum of knowledge and skills, where knowledge is something theoretical or academic, while skills is about the ability to solve problems in practice. However, this has broadened and become more dynamic. A definition from Lai (2013: 46) states that: "Competence is the combined knowledge, skills, abilities and attitudes that make it possible to perform appropriate tasks in line with defined requirements and targets". Attitudes influence the ability to master, and is therefore a part of this approach to competence. The reasoning is that if you learn something important (knowledge) and are able to perform a job on the basis of the skills, but lack the will (attitude) to use this knowledge and these skills, the result is still unsatisfactory. For the agricultural sector, in relation to competence, more emphasis must be put on attitudes and people's motivation, both to acquire new knowledge and to apply the skills (Stræte et al. In

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

process). Thus, an important part of extension and advisory services is to increase consciousness of e.g. good practices and to motivate farmers. Thereby the farmers' competence is closely related to their professional networks.

In agriculture, "advisory services" and "extension services" are often used interchangeably. Yet, advisory is most often related to the commercial activity. Here we follow the definition of advisory services proposed by Faure et al (2012:462): "Broadly speaking, advisory services include: (i) the actors involved in the advisory activity and the relationships they maintain with each other and with other external actors; and (ii) the methods that are used by advisory service actors to create knowledge and know-how in individual and/or collective learning processes." Farm advisory services assist farmers in a broad range of issues, for example technical, financial, business management, ethical (animal welfare), and regulatory issues, which are often interconnected and thus require complementary or joint efforts between several advisors (Klerkx & Jansen, 2010; Phillipson et al., 2016; Proctor et al., 2012). The farm advisory system is a part of the broader Agricultural Knowledge and Innovation System (AKIS) (EU SCAR 2013).

From this perspective of competence and knowledge it follows that a broad number of elements are relevant – and needed – to understand competence and knowledge in farming. One way to explore this mixed landscape is through the development of actor typologies. Typologies are applied in e.g. studies of how farmers adjust their farming and life according to ownership, labour, mechanizations, perceptions of climate change etc. (see e.g. Andersson and Lundquist, 2016, Hyland et al 2016). Yet, very few studies combine the development of actor typologies with the issue of knowledge, competence and farming. Hereby, this study fills a gap in the research literature.

Methods and data

This paper is built on data from the biennial study, "Trends in Norwegian agriculture". The survey that has been performed every second year since 2002. The population for the survey is active farmers in Norway, defined as persons managing a farm with at least 0.5 ha of farmland and registered in the Register of Producers at the Norwegian Agricultural Authority. In this paper, data from the 2016 survey is used. For the whole country, a random sample of 3200 farmers out of the population of 41 846 farmers (by end of 2015) was selected. From these, 1208 farmers responded. This give a response rate of 41 %. In this paper we have added data from extra samples in two Norwegian counties – Rogaland and Møre og Romsdal (same survey). Here the response rate was 33 and 41 %. This procedure gave us a dataset of totally 1868 farmers. Altogether, tests show that the Trend survey mirrors Norwegian agriculture well (Heggem and Thanem 2016).

The survey consists of a wide array of questions. There are questions on personal background of the farmers, such as age, gender, marital status and family. Other variables in the data set concern farm features such as size, types of production and regional localization; and socioeconomic aspects such as total household income, income from farming, education etc. There are also a set of questions on plans and expectations for the future, attitudes towards agricultural policy issues etc. Of special interest for this paper is a set of questions that relates to education, knowledge, competence and use of advisory services.

What we aim at in this paper is to build an empirically based typology of farmers that is focused on how farmers are oriented in terms of competence and knowledge. In order to do that we have performed a principal component analysis (PCA) of data from the survey. In terms of statistics we have used the PCA technique in SPSS, and Varimax with Kaiser normalization as rotation method: This procedure implies that variables in a large dataset are explored to find latent or underlying variables – components – in the material (e.g. Loehlin 2003), and that these are constructed to minimize the number of variables with high loadings on each factor (IBM SPSS 2016). This method simplifies the interpretation of the findings.

