TO EMBED SCIENTIFIC AND LOCAL KNOWLEDGE IN THE LIFE OF EVERYDAY LEARNING PROCESSES AT FARM LEVEL.

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ABSTRACT
To develop agriculture we must know what we are heading for. What do we want? Who is deciding? Through generations farmers have created their own knowledge about soils, crops and animals using sensory observation and intuition. With the help of sophisticated instruments science has extended the possibilities to observe and measure new properties of nature. But is the increasing amount of measurable data information inhibiting a true and clean dialogue with life itself? How is the relation between farmers' knowledge and resources at farm level? In this paper six different epistemological approaches are presented. Their rate of embeddedness in the human mind and studied objects will be analysed and discussed. Dualism as a possible worldview will be taken under consideration. Then the functions of tacit and reflective knowledge are elucidated for better understanding how personal knowledge works in the learning process. The nature of the learning process at farm level is introduced. One learning method that develops proficiency how to recognise qualities of sensory impressions as they appear during the soil study will be presented briefly. Finally future possible research directions are outlined. In the life of everyday learning processes at farm level the advanced process takes place within the human mind and nature, while the physical tools may be more or less simple. The documentation of soil fertility may call for new kinds of notations of observations that enables us to catch sensory impressions of soil consistency, structure, root development etc. This will make it possible to communicate knowledge that used to be tacit. Colleagues, advisers and researchers may join the local work at farm level with a deeper understanding.

BACKGROUND
Everyday learning processes have over time produced a huge body of practical knowledge where the tacit part is of fundamental importance. Farmers' ability to make observations finds expression in several different methods. Through milk testing chemical and biological properties indicate deviations from expected normal distributions. However measurable data do not yet replace sensory impressions and thoughts. It is still necessary to be among the animals to get to know them one by one with own eyes and hands. The situation is a little bit different talking about the soils. Many farmers do soil mapping. Through chemical analysis the contents of nitrogen, phosphorus and potassium are known. Rate of acidification and lime requirement of soil are also analysed. But that's it! Mechanisation and rationalisation of soil management have put the farmer further away from one's own plot of land sitting in a tractor listening to world news on the radio. What still is impossible to many farmers within animal husbandry, to reduce the animal into chemical properties, seems to be more accepted when it comes to cultivate the soil. In the 1950s in Sweden it was unthinkable to leave the field without cleaning the tractor wheels from top soil. Today you find tracks of top soil left by the farmer on the road. In modern farming the technology is rapidly developing. Through new innovations the possibilities to document the local resources are increasing. Field properties can be mapped during harvesting, ploughing, fertilising etc. using global positioning systems (GPS) to determine position of data in the field. This kind of new technology, precision agriculture, is aiming at a site-specific management of the field (Robert et al, 1998). What kind of knowledge is developed through the use of these high technology methods? Spades for digging, pickaxes, spits, shovels and hands are antiquated and replaced by excavators. However methods where we by hand investigate the soil are rare, but nevertheless they are important (Batey, 1988; Görbing, 1947a; 1947b; Hamilton, 1995; Peerlkamp, 1959; Preuschen 1987; Sobelius, 1995). In this article this will be further elucidated.

EMBEDDEDNESS OF KNOWLEDGE
Different Epistemologies
There are different approaches to reality. In the following focus will be on the concepts of thought / matter and subject / object to describe six different epistemologies relevant to the discussion about rate of embeddedness at farm level. The first three views place their emphasis on 'matter' i.e. the material which makes up the world and everything in space which can be seen or touched, as opposed to thought or mind (Procter, 1978). They conclude in different ways that all our knowledge is derived from experience. Their beliefs are grounded on hard scientific data and they do not want to understand phenomena as thoughts, feelings and wills as more than secondary qualities emanated from and totally dependent on complex and dynamic interactions between atomic and

