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The Four Horsemen of Innovation

Learning Styles, Entrepreneurship, Attitudes, and Knowledge Network

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Abstract
Although previous research programs have yielded valuable knowledge that can help sugar beet growers to innovate farming processes, actual transfer of this knowledge to the growers so far is lacking. Currents ways of knowledge transfer do not match learning styles, personal traits or the social environment of previously identified groups of growers.
The current research was designed to asses to which level new means of knowledge transfer are suitable: using both digital means, e.g., decision support systems, and other means, e.g. study groups, knowledge transfer can be re-assessed to form specific inspiring learning environments. A survey study assessed learning styles, attitudes toward innovation, personality traits related to entrepreneurship and the social network growers use to obtain new knowledge. These data were linked to the crop yield data over the previous five years, to be able to compare the influence of learning styles, attitudes, network and individual differences on the occurrence and effectiveness of certain types of innovative behaviour.
Results indicate that different learning styles correlate with different ways of using one's knowledge network: for instance, people who are more prone to seek help, have significantly more contacts and exchange more knowledge within their networks. Growers whom significantly participate more in meetings and interactions with colleagues, produce an above average crop yield, as compared to other groups. The innovation attitude appeared to predict the innovation intention of growers; people with more positive attitudes are more willing to try new ideas and implement not fully tested techniques than growers with less positive attitudes toward innovation. Knowledge networks are comprised of fellow growers, friends, family, but mostly the growers receive their knowledge from advisors, suppliers and study groups. Preferences for learning and innovating correlate with the size of the network, and how intensively it is used.

Key words:
Agricultural renewal, knowledge transfer

Introduction
Agriculture is facing major and rapid changes which can significantly affect the sustainability of the European Union. These changes may include intensification of land use, and depopulation and land abandonment. The (new) policy for market price support may lead to minor changes in production but to profound changes in land prices, income and farm structure. Currently, only a small part of sugar beet growers reach a sufficient return on crops to ensure continuation of the farm. Although previous research programs have yielded valuable knowledge that can help beet growers to innovate farming processes, actual transfer of this knowledge to the growers so far is lacking. Previous studies show that currents ways of knowledge transfer do not match learning

styles, personal traits or the social environment of previously identified groups of growers (Pieters, 2005; Tuin, 2006; Faber, 2006). As a result, the current organization of knowledge transfer has had little contribution to innovation in farms and farming processes.
In a search for alternative ways for knowledge transfer, this study focuses on the ways farmers process knowledge, building on the notion that humans are information processors (Newell & Simon, 1972). As information processors, the innovative behaviour of farmers is considered a result of the ways they process new knowledge and insights about farming. A closer consideration of innovative behaviour and knowledge processes, shows four underlying determinants that need to be observed, affecting the way an individual obtains knowledge, processes knowledge, and brings knowledge to practice.
The first determinant consists of the learning processes that enable individuals to obtain new knowledge and insights. The manner in which learning takes place is typified by the concept of learning styles. Vermunt (1992) considers learning styles as a combination of various factors (Busato, 1998). The first factor to shape a learning style are cognitive processing activities. These are thinking activities that are used to process information resulting in knowledge and insight by the individual. Affective processing activities are the second factor of learning styles. These activities focus on positive and negative emotions and feelings during learning, such as expectation, evaluation, appreciation, and motivation. Meta-cognition refers to the co-ordination and control of both the cognitive and affective processing activities of the individual, and forms the final factors of learning styles. Individuals use meta-cognitive activities to control the process and results of their learning processes. This leads to the following hypothesis:

H1: The knowledge and insights an individual will obtain, and hence the innovative behaviour s/he will show, depends on the configuration of his / her learning style.