PCA has been used as a tool in making typologies and analysing diversity in a series of studies of farmers. Barbieri and Mahoney (2009) study diversification strategies among Texas farmers; Visser, Moran et al. (2007) study land use conflicts and EU environmental schemes among farmers and non-farmers in Ireland; and Karali, Brunner et al. (2013) develop a typology of farmers and their approach to, e.g., farm management in Switzerland, using a method that included PCA. Our study is similar in that it uses the PCA method as a tool for

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

data reduction and clustering of the data. We do, however, combine this with explicit qualitative reasoning on, and interpretation of, the substance of the clusters or categories.

Methodologically, the method combine the statistical method with a qualitative interpretative approach. While the statistical method is rather fixed and standard at the outset, the practicalities of the procedure are more complex and context sensitive. First, the set-up of the survey and the questions is based on research based interest in the actual issues. We do for instance have an initial interest in the farmers' competencies and the knowledge systems they are parts of – and their own interpretations of these. Second, in the process of constructing a useful PCA model, a substantial amount of discretion and "trial and error" by adding and taking away variables has been performed to reach a result without too many factors/categories. Third, we have labelled the factors – or underlying tendencies – based on a combination of the variables that have the strongest correlation with the actual factor, and an experience based judgement of "competence attitudes" and farming styles among Norwegian farmers. This is therefore built on meta-knowledge about context we as researchers have gained during many years of agricultural research in Norway.

Thus, the methodology applied can neither be described as inductive, purely technical and empirical, nor as a classical theory-based hypothetical-deductive method. Rather, the methodology is pragmatic and follows an abductive logic (Feilzer 2010). It also follows from the methodology that there are certain degrees of interpretative flexibility and uncertainty.

Results

In this section we present descriptive statistics of the variables included in the PCA, and we present the results of the PCA.

The descriptive variables are presented in table 1. In the analysis we have included the following variables: The farmer age, in years. The range is 22-84 years with 53,6 years as mean; the farmers' experience as farmers, also measured in years, here the range is from 0 to 60 years of experience, with 22 years as mean; The size of the farm is included, and is measured in categories, where 1 is 1-9 da, 2 is 10-19, 3 is 20-49, 4 is 50-99, 5 is 100-249, 6 is 250-499, 7 is 500-999, and 8 is above 1000 da (100 ha); Another measure of size – particularly important for milk producers – is the milk quotas, measured in litre. We also use a production specific variable for the grain producers. This is arable land used for grain and oil production, measured in decare (0,1 hectare). Two measures address economy. The first is a measure of the share of family income from farming. This may be seen both as a measure of the economic significance of the farm activity and a measure of degree of pluriactivity and thereby also degree of connection to economic and social networks outside farming. This is measured in categories from 1-6 where 1 indicate no income from farming, and 6 indicates that all the income comes from farming. We also included a variable where the farmers should evaluate the level of their debts in relation to the production level. The categories range from 1 (no debt) to 5 (too much debt). We have two measures of formal education. The first is general education, where we have categories from 1-5, where 1 is basic education and 5 is higher university education. We have also used a measure of more specific formal agricultural education, with categories from 1-3, where 1 is a 1-year basic education in agriculture, 2 is a 2-3 years' agricultural education, and 3 is longer agricultural education. One variable measures if – and for how much money – the farmer purchases advisory services besides what is covered in membership fees.

The rest of the variables address different measures and evaluation of knowledge and knowledge sources, and they are all measured as degrees of satisfaction; importance; coverage; or valuation of own competence. These variables are: Satisfaction with professional environment; Satisfaction with local agricultural administration; Importance of other local farmers as knowledge sources; Importance of advisors in "Norwegian Agricultural Extension Service" (a cooperative of advisory services for farmers) as knowledge source; Feeling that the need for professional knowledge is covered; valuation of own competence in Plant production, husbandry, technology, economy, and finally market issues.