molecular structures. The latter three epistemologies start with the 'thought' instead. In addition there are also differences in how the relation between subject and object is perceived (figure 1.). According to John Locke there are no innate ideas or principles. Ideas are derived from two sources (a) sensation, and (b) perception of the operation of the mind. Since we can only think by means of ideas, and since all ideas come from experience, it is evident that none of our knowledge can antedate experience (Russel, 1946). This is Locke's doctrine - the mind is a tabula rasa. On the contrary Maturana and Varela (1998) argue that all knowing depends on our biological and social structure. Humans and their environment are coupled with each other structurally and operate reciprocally. The nervous system selects the structural changes that permit it to continue operating in the environment i.e. guaranteeing a survival. However we can not separate our history of biological and social actions from how this world appear to us. Thus our nervous system does not function completely in a vaccuum. But it does not operate with representations of the world. It functions from moment to moment as a definite system with 'operational closure' i.e. a closed network of molecular changes within itself. In this manner worldviews are constructed through never ending interactions between subjects and their environment. Still there is a difference between subject and object. Bateson (1988) does however go one step further when he claims that the evolutionary dynamics and the human learning process (including our thinking) are two sides of the same coin - both stochastic processes! These two stochastic systems working at different logical levels fit together in the one and only continuously developing biosphere. Mind and nature are a necessary unit. Instead of a world of objects Bateson perceives a lot of complex networks at different levels where the organisation of matter is the most primary thing. Everything is more or less integrated and connected and no absolute distinctions are drawn. Hence a subject who feels deeply involved in its surroundings without perceiving any absolute distinctive difference with other beings may not be ruthless. Bateson somehow creates a great mix of holism in a world governed by a random hand.

MATTER	1. Locke *empirical*	2. Maturana & Varela *matter constructive*	3. Bateson *random holistic*
MIND	4. Descartes *discursive*	5. Goethe *intuitive*	6. Merton *contemplative*
	SUBJECT- OBJECT		SUBJECT- SUBJECT

Figure 1. Different Approaches to Reality

Descartes is the founder of modern philosophy (Russel, 1946). His outlook is profoundly affected by the new physics and astronomy. Descartes' sentence 'I think, therefore I am' ('je pense, donc je suis'; 1637/1967) gives the mind an exceptional position related to matter. Mind seems to be more clear and certain than matter, without any extension but with the thinking quality. In philosophy and mathematics, his work was of supreme importance. A gradual progressiveness from one thought to another linking up to a whole train of thoughts is the way of understanding that Descartes chooses. Here this way of understanding will be called *reasoning understanding* (figure 2). Following his thread of thoughts his spirit is found in works as Karl Friedrich Gauss', John Couch Adams' and Jean Josef Leverrier's whose mathematical and very precise calculations led to the discoveries of the celestial bodies Ceres and Neptune. *Intuitive understanding,* on the other hand, arises according as one is capable of keeping manifold thoughts imperturbable, but interwoven into each other - simultaneously (Larsson, 1912; 1920). An interpretation of this is shown in figure 2. Life is only understood when observed objects are put into a context. Since no relations can be found between objects through pure sensory or instrumental observations their source of context must be found somewhere else. The source of context is found, but only within and through the thinking process and nowhere else. Hence all that order possible to study is related to thinking processes. In fact thinking processes are literally penetrating and ruminating nature discovering its object related thoughts. During the very concentrated sensory observation of objects their contextual relations will be unmasked by intuitive understanding. In modern science statistical methods are used (Dunn & Clark, 1974) that partly "replace" intuition. Multivariate strategy is the most advanced statistical tool (Wold, 1981; Wold et al, 1987). It is said partly because in the end it all has to be interpreted by intuitive understanding. These statistical ways of linking objects can be denoted as advanced statistical understanding. Goethe, working in an intuitive

way, minted the words 'thinking observation and observing thinking' ('denkend anschauen und anschauend denken') and he meant that a judgement formed according to this was preferable (Steiner, 1979). Goethe criticised Newton and his colleagues to be too narrow-minded when choosing methods to study the nature of colours and light. He thought they were conducted by the wish to find simple mathematical descriptions of their experiences making their experimentations more to verify their hypothesises than to get to know more about the phenomena themselves. Goethe presented his own theories about colours and light and did this in an interdisciplinary way (Goethe, 1979).