The second determinant of innovative behaviour is entrepreneurial activity of individuals and links to the manner in which an individual processes obtained knowledge and translates that to action. Innovation and entrepreneurship are for long considered strongly interrelated, from a theoretical perspective (e.g. Schumpeter, 1934). Recent studies indicate that entrepreneurs utilize knowledge processes that differ from non-entrepreneurs; entrepreneurs have different ways of reasoning than managers (Sarasvathy, 2001). Entrepreneurial reasoning, labelled as effectuation, is contrasted with managerial reasoning, labelled as causation. The first difference between these two positions concerns the starting point of reasoning activities. Causation starts from the belief of a reachable goal. Through causal reasoning, the goal is broken down into sub goals, until the path from the current situation to the goal is created. In contrast, effectuation has no specific goal orientation, but considers the means available. By combining these available means, the entrepreneur realizes a situation, differing from the initial situation that might be desirable (e.g. profitable). Additionally effectuation and causation differ regarding the perspective on control and prediction. Whereas causation considers predictability equal to controllability, the stance of effectuation is that being able to control means reduces the need to predict. Furthermore, effectuation considers affordable losses, while a causation perspective reasons from the notion of expected return. The sketched differences provides an indication that innovative behaviour requires an effectuation kind of reasoning pattern, for innovation has an unclear objective, is unpredictable, and mostly can only be expressed in terms of certain costs and uncertain benefits. Therefore, the second hypothesis is on entrepreneurial activity:

H2: An effectuation reasoning style relates positively to innovative behaviour; a causation

reasoning style leads to less innovative behaviour.

The third determinant of innovative behaviour is an individual's attitude towards innovation and how this affects willingness to display innovative behaviour. Tuin (2006) found that attitudes towards innovation make a strong determinant of innovative behaviour among farmers. The attitude towards innovation in itself is influenced by the behavioural convictions of the individual (Tuin, 2006). The third hypothesis is:
It would be nice to incorporate here or in H4 the work of Carol Dweck (Harvard) on mindset.
H3: a positive attitude towards renewal leads to more innovative behaviour.

The fourth determinant concerns an individual's embeddedness in his social environment. The way individuals communicate with external parties, determines what knowledge they will obtain and hence the innovative behaviour they are able to display. In this study, the way of communication is considered as the amount of connections with distinct external parties. The more, distinct external parties an individual communicates with provides him with a broader range of knowledge. Thus the fourth hypothesis is:

H4: The more, distinct connections an individual has, the higher the level of innovative behaviour.

Because current approaches towards knowledge transfer consider the four mentioned determinants insufficiently, an alternative way of knowledge transfer is to incorporate them. This study aims to develop new means of knowledge transfer that incorporate the four determinants.

Method
To gain insight in the knowledge processes and innovative behaviour of sugar beet growers in the Netherlands, printed surveys were sent to approximately 3000 persons. The response rate was 24%, with 716 surveys that could be entered into a database returned. In the Appendix, the questions pertaining to the variables, mostly scales, in this paper are presented. The questionnaire was specifically designed for the current research: several scales from the Motivation and Learning Strategies Questionnaire (MSLQ, Pintrich & de Groot, 1990) and the innovation attitude scale by Tuin (2006) were adapted to fit the domain of sugar beet growing. The questions pertaining to knowledge embeddedness, were newly developed. The frequency of communication in diverse locations and frequency of personal communication with diverse persons were assumed to be good indicators of a farmer's informal knowledge network. Questions pertaining to entrepreneurial activity were based on Sarasvathy's (2001) notion of effectuation versus causation.

Sample
Sugar beet growers were randomly selected from the Suiker Unie database. Each region of the Netherlands was represented in the sample; no reliable effects for region were found, and will not be reported here. The average age of our respondents was 47 (SD = 10.3); the average farm size was 82.7 hectares (SD = 72.4). The area used for sugar beets is on average 12.0 (SD = 12.3) hectares, for starch potatoes 8.8 (SD = 23.0), for consumption potatoes 12.0 (SD = 18.9) and for seed-potatoes 6.7 (SD = 15.4) hectares.

Results

The questions pertaining to our dependent and independent variables (see the Appendix) showed good internal consistency. The indicators for innovative behaviour (alpha = .78), attitudes toward innovation (alpha = .87), extrinsic motivation (alpha = ??) , help seeking (alpha = ??) and peer learning (alpha = .79) and in conclusion knowledge embeddedness (alpha = 0.82) appeared reliable. These variables were entered into a regression analysis, with innovative behaviour as dependent, and learning styles (extrinsic motivation, peer learning and help seeking), attitude, and knowledge embeddedness, frequency of communication in diverse locations and frequency of personal communication with diverse persons) as independent variables, using the forward method to enter the independent variables into the regression model (see table 1). This resulted in the following regression equation: innovative behaviour = 2.11 + 0.292 attitude + 0.116 extrinsic motivation - 0.107 personal communication. The constructs not mentioned in the equation did not reach the conventional level of significance. As the regression analysis did not yield a full insight, further analyses were done.