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

Table 1. Descriptive statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
Age	1845	62.00	22.00	84.00	53.5837	.26438	11.35620	-.164	.057
Years of experience (as farmer)	1797	59.00	.00	59.00	21.9638	.28821	12.21751	.184	.058
Agricultural land (categories)	1845	7	1	8	5.01	.030	1.271	-.447	.057
Grain production area (da)	1846	1620.00	.00	1620.00	54.2692	3.36645	144.63992	4.301	.057
Milk quota (liter)	1869	900000.00	.00	900000.00	55283.2269	2404.72756	103961.01990	2.868	.057
Share of family income from farming (categories)	1778	5	1	6	2.88	.031	1.326	.764	.058
Own general education (categories)	1832	4	1	5	2.77	.028	1.219	.547	.057
Own agricultural education (categories)	1845	2	1	3	1.55	.015	.634	.727	.057
Evaluation of own debt in relation to production (categories)	1843	4	1	5	2.42	.026	1.121	.354	.057
I buy advisory services (categories of money used on advisory services)	1803	3	1	4	1.49	.019	.791	1.509	.058
Satisfaction with professional environment (degree of satisfaction)	1807	9	1	10	6.18	.051	2.157	-.173	.058
Satisfaction with local agricultural administration (degree of satisfaction)	1817	4	1	5	3.47	.023	.975	-.487	.057
Importance as knowledge source: other local farmers (degree of importance)	1790	4	1	5	3.76	.024	.997	-.601	.058
Importance as knowledge source: advisors in NLR (degree of importance)	1760	4	1	5	3.17	.029	1.232	-.412	.058
Need for professional knowledge is covered (degree of coverage)	1838	3	1	4	3.17	.015	.644	-.357	.057
Plant production cometetence (degrees of competence considered by farmer herself)	1730	4	1	5	3.92	.018	.744	-.434	.059
Husbandry competence (degrees of competence considered by farmer herself)	1586	4	1	5	4.26	.020	.802	-1.246	.061
Technical competence (degrees of competence considered by farmer herself)	1738	4	1	5	3.85	.019	.801	-.385	.059
Economic cometence (degrees of competence considered by farmer herself)	1823	4	1	5	3.99	.018	.782	-.438	.057
Market competence (degrees of competence considered by farmer herself)	1732	4	1	5	3.74	.018	.761	-.199	.059
Valid N (listwise)	1164								

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

The above described variables were used in a PCA, using the IBM SPSS statistics program.

In the analysis, 6 components had eigenvalues above 1 and are thus used as components. The 6 components explain around 56 % of the variance. See table 2.

Table 2. Variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Comp	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.350	16.750	16.750	3.350	16.750	16.750	2.407	12.036	12.036
2	2.269	11.343	28.093	2.269	11.343	28.093	2.251	11.255	23.290
3	1.736	8.681	36.774	1.736	8.681	36.774	2.247	11.234	34.524
4	1.497	7.485	44.259	1.497	7.485	44.259	1.605	8.025	42.550
5	1.302	6.510	50.768	1.302	6.510	50.768	1.431	7.155	49.704
6	1.126	5.630	56.398	1.126	5.630	56.398	1.339	6.694	56.398
Extraction Method: Principal Component Analysis.									

The model with 6 components was rotated using the Varimax method. This is “An orthogonal rotation method that minimizes the number of variables that have high loadings on each factor” (IBM SPSS 2016). This means that the differences between components (or types) is maximized. The method is meant to simplify interpretation of the factors.

In the rotated solution we see that the individual models explain from 6.7 to 12 % of the variation in the initial variables. The results of the rotated PCA are shown in table 3, below. The table displays the input variables, the 6 extracted components and the correlations between the initial variables and the components.

We use this matrix as a starting point to describe a typology of farmers that have different farm and farmer characteristics, knowledge attributes, and also have different approaches towards knowledge and competence. In table 3, we have manually framed the set of values under each component that has the strongest correlation with the input variables. These are important in the task of identifying and categorizing the different knowledge types of farmers. The task of identifying, labelling, classifying and describing these types involves interpretation and discussion, and will therefore be done under the discussion section.