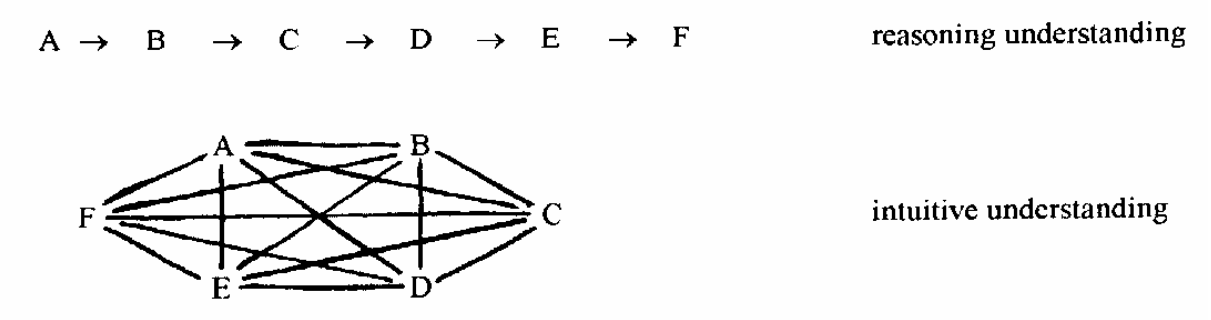

Figure 2. Different concepts of the relations between the thoughts A, B, C, D, E and F; reasoning and intuitive understanding. Intuitive understanding is like building a crystal of interrelated thoughts.

Stinissen (1979) says that it is necessary to know things in their original state without always mixing it up with own judgements, memories, earlier experiences, expectations. In other words contact with things must not only go through 'perception'. It is important to rediscover the 'original sensory impression'. Through perception things are recognised, judged, put a label on and limited to their objective matter of fact. Perception is a subject - object relation: 'I am the subject, the things is the objects. These objects are in my service, they can enrich me. Everything is going on in the sphere of having ('la sphère de l'avoir': Gabriel Marcel). I appropriate the things increasing my property to my benefit and success in the world'. This is of course in one sense legitimate, the things do have a dimension of pragmatism: they are the material which people ought to work with to develop their life in this world. But the things are not only a matter of fact. And it is precisely in the pure sensory impression that there is a possibility to drive towards a deeper layer. The things belong to the being life. Every *thing* says something about the being life in its own way. The things must again let to be revealed in their complete 'relativity': 'You can see how the things entirely are 'relations', how they refer to another, to somebody. The things are no longer clearly demarcated, no longer opaque but transparent. The dead things become living, the dumb things begin to speak. Everything gets a face, everything has eyes and mouth, everything comes to meet us as an *you*: subject meets a subject'. Stinissen prefer to describe this approach as *objectless meditation*, but more usual the term *contemplation* (Merton, 1987) is used.

Rate of Embeddedness

Following two assumptions about embeddedness define what is meant when using this concept in this article. Firstly – the *mind* is more embedded in humans than *matter*. For instance – thoughts about matter precede matter itself. Secondly – looking at the relation mind-environment as a *subject-subject* relation embeds the mind more in its environment than when a *subject-object* relation is chosen. Referring to the six epistemologies and figure 1 this means that the highest rate of embeddedness is found by the 'contemplative approach' and the lowest rate by the 'empirical approach'. Thus in figure 1 the rate of embeddedness is illustrated through a six graded scale where 'number one' resembles the lowest and 'number six' the highest rate of embeddedness. *Hence to develop knowledge with a high rate of embeddedness at farm level we ought to use adequate technologies and methods that promote our intuitive and contemplative skills, know-how and competence.*

The Illusion of Dualism?

The epistemologies given as examples in figure 1 show the possibility of dualistic worldviews. According to Descartes mind and matter are of completely different nature. But does this automatically lead to the conclusion that our world - in reality - is dualistic? Malebranche (1674-75/1946) tries to connect the thoughts of Descartes with Christianity especially the writings of Aurelius Augustinus. God becomes the link between mind and matter and the cause of all physical dynamic. Leibniz (1695/1927) does not like this kind of mixing mind and matter. Instead he presents the idea of the *predetermined harmony*, where there is no connection between mind and matter. But because of God the functions of mind and matter work in a parallel way, so thoughts always match what is going on in the physical world. Spinoza (1677/1843) solves the problem in a different way. He intro-