Table 1 Regression analysis

	Model 1				**Model 2**				**Model 3**			
model summary	R^2 = .087 adj. R^2 = .083 F(1,250) = 23.803, sig. = .000				R^2 = .099 adj. R^2 = .091 F(2,249) = 13.628, sig. = .000				R^2 = .110 adj. R^2 = .099 F(3,248) = 10.213, sig. = .000			
	unst. coeff.	stand. coeff.	t	sig.	unst. coeff.	stand. coeff.	t	sig.	unst. coeff.	stand. coeff.	t	sig.
intercept	2.278	-	6.603	.000	1.859	-	4.479	.000	2.110	-	4.831	.000
attitude	.378	.295	4.879	.000	.367	.279	4.595	.000	.384	.292	4.793	.000
ext. motivation	-	-	-	-	.123	.109	1.800	.073	.130	.116	1.906	.058
pers. communication	-	-	-	-	-	-	-	-	-.103	-.107	-1.774	.077

To assess the direct effects of learning styles, attitudes, entrepreneurial activity, and knowledge embeddedness on innovative behaviour, we performed a mean split on the innovative behaviour scale. This way, we formed two groups: a group low in reported innovative behaviour, and one group reporting high levels of innovative behaviour. With a series of Analyses of Variance (ANOVA), we compared these two groups with respect to the other variables. This series of analyses showed that the help seeking scale and the frequency of communications in diverse locations yielded no reliable effects (both *F*'s <1, *ns*). However, respondents high in innovative behaviour were significantly more extrinsically motivated, $M = 1.2$, $SD = 0.4$, as compared to the low innovative behaviour group, $M = 1.6$, $SD = 0.5$, $F(1, 694) = 17.5$, $p < .001$. This indicates that people who like to do better than colleagues and are only satisfied with the best results, show more innovative behaviour. The other learning style scale, peer learning, also showed reliable differences: the high innovative behaviour group is more likely to learn from their peers, $M = 1.6$, $SD = 0.5$, than the lower innovative behaviour group, $M = 1.5$, $SD = 0.5$, $F(1, 686) = 5.6$, $p = .019$.

The frequency of personal communication with diverse persons was higher for sugar beet growers who are high in innovative behaviour, $M = 3.4$, $SD = 0.6$, than for those who are low on the innovative behaviour scale, $M = 3.3$, $SD = 0.6$, $F(1, 669) = 5.5$, $p = .019$.

Entrepreneurial activity was measured with five statements; two of them showed reliable effects. We will return to this in the Discussion. The statement "I invest mainly on my feelings" was met with more agreement by the low innovative group, $M = 3.3$, $SD = 1.1$, than the high innovative behaviour group, $M = 3.1$, $SD = 1.1$, $F(1, 687) = 3.9$, $p = .049$. The same pattern was observed with the statement "I set clear goals and find means to obtain them": the low innovative group

agreed less, and thus showed less of a causation style, $M = 3.7$, $SD = 0.7$, than the high innovative behaviour group, $M = 3.9$, $SD = 0.7$, $F(1, 685) = 10.6$, $p = .001$.
Concluding, people in the high innovative behaviour group showed a significantly more positive attitude towards renewal in their business processes, $M = 4.4$, SD = 0.6, than beet growers in the low innovative behaviour group, $M = 4.1$, $SD = 0.6$, $F(1, 661) = 50.1$, $p < .001$.