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

Table 3 Principal Component Analysis – rotated component matrix

	Component					
	1	2	3	4	5	6
Age	-.062	-.075	.871			-.058
Years of experience		.074	.864	-.078		-.112
Milk quota	.052	.796	-.133		-.100	
Agricultural land	.171	.514	-.141		.573	
Share of family income from farming	.194	.666	.127	.111		-.117
General education		-.186	-.213			.800
Agricultural education	.205	.309	.062		.094	.630
Grain production area	.058	-.091			.885	.084
Debt		.244	-.588		.107	
Importance as knowledge source: other local farmers		-.085	-.360	.589	.093	-.179
Satisfaction with professional environment	.151	.082	-.091	.703	-.061	
Satisfaction with local agricultural administration	-.089		.258	.582	-.052	.094
Importance as knowledge source: advisors in NLR	-.057	.279	-.100	.459	.338	
Need for professional knowledeg is covered	.333	.311	.093	.397	.177	.127
Plant production competence	.627	.183	.117	.126	.229	
Husbandry competence	.549	.270	-.107		-.240	-.143
Technology competence	.699	.074	-.092		.073	-.212
Economic competence	.722		.057			.221
Market competence	.658	-.074				.268
I buy advisory services		.626	-.179	.109	.104	.138

Rotated Component Matrix (Rotation converged in 6 iterations) Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Discussion

In this section we will present and discuss the various types of farmers in table 3 in more detail. The model extracted 6 different components. These are present in all farmers – but in varying degree. It is the interpretation of this variation that constitutes a typology. We use these findings as a basis for stating that farmers with a high score on e.g. component 1 may be described as a type that have the attributes of component 1, and so on. Thus, on the basis of the strongest correlation under each component we have identified the following six farmer knowledge types. We elaborate:

The self-confident farmer

Based on component 1 we have identified a type of farmer we have labelled "the self-confident farmer". This type of farmer can be recognized by the fact that they are highly confident in their own competence in all subfields: economic competence, market competence, technical competence, plant production competence, as well as competence in husbandry. These farmers also holds that they are getting the need for updated

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

relevant competence satisfactory covered. They are relatively satisfied with the professional environment in their area, but don't put high value on neither local agricultural administration nor the advisors of the Norwegian Agricultural Extension Service. They tend to have more agricultural education than most farmers.

This type of farmers tends to be somewhat younger than the average, their farms are a bit above average size, and – more of the family income comes from farming than the average Norwegian farmer – that is, they are less pluriactive.

In terms of knowledge, this is a type that highly values his or her own individual expertise. He has, or thinks that he has, most of the necessary knowledge that is needed to be a farmer himself. We have not tested their actual level of knowledge. Thus, we cannot decide whether they have a high level of competence or they just have high confidence in themselves. The described features indicate that this is a type of farmer that is not easily accessed by advisors or advisory services as they believe they hold the necessary knowledge in most fields themselves.

The knowledge seeking farmer

Component 2 reveals a type of farmers that is quite different from the first one. We have labelled this the knowledge-seeking farmer. This is a type of farmer that actively seeks – and to a large extent is willing to pay extra for – relevant knowledge from various sources. It is also a farmer that to a high degree has formal agricultural education, higher than "the self-confident farmer", and may be described as a classical "professional farmer", which typically is a full-time farmer that produces milk (high milk quotas) on a farm that is substantially above average farm size in Norway. This is also the most indebted farm type – probably due to heavy investments that have been necessary to become a large dairy farmer.

These farmers seeks knowledge, but also values their own knowledge. As could be expected from their tendency to be milk producers they hold that they have good competence in working with animals, while the results are more mixed regarding other forms of knowledge.

The approach to knowledge that theses farmers have implies that they actively seek the best available knowledge and they do not take it as granted that they possess it themselves. This is generally a good starting point for learning and accessing knowledge.

The experienced farmer

Component 3 highlights age and experience. These variables do indicate a high degree of practical and tacit knowledge, developed over years. We also see that these farmers score relatively low on the valuation of other local farmers as sources of knowledge, while they are quite satisfied with the local agricultural administration. This makes sense, and corresponds with the historically important role that was played by the local agricultural administration in reaching out to farmers with agronomic as well as technical and economic advice in the expansive period from early 1970's to mid-1990's.