duces the concept *substance* and means that there is no other substance but one. But this substance has different attributes depending on how it is experienced and described. Thus matter and its properties are more dependent on for example the way science chooses methods for investigation. By different kinds of observation methods different kinds of sets of data are created. In this way parallel worlds are created. There are no links (in reality) between these 'apples and pears'. For instance - a special feeling can never be the real cause of a chemical reaction in the body. But the one and only substance shows dynamics that can be observed as feelings or chemical properties depending on way of looking at it. When deciding to reduce the substance to measurable properties trying to formulate a hypothesis about its nature, one kind of picture will be given. Parallel to this investigation it is possible to study other attributes of the substance – perhaps sensory impressions, thoughts, feelings, wills etc. But then the picture will be different, but only the picture of the substance, nor the substance itself or the world will be altered because of the choice of observation methods. According to Spinoza mind and matter are only different human constructions resulting in different pictures of the only substance. If the only substance is named God or not, drawing to Descartes the central role of thinking can be concluded. And perhaps it is possible to see how Descartes, Malebranche, Leibniz and Spinoza should come to an agreement. Seen through the Spinoza lenses all epistemologies in figure 1 are very well fitting together if matter is looked at as just another level of consciousness – a secondary level. The dualism is just an illusory belief. Maturana and Varela studying neurobiology about perception and the theory of mind rather talk about a duality than dualism saying (1998) that language 'was never invented by anyone only to take in an outside world. Therefore, it cannot be used as a tool to reveal that world. Rather, it is by languaging that the act of knowing, in the behavioural coordination which is language, brings forth a world' i.e. the concept of dualism must be a result of 'languaging'. The only way to reveal an "outside world" is to be conscious about its 'languaging' origin from the concept of dualism. By using the language in a special way dualism in the world was created by humans. Being aware of this makes it possible to join a more direct and natural way of communication with life itself. The huge difference between reality and its measurable aspects can also create the feeling of being simultaneously living in two qualitatively different worlds. A 'wall' of measurable data information inhibits a true and clean dialogue with life itself. An example of this is: how to know the clay content of the soil? When a soil sample is analysed in a laboratory the percentage distribution of different soil textural classes will be the final result. *Based on these textural properties the soil will be put into its own class using the classification system arisen from laboratory analysis and measuring methods* (Ekström, 1927). There has been an interest to develop field methods matching these laboratory classifications trying to decide the percentage of clay in the soil. However the farmer might be more interested in the structure of the soil and its consistency. Because both structure and consistency are basic properties when deciding what cultivation measures are the most appropriate. *The soil structure and consistency are also properties within the field of farmers' world of experiences possible to get to know through sensory impressions.* To get to know one's soil is one thing and to decide the percentage of clay is a totally different one. The instrumental observations may tempt us to ask questions and develop intellectual structures that in spite their glorious appearances do not help the farmer at farm level very much.

TACIT KNOWLEDGE AND REFLECTIVE KNOWLEDGE

Knowledge can work in a tacit way i.e. without having articulated it. Sometimes it is difficult to find the words to express inner feelings and thoughts. Nevertheless they affect the way of acting. Since the language is an expression of how the world is interpreted and in that sense is the way that culture makes a hypothesis about reality, new experiences will call for new words. In the meantime - before having found or invented these very much wanted articulations - tacit "words" in the mind will guide through everyday experiences. These unspoken words are examples of tacit knowledge. How does tacit knowledge at farm level look like? Through symbols or other kinds of notations knowledge can be articulated and be learnt more. When tacit knowledge is successfully articulated it will be possible to spread, to criticise it and expand it. One good example is the articulation of music through adequate notation (van Beethoven, 1804). Polanyi (1958) argues that cultural knowledge mainly develops through articulation and reflection of tacit knowledge. The main logical difference between the two types of knowledge is the ability to critically reflect on what have been explicitly presented compared to thoughts only visible in the tacit consciousness. Reflected knowledge is knowledge made to the focal point through articulation so as to be undertaken logical operations to interpret, analyse, specify, compare or criticise making it possible to draw conclusions (Rolf, 1991). Reflection presupposes intellectual fellowship. The typical human development of knowledge needs language, culture and social interplay. Is the current language at farm level sufficient and appropriate?

Practical Knowledge

Practical knowledge is grounded on rules with a tacit function. Polanyi (1946) distinguishes between two degrees of practical knowledge where elementary and qualified practical knowledge respectively constitute the extreme points. Rolf (1991) summarises these two aspects in the following way:

	Elementary Practical Knowledge	Qualified Practical Knowledge
1.	Knowledge management is conducted by strict rules. Rules can be formulated rather unambiguously.	Knowledge management is grounded on rules which are difficult to formulate, are ambiguous and must be adapted to the situation.
2.	Knowledge creates ability to solve routine tasks in a predictable and stable environment.	Knowledge presupposes creative thinking by oneself as a cause of others creative thinking. The situation is hard to predict and is unstable.
3.	Knowledge can be transmitted as instructions and information which cover present situations.	Knowledge must be transmitted as real examples, which test the knowledge transmitted by the master.
4.	Instructions can be made through a central specific authority, which takes care of innovations and new interpretations.	A universal and diffuse authority arises through the co-ordination of individuals due to probation and judgement.
5.	The authority only is assumed to have knowledge and authorisation necessary for innovation and new interpretation.	Knowledge and normative authorisation for innovation and new interpretation are spread among those who exercise knowledge.
6.	Knowledge of the individual means to conform oneself to the strict rules.	Knowledge and authorisation of the individual are embedded in a professional conscience combining innovation and criticism.

