

## FutureFarm vision

K. Charvát, P. Gnip, W. Mayer

WirelessInfo, ProGis, Litovel, Czech Republic

### Abstract

This paper defines the first version of a vision of Future Farming project and also a knowledge management system used by European farms which will be designed and developed by the Future Farm project. An important part of the vision is a definition of external drivers and their influence on farm business in future. Paper is looking on a situation in three periods: short (2013), middle (2020) and long-term (2030). Our vision expects that the farming system will continuously converge to the situation of two types of farm: an industrial farm, which will guarantee both the food safety and the food security for European citizens, and multifunctional farms focused on environment protection. The recommendation proposes an architecture based on communication of interoperable services, so called Service Oriented Architecture (SOA), for easy integration of different levels and components of farm management.

### Key words

Farming, external drivers, future vision, knowledge management, SOA

### Anotace

Tento dokument definuje první verzi vize budoucnosti Evropského zemědělství a znalostního managementu v zemědělství, jak který je navrhován a vyvíjen v projektu Future Farm. Důležitou součástí vize je definice externích driverů a jejich vlivu na hospodaření zemědělských podniků v budoucnu. Článek předpovídá situaci ve třech obdobích: krátkém (2013), středním (2020) a dlouhodobém (2030). Vize předpokládá, že v zemědělství budou v budoucnu vznikat dva typy podniků: průmyslová hospodářství, které zaručí jak dostatek potravin tak jejich kvalitu pro evropské občany a multifunkční hospodářství, která budou zaměřena na ochranu životního prostředí. Doporučení navrhuje architekturu založenou na interoperabilních službách, tzv. Service Oriented Architecture (SOA) pro snadnou integraci různých systémů a součástí řízení zemědělských podniků.

### Klíčová slova

Zemědělství, externí vlivy, vize budoucnosti, znalostní řízení, SOA

### Introduction

In order to build a vision for future knowledge management in arable farming, there were analysed examples of existing knowledge management systems and also drivers, which will have a potential influence on agricultural sector in future. The objective of knowledge management is to help farmers to be competitive on the market in the sense of required products, quality and amount, to be able to react on changes on the market, changes in subsidies systems, requirements about the environment protection, but also to be able to react for example to increase of inputs costs or to climatic changes. It is also important to produce sustainability of the farm in a long term, to protect soil as the main mean of farming production.

Within the Future Farm project, a trans-European investigation has led to the definition of the key objectives needed for realization of this vision of a new concept of farming knowledge management respecting changing conditions and demands.

As a result of the Future Farm analysis we can recognise next groups of drivers which will have an influence on farm management and which could also eventually stimulate a new demand for the knowledge management:

Climate changes

- Demography (Growing population, Urbanisation and land abandonment)
- Energy cost

- New demands on quality of food (Food quality and safety, Aging population and health problems, Ethical and cultural changes)
- Innovative drivers (Knowledge based on bio economy, Research and development, Information and communication, Education, Investment)
- Policies (Subsidies, Standardisation and regulation, National strategies for rural development)
- Economy (Economical instruments, Partnerships, Cooperation and Integration and voluntary agreements)
- Sustainability and environmental issue (Valuation of ecological performances, Development of sustainable agriculture)
- Public opinion (Press, International Organisation, Politicians)

A result of the knowledge system analysis is a division of knowledge management systems into three levels:

- Macro level, which includes management of external information, for example about market, subsidies system, weather prediction, global market and traceability systems, etc.)
- Farm level, which include for example economical systems, crop rotation, decision supporting system.
- Field level, including the precision farming, collection of information about traceability and in the future also robotics.

Future farm knowledge management systems have to support not only direct profitability of farms or environment protection, but also activities of individuals and groups allowing an effective collaboration among groups in agri-food industry, consumers and wider communities, especially in rural domain. Having these considerations in mind, the proposed vision lays the foundation for meeting ambitious but achievable operational objectives that will definitively contribute to fulfilment of identified needs in the long run. From the level of cooperation or collaboration requirements, the knowledge management systems could be split into two groups:

- Groups of individual farmers that cooperate and share machines or also workers - e.g.

organized with the help of cooperatives as there are machine cooperatives

- Supply chain management itself - that means also when a chain management of car industry is much easier than a chain management of farmers, it has to be organized also with the help of IT in the future. The farmers, partners of farmers organized in cooperatives, than partners of the farmers, who deliver input to the farm and buy products from the farmers have information needs that have to be covered by chain management structures. Today, farmers have to document lots of information to different stakeholders of the market:
  - Ministries for subsidies or government bodies for several other tasks,
  - Buyers of food products from a farm need to get documents to allow them to follow the farm-to-fork legislation;
  - It is expected that in the near future (2010), farms producing biomass will have to document information for the biomass industry for reasons of sustainability.

### Rationale

The agriculture sector is a unique sector due to its strategic importance for both European citizens (consumers) and European economy (regional and global) which, ideally, should make the whole sector a network of interacting organisations. Rural areas are of particular importance with respect to the agri-food sector and should be specifically addressed to this scope. As in no other sector, there is an increasing tension among requirements to assure a full safety and keep costs under control, but also to assure the long-term strategic interests of Europe and worldwide. The balance between food safety and food security will be important task for future farming worldwide, but also for farming knowledge management. Complexity arises both with regard to the production itself, taking into account its diversity and perishable nature of food products, which is much higher than in many other sectors, and the very nature of the sectoral networks. Knowledge management systems for generation of homogeneous information for traceability transfer and business as well as integration and management of such information are thus specifically complex issues in this sector. Therefore, the challenging problem is twofold.

Firstly, how to assure the full security and safety of products, but minimising costs. Secondly, how to provide benefit to the food sector networks of organisations enabling them to interoperate, to exchange information and data and to fully integrate miscellaneous business functions along the value chain. These problems (partly valid for a number of other sectors) are increasingly becoming critical and difficult in the agri-food sector (due to complexity of full traceability and minimal margins).

The farming sector doesn't play only a role of food producers, but there are also other tasks or challenges of farming sector. The most controversial issue in last years is a bio energy production. The last year's experiences open many new questions about bio energy production, and it is clear, that current methods of bio energy production are not able to guarantee the long time sustainability of food production. There are clear requirements for innovation and mainly new development in knowledge based bio economy.

Other important aspects of the farm decision are, if it is better for a farm to be oriented on food or non-food production, or on non-production farming activities as agro tourism, or any combination of it.

An important question is also the environmental role of farming. The farming could positively or negatively influence the landscape, but, there is also an influence on water protection, soil protection and on CO<sub>2</sub> production. These all are interests not only of farmers, but all society. So, there is important, who will pay these costs, and how it will be valorised to farmers.

### The domain

The objective of the vision and its subsequent implementation is to investigate, develop and facilitate the uptake of a set of most demanded innovative