These farmers score relatively low on general education. Furthermore, it is interesting to see that these experienced farmers seem to be modest in the valuation of their own competences in different subfields as technology and husbandry – fields where there has been a substantial development over the last years, i.e. they realize the limitations of their own competence. This may also be a result of a tendency to put less value on tacit practical knowledge than on the more codified explicit knowledge associated with education and updated technological knowledge.

The collective-knowledge farmer

Component 4, we have labelled the collective-knowledge farmer since (s)he reveals strong correlation with a set of variables that indicate a collective orientation in terms of knowledge: Other local farmers are important; they are highly satisfied with the professional environment where they live; and they are satisfied with the local agricultural administration. This farmer also sees the advisors in the Norwegian Agricultural Extension Service as important sources of knowledge. Finally, they hold that their need for professional knowledge is covered – even though they don't stand out in valuation of their own individual knowledge.

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

In terms of most other variables they are quite average. It is first and foremost the open attitude to knowledge in their surroundings – the collective approach to agricultural knowledge and networks – that characterises these farmers.

The knowledge-purchasing farmer

Component 5 scores high on only a few variables. Yet, in the Norwegian context (s)he is easily recognisable. This is a farmer with large (in Norwegian context) agricultural land, and who uses this for grain and oil seed production. Even though these farms are large, they don't have a large share of total family income from agriculture. Grain production in Norway – even in relative large scale – is normally done by farmers that have additional work, and they live in central parts of Norway. This is both a result of climatic conditions and an agricultural policy with regional production distribution as a corner stone (Almås and Gjerdåker 2004; Vik 2016). In terms of knowledge, the grain producers traditionally have a close collaboration with local advisors from the Norwegian Agricultural Extension Service (NAES), and it is therefore as expected that these famers hold NAES advisors as important sources of knowledge. We may also see this as a resource-effective way to access relevant and concrete knowledge in a very busy growing season.

The highly educated farmer

Our last component scores high on especially two components – those two that measure formal education. Thus these farmers tend to have high agricultural or general education. The farmers are slightly younger; have slightly less experience and have a little less of the family income from farming than the average. Most other variables are around average. We see a tendency that they have less knowledge of husbandry and plant production, and slightly more technology, economic, and market knowledge, something that correspond to high levels of codified formal knowledge and less practical and tacit knowledge.

Types of farmers and of knowledge

Above, we have presented a typology that has been developed through a combination of a formal PCA procedure and a qualitative interpretation based on knowledge of the Norwegian agricultural context. As such, the study may have specific resonance among Norwegian readers. However, there are some general points that may be of interest to a larger audience as well.

First, we see that knowledge and competence are not isolated features of the farmers. There are systematic relations between the structural characteristics and the practices of farmers on the one hand, and the way they approach knowledge on the other. Knowledge and competence are embedded in the production environment, the daily household activities and, in short, the larger socio-economic networks of the farmers. From this follows, competence is not only an individual personal issue but is related to and varies with other factors.

Second, the typology also reveal what many typologies and classification tend to do: diversity. Here we see a diversity in farmers' knowledge, knowledge types and approaches to knowledge. This picture resonates with our experiences from work with the agricultural sector – farmers do have very different approaches to knowledge and advisory services. We also see that the typology, and the types within it, resemble classical dimensions in the knowledge literature. To explore that more, we may see the empirically based typology developed here in relation to other, more theoretical typologies of knowledge. As mentioned, Amin and Cohendet (2004: 34) synthesised a knowledge typology, based on a review of other knowledge categorizations (e.g. Lundvall and Johnsen 1994), that sorts knowledge along the two dimensions tacit-explicit, and individual-collective(social). In table 4, below, we combine the two typologies.

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

Table 4 Farmer types in a generalized knowledge typology.