Is the practical knowledge in the agricultural systems of today mainly elementary or qualified? Who decides? Who is bothering? Where is new knowledge created?

There are three different types of practical knowledge: *skill*, *know-how* and *competence*. Rolf (1991) gives the following definitions. Skill is practical knowledge following given rules, where the success of following the rules can be judged without any reference to other judges but the actor performing the action. Know-how is practical knowledge following given rules, where ultimately the success of following the rules only can be judged by other judges than the actor performing the action. If it is stated that actor A has competence within field F, then

a) There are within the field certain rules or criteria of quality distinguishing a well performed action from a worse or badly performed action
b) These rules or criteria are deeply rooted among actors within the field. Their judgement decides what is a good or bad performance.
c) The actor is able to perform according to these rules because of his or her tacit knowledge about these criteria or rules.
d) The ability of the actor comprises management of symbolic, theoretical and reflecting elements or elements of criticism.
e) The actor can use the reflecting elements to affect the criteria of quality within the field in a predictive way.
f) This affection improves the rules – through certain latent rules – more than otherwise.

Personal Knowledge

According to Polanyi (1940; 1946) personal knowledge ties together the individual with her culture, i.e. individual experiences, feelings and interests claim to have validity in a social context. The individual creates cultural objects for instance within science and arts. The culture gives the individual tools through personal knowledge that increase her ability to understand and aesthetically enjoy the reality she herself partly has created. The individual is born into a matrix of traditions formed by unknown authorities through generations. This matrix affects language, routines, actions etc. What possibilities exist to test the soundness and value of one's own culture in a thorough way? It is important to be conscious about the sources of personal knowledge – the personal cognitive structure. This is the reference framework built up by personal experience to interpret and understand life. Here the concepts of Kolb (1984) and Jean Piaget and J P Guildford drawing to Hård af Segerstad et al. (1996) are used (figure 3). Kolb describes learning as a cyclic process in four steps: *concrete experience*, *reflective obser-*

vation, abstract generalisation and active experimentation. The point is to integrate the context of concrete experiences through reflective observation with abstract generalisation, i.e. generate a hypothesis. If this hypothesis does not yet exist it must be created. The hypothesis is tested by active experimentation and is evaluated - either accepted or rejected. Kolb focuses on the hypothesis coming into being and its death. Piaget rather emphasises what is happening with our thinking and personal cognitive structure when accepting (*assimilation*) or rejecting (*accommodation*) a hypothesis. Finally Guildford describes the character of the thinking process after rejecting a hypothesis (*divergence*) until a new hypothesis is created (*convergence*).