Discussion

The data confirmed three of our initial four hypotheses. Learning styles do have a significant effect on innovative behaviour (H1); in both the regression analysis (extrinsic motivation) and the ANOVA's (extrinsic motivation and peer learning). As predicted, the more positive a person's attitude towards innovation, the more likely that person is to do renewals in agriculture (H3). This was strong, in both the regression analyses and the ANOVA. Our fourth hypothesis, the more, distinct connections an individual has, the higher the level of innovative behaviour, was also confirmed with an ANOVA.
Our second hypothesis, an effectuation reasoning style relates positively to innovative behaviour; a causation reasoning style leads to less innovative behaviour, was not confirmed. Rather, the predicted relationship appeared to be the reverse of our prediction. Although this conclusion may only be drawn tentatively, as it is based on only two survey questions, it seems as though a causation reasoning style is associated with a higher level of innovative behaviour.
This last effect may be explained by looking at what is innovated in a sugar beet grower's business. Tuin (2006) reported that growers are inclined to innovate if they assess the innovation to help them to improve farming efficiency. Innovations that help farmers to increase their yields or allow them to grow different kinds of crops are not considered in innovation decisions. West & Farr (1990) identify such efficiency oriented innovation as process innovations. In contrast to product innovations, process innovations target the improvement of the production processes of an organisation, without changing the products or services that are produced. Process innovations follow from the need to improve production efficiency and decrease costs; process innovations mostly concern incremental improvements of production processes. For participation to agricultural growths concern long term investments, switching crops, which is considered a product innovation, is hardly considered. Our initial expectation of finding a positive relation between innovation and effectuation should therefore be considered more carefully. An effectuation reasoning style incorporates risk taking and exploring multiple directions (e.g. experimenting with different kinds of crops). Therefore, an effectuation reasoning style should be considered related to product innovation. A causation reasoning style appears to be more appropriate in relation to process innovation, following from emphasis of incremental improvements of the latter. Further research will be needed to verify this relation.

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Appendix: Building the constructs

Innovative behaviour:
Answers are on a 5 point scale, ranging from 1 (I do not agree at all) to 5 (I completely agree)

- I don't entirely see the use for renewal (h)
- I agree with agricultural organizations: renewal is very important
- I enjoy learning new things about my work

Knowledge embeddedness:
Answers are on a 5 point scale, ranging from 1 (never) to 5 (very often)
How often do you talk about your work in these situations?

- Living room
- In a café (pub)
- Coincidental meeting (for instance, in a street)
- Organized work meetings
- Study groups
- Excursions
- Demonstration days

How often do you talk with these persons about your work?

- Neighbours
- Family
- Friends
- Suppliers
- Buyers

Attitude towards innovation:

This question is about your view on innovation. Please complete this sentence:

"If I carry out innovations in the next five years, I would find that…"

bad	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	Good
Damaging	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	Useful
Unpleasant (to me)	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	Pleasant (to me)
Ill-advised	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	Wise
Worthless	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	Valuable

Peer Learning:
Answers are on a 5 point scale, ranging from 1 (I do not agree at all) to 5 (I completely agree).

- I like to discuss things I read in professional journals with others
- I regularly confer with others about my growth- and business problems
- When I am working on something new, I like to confer with others
- You can get professional skills by talking a lot to colleagues
- I like to give advice to others

Help Seeking:
Answers are on a 5 point scale, ranging from 1 (I do not agree at all) to 5 (I completely agree).

If I do not understand something in the domain of growing my crops, I:
- try and solve the problem myself, without help from others (h)
- I ask my crop advisor ("teeltbegeleider")
- I ask my neighbours
- I ask my friends
- I ask my family

Extrinsic Motivation:
Answers are on a 5 point scale, ranging from 1 (I do not agree at all) to 5 (I completely agree).

- I am only satisfied with the best results
- If possible, I would like to outperform my colleagues
- I do not need new knowledge, as my business is yielding good returns at the moment

Entrepreneurial activity:
Answers are on a 5 point scale, ranging from 1 (I do not agree at all) to 5 (I completely agree).

To which extent do you agree with these statements?

- If I invest, I mainly trust my feelings; I don't need to calculate everything first
- I mostly think of suppliers, buyers and other sugar beet growers as (possible) partners, in stead of competitors
- When the future of my business is concerned, I often use existing knowledge; I don't just jump into occurring possibilities
- When the future of my business is concerned, I set clear goals and find the means to obtain those goals
- When the future of my business is concerned, I mainly use what is available to me and use that creatively