Knowledge types	Individual	Collective
Explicit (codified)	The well-educated farmer (6)	The knowledge-seeking farmer (2) The knowledge purchasing farmer (5)
Tacit	The self-confident farmer (1) The experienced farmer (3)	The collective-knowledge farmer (4)

In practice, knowledge and competence are multifaceted phenomenon. Farming typically includes tacit *and* codified knowledge; knowledge individually possessed *and* shared in a farming community and the agricultural innovation system. Yet, we see that farmers to a varying degree have and/or rely on knowledge that to a varying degree is tacit or explicit, and individual or collective. This has consequences for how we may think of advisory services and knowledge networks. Some farmers have a strong individual knowledge orientation, while others rely heavily on the available knowledge in their farming communities. Some seem to have a high degree of experience based tacit knowledge while others have high levels of formal education. This indicates, in turn, that actors in the agricultural innovation system should be careful with one size-fits-all solutions. It is not likely that the self-confident farmers, the knowledge-seeking farmers, the knowledge-purchasing farmers, the experienced farmers, the collective- knowledge farmers, and the well-educated farmers seek and adjust to knowledge from the same kind of sources. Advisory services may work well in cooperation with one of the types while having problems even coming in contact with others. This is an insight that those who work within the extended agricultural knowledge systems should take into account. Our argument here is not original, it is similar to Labarthe and Laurents (2013) argument that it is necessary to combine different extension methods for enhancing knowledge transfer and improving learning in agriculture. It is also very possible that methods in e.g. extension services addressing financial issues (Hansen 2015) should be different from extension aiming at developing e.g. farmers' consciousness regarding sustainable farming (Curry and Kirwan 2014).

A nuanced and informed picture of the diversity in knowledge and knowledge approaches among farmers may also have contested political implications. In many countries it is on the political agenda to introduce formal competence requirements for farmers, like green card etc. Arguments for this follow from the need to apply to environmental restrictions, animal welfare concerns, and occupational health and safety (OHS) issues. However, our findings on the different ways farmers seek and access knowledge and experience, indicate that it may be demanding to successfully introduce a set of formal competence requirements that do not exclude entire groups of farmers. Thus, certification may be a tool to document certain kinds of knowledge, but not all kinds of relevant knowledge for all kinds of farmers.

Conclusion

In this paper, we have explored the diversity of farmers' knowledge and their relation to extended agricultural innovation system through a typology of farmers, based on the interpretation of a principal component analysis. We extracted 6 components that we used as types in a typology: 1) the self-confident farmers; 2) the knowledge-seeking farmers; 3) the knowledge-purchasing farmers; 4) the experienced farmers; 5) the collective- knowledge farmers; and, 6) the well-educated farmers.

After identifying and labelling the types, we discussed some key features of each type, before we positioned each type in a standard knowledge typology consisting of the knowledge dimensions tacit-explicit and individual-collective. The findings reveal first, that farmers' knowledge and competence is embedded in their practices and socioeconomic networks, and second that there is substantial diversity in the types of knowledge and competence farmers possess, and the ways farmers seek and approach knowledge.

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

Based on the description of the analysis, we conclude that advisory services, agricultural innovation systems, and policy makers in the agricultural sector should pay careful attention the substantially multifaceted and diverse nature of knowledge in farming communities.

For future research on extension and advisory services one key implication of our findings is that there is a need for systematic research on how different approaches in the broader Agricultural Knowledge and Innovation System (AKIS) fit with the diversity of embedded knowledge in the agricultural communities.

References

Almås, R. and B. Gjerdåker (2004). *Norwegian agricultural history.* Trondheim, Tapir Academic Press.

Amin, A. and P. Cohendet (2004). *Architectures of knowledge: Firms, capabilities, and communities*. New York. Oxford University Press.

Andersson, E. and P. Lundqvist (2016). "Gendered time in Swedish family farming: Operationalising an agrarian typology using the Swedish Farm Accountancy Data Network", *Journal of Family Business Management*, Vol. 6 Iss: 3, pp. 310–329.

Barbieri, C. and E. Mahoney (2009). "Why is diversification an attractive farm adjustment strategy? Insights from Texas farmers and ranchers", *Journal of Rural Studies* 25(1): 58–66.