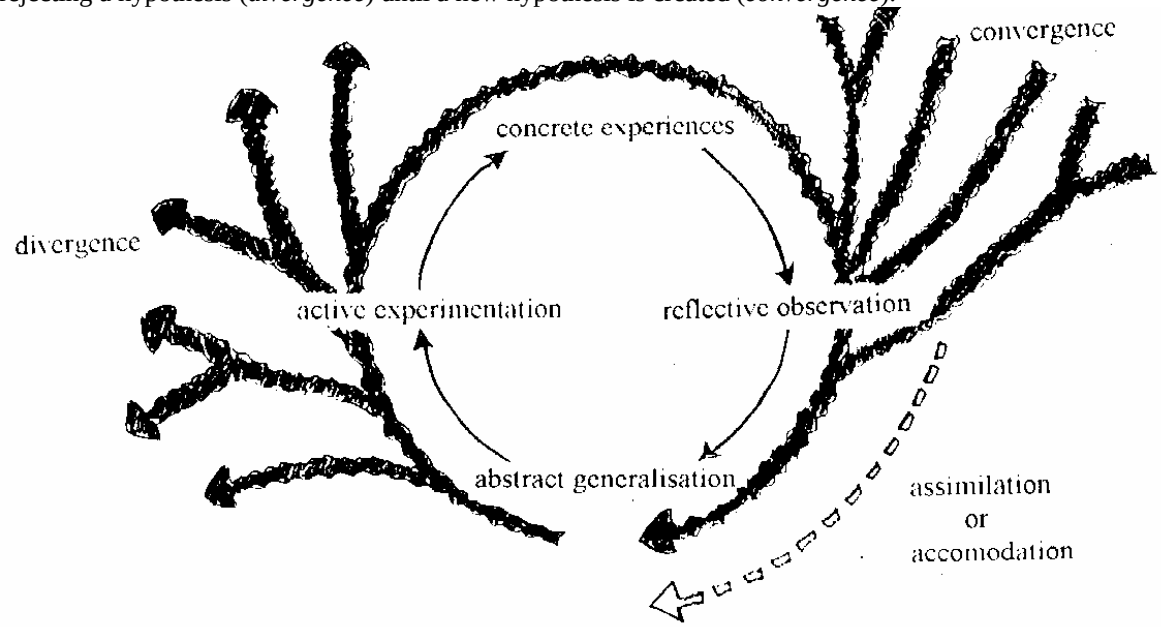

Figure 3. Learning process from the points of view of Kolb, Piaget and Guildford.

Hence the learning process or object management may start with concrete experiences. These concrete experiences lead to a reflective observation. The fruit of reflective observation is the hypothesis. If the hypothesis fits into the present personal cognitive structure there is an assimilation. If not, there is an accommodation - the cognitive structure must be altered. The thinking must be divergent, i.e. new aspects will be taken into consideration and from new points of view the thinking converges the manifold of hypothesises into a new personal cognitive structure which will be tested by new experimentations. If these generated concrete experiences confirm the hypothesis it will be assimilated in the new cognitive structure. The divergence and convergence of Guildford will only be activated when the accommodation by Piaget is demanded. By assimilation new active experimentation may challenge the current hypothesis. If new concrete experiences challenge the basis of the personal cognitive structure we talk about a shift of paradigm.

The learning process is individual but can be shared, during favourable conditions, with other individuals generating collective understanding. It can be shared in at least two ways. Usually the individual researcher writes a report where the background thinking (leading to adequate questions), methods, results, discussions and conclusions are presented. By reading this report colleagues within the same discipline can share the presented understanding. Secondly a group of researchers may go through a learning process together. Working with social issues and depending on whether the researcher just makes observations or actively takes part in the social processes being studied we talk about pure research and action research (King et al, 1999) respectively. If the action research is successful the researchers can 'hand over the stick' to the participants who continue the learning process by using a whole range of PRA tools (Chambers, 1992). Embedding scientific and local knowledge in the life of everyday learning processes at farm level demands institutional arrangements that empower people through the use of adequate tools, tools that are available, and once learnt, independent of farmers inputs from outside.

LEARNING PROCESSES AT FARM LEVEL

To develop sustainable agricultural systems new research and extension approaches at farm level are needed. In general farmers experiment as an integral part of their farming activities generating site-specific information. Experiments are carried out for several reasons: by curiosity, to solve problems or to adapt unknown technology within a known environment or vice versa (Rhoades & Bebbington, 1991). The value of their accumulated experience plays an important role in their daily work. They rather adapt than adopt agricultural techniques to suit their individual circumstances (Sumberg & Okali, 1997). In sustainable agriculture the biological production should be, to the greatest degree possible, based on local and renewable resources. Therefore sustainable agri-

culture needs to develop practices that strengthen and develop the independent learning approach among farmers.

The arable soil is the cornerstone of a sustainable agriculture. Through the crop sequence a meaningful interaction is brought about between the cultivated plants and between them and the different soils. Together they are forming the conditions for animal husbandry. Thus the choice of domestic animals, number and kind, is a function of the farm soil and plant production. Hence all forage should, to the greatest degree possible, be produced in the fields of the farm. Finally the farmers are the ones who leaves their mark on the farms by composing the optimum mixture of soils, plants and animals. It is the farmer's own interest that there is knowledge about how the farm can be developed in the best way. Since the possibility of development to a large extent is limited by and dependent on local and renewable resources the farmer is suited for learning and developing new knowing since she is making observations every day on the spot. *Sensory impressions, intuition and contemplation constitute the main inner resources at farm level.* Thus in a sustainable agriculture the knowledge is made by the farmer herself, i.e. her power of observation and experience. It is important to study the potential of the local and renewable resources from the farmer's point of view. The duty of the advisor and researcher is in facilitating the farmer to elaborate the guiding principles of finding a conscious attitude to the inner resources. In a sustainable agriculture the research work at farm level is an obvious necessity where the farmer is the centre of attraction and with the advisor and researcher as the welcome support. Chambers (1989) emphasises the importance to empower farmers to learn, adapt and do better. Farmers do not need precepts, messages nor packages of practices to be adopted, but principles, methods and baskets of choices from which to select. But this is not enough. There is a need for new institutional frameworks in which farmers are embedded. But existing institutional structures mitigate against the new networks and institutions that are emerging in response to the challenge of a sustainable agriculture (Röling & Jiggins, 1998). Röling & Jiggins say 'the transformation to ecologically sound agriculture cannot be realised without struggle, as new actor networks emerge and undermine the power of others. To be effective, policies will need to address this issue explicitly'. *To what extent is this a struggle between different epistemologies?*

To Hand over the Stick

When the adviser and researcher want to facilitate the farmers' learning process it is important to use methods that are possible to embed in the everyday life at farm level. Otherwise it will not be possible to "hand over the stick". It is not enough if the learning methods allow the farmer to make own observations. Also the technology used as learning tool must be adapted to the general level of development. Thus one learning technology suitable in one place may not necessarily be it in another. The farming context is decisive. The rainfall simulator for instance (Hamilton, 1995) is a good example of a pedagogic method adequate in the Australian context. Other technologically simpler on farm methods are such as soil corers (Foale et al, 1994) and the spade diagnosis method (Görbing, 1947a; 1947b; Preuschen, 1987; Sobelius, 1995). Batey (1988) and Peerlkamp (1959) do only need an ordinary spade. The spade diagnosis method develops proficiency in learning how to recognise qualities of sensory impressions as they appear during the soil profile study. The plant root development and the soil structure are studied in the top soil and upper sub soil. Attention is paid to the closer relation between soil fertility and yields of plant production. Only a few tools are needed when making the spade diagnosis. The most important tool is the diagnostic spade made of flat steel and it is very easy to construct. Spade diagnosis works as an example to illustrate an attempt and possible way for future methodologies helping the farmer to adapt his measurements to the everyday life.

At the risk of loosing oneself into details or missing essential objects when making a spade diagnosis a systematic documentation is required. By means of a notebook and camera it will be easier to remember the soil profile the following years. The careful study of the soil profile is made of different aspects:

1. Coarse structure (soil type, horizons, moisture content and density)
2. Fine structure (crumbs, aggregates, size and degree of hardness)
3. Roots and soil animals (ramification, root hairs, nodule bacteria and earthworms, insects etc.)

The careful study of the soil profile is further documented with adequate notation, i.e. symbolising a wide range of sensory impressions of the soil properties, to make a material of comparison. Notations of soil consistency are shown as an example in figure 4 (Sobelius, 1995) following the FAO (1990) guidelines. To document the soil colours Oyama & Takehara (1992) have developed a handbook with colour charts.