Bryson, J. R. et al. (eds.) (2000). *_knowledge _space _economy*. London: Routledge.

Curry, N., & J. Kirwan (2014). "The role of tacit knowledge in developing networks for sustainable agriculture", *Sociologia Ruralis*, 54(3), 341–361.

Dolinska, A., & P. d'Aquino (2016). "Farmers as agents in innovation systems: Empowering farmers for innovation through communities of practice", *Agricultural Systems*, 142, 122–130.

European Union Standing Committee on Agricultural Research [EU SCAR] (2013). Agricultural knowledge and innovation systems towards 2020: An orientation paper on linking innovation and research. Brussels.

FAO - High-Level Expert Forum (2009). How to Feed the World in 2050. Rome, FAO.

Faure, G., Y. Desjeux, and P. Gasselin (2012). "New Challenges in Agricultural Advisory Services from a Research Perspective: A Literature Review, Synthesis and Research Agenda", *Journal of Agricultural Education and Extension*, 18: 461-92.

Feilzer, M. Y. (2010). "Doing mixed methods research pragmatically: Implications for the rediscovery of pragmatism as a research paradigm", *Journal of Mixed Methods Research* 4(1): 6–16.

Godfray, H. C. J., J. R. Beddington, I. R. Crute, L. Haddad, D. Lawrence, J. F. Muir, J. Pretty, S. Robinson, S. M. Thomas, and C. Toulmin (2010). "Food security: The challenge of feeding 9 billion people", *Science*, 327: 812-18.

Goulet, F. (2013). "Narratives of experience and production of knowledge within farmers' groups", *Journal of Rural Studies*, 32, 439–447.

Hansen, B. G. (2015). "Financial extension that challenges farmers' thinking in discussion clubs helps farmers improve their problem solving abilities", *Agricultural Systems*, 132, 85–92.

Heggem, R. and A. Thanem (2016). Trender i norsk landbruk 2016. Trondheim, Report no 6/2016. Centre for Rural Research.

Hyland, J. J. et al. (2016). "Farmers' perceptions of climate change: identifying types." *Agriculture and Human Values* 33(2): 323–339.

IBM SPSS (2016). Factor analysis rotation.

Karali, E. et al. (2013). "The effect of farmer attitudes and objectives on the heterogeneity of farm attributes and management in Switzerland", *Human Ecology* 41(6): 915–926.

Loehlin, J. C. (2003). *Latent variable models: An introduction to factor, path, and structural equation analysis*.

Lundvall B., and B. Johnson (1994). "The learning economy", *Journal of Industry Studies* 1(2): 23–41.

Nonaka I. and H. Takeuchi (1995). *The knowledge creating company: How the Japanese companies create the dynamic of innovation.* New York. Oxford University Press.

Polanyi, M. (1967). *The tacit dimension.* New York. Doubleday.

Prager, K., P. Labarthe, M. Caggiano, & A. Lorenzo–Arribas (2016). "How does commercialisation impact on the provision of farm advisory services? Evidence from Belgium, Italy, Ireland and the UK", *Land Use Policy*, 52, 329–344.

Prager, K., R. Creaney, & A. Lorenzo–Arribas (2017). "Criteria for a system level evaluation of farm advisory services", *Land Use Policy*, 61, 86–98.

Stræte et al. (In press). Review: Studies of competence and extension in agriculture. [Report in Norwegian]

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740

Vik, J. (2006). *Knowledge, mobility and configurations of power: an asset specificity perspective on power in the knowledge society*. Trondheim, Norwegian University of Science and Technology, Faculty of Social Sciences and Technology Management.

Vik, J. (2016). Fôrproduksjon, strukturutvikling og landbrukspolitikk. Trondheim, Report no 4/2016. Norsk senter for bygdeforskning [Centre for Rural Research].

Visser, M. et al. (2007). "The Irish agri-environment: How turlough users and non-users view converging EU agendas of Natura 2000 and CAP", *Land Use Policy* 24(2): 362–373.

DOI: http://dx.doi.org/10.18461/pfsd.2017.1740