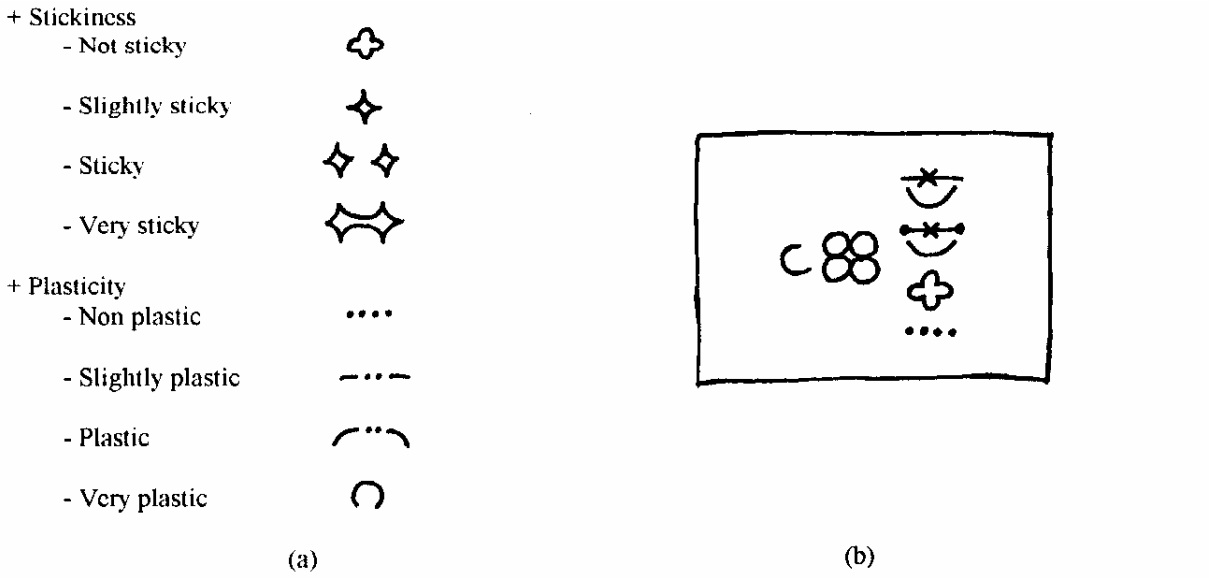

Figure 4. (a) Notations of soil consistency when wet; stickiness and plasticity (b) Example of documentation of just a few different soil properties; type of structure (ex. granular), size class of granular structure (ex. fine) and soil consistency when dry (ex. slightly hard), moist (ex. firm) and wet (ex. not sticky, non plastic). To picture the soil in this way it will be easier to remember its properties for future comparisons (following FAO, 1990; Sobelius, 1995).

The documentation results in a 'living and crystalline' picture of sensory impressions with matching and adequate thoughts (compare A, B, C, D, E and F; figure 2) making it possible to remember their interrelations building a crystal of intuitive understanding (figure 2). Returning to the same place in the field, year after year, repeating the documentation there will finally be a sequence of pictures. These pictures of intuitive understanding will, like a movie, show the dynamics of soil processes embedding the farmer's mind into them. This will guide and help the farmer to improve practical knowledge and to find optimal cultivation measures. The development of an adequate notation is an important part of the work with the spade diagnosis method. All scientific development implies a language i.e. a social process making it possible to discuss the things observed. Then the concept formation can be developed in a successful way. In the work at farm level the design of the notation is essential. What is convenient for the farmer? Okali et al (1994) say 'If farmer participatory research is to make a significant contribution to the establishment of a dynamic, collegiate interface between formal and informal research, new conceptual frameworks and methods that permit the description and analysis of local experimentation and information exchange will be required'. Is the notation in figure 4 an example of this? This must be further evaluated in the ongoing work at farm level. - The notation is a tool, and it is important to be conscious about that. However, notations sometimes totally dominate what are in our focus. Its original function is then forgotten i.e. the symbolising one. Measured data also represent a sort of notation decided by our use of measuring instruments. In science notation too often is believed to be more truly than reality itself. But any notation is just a possible attribute of the only existing substance, drawing to Spinoza (1677/1843).

FUTURE RESEARCH DIRECTIONS

To survive people very early understood the necessity of understanding life processes in their environment. In the beginning they probably did not reflect upon learning processes at all. Life itself was a given thing and man was just a string in its web. The understanding and knowledge about the whole living system was embedded in the everyday life as the sunbeams and raindrops. However different religious traditions and beliefs describe the human nature to be responsible of taking care of nature. Originally these views were felt to be good descriptions of experiences made in the communications with spiritual beings. Thus the very first teachers may not have been humans. But of course from a materialistic point of view human knowledge and learning processes are the result of trial and error and lots of patience. Is it possible to describe materialism as the fruit of having lost contact with the spiritual dimensions of life? Is time ripe to add new perspectives into traditional agricultural sciences? The COMPAS network for comparing and supporting endogenous development is an interesting example. It began in 1995 when NGOs and universities in India, Sri Lanka, Ghana, the Netherlands, Norway, Mexico, Bolivia and

Peru agreed to take a fresh look at the farming communities they were working with. It seems to be a challenging approach 'taking the cosmovision of the rural people as a point off departure for development' and 'taking spirituality seriously' (Haverkort & Hiemstra, 1999). Discovering the central role of thinking perhaps a new way towards a very deep-going reunion between human culture and environment can take place. Do we see farming as an opportunity to learn how to communicate with life itself? And what appropriate methods do we have? Finally our epistemological approach will be decisive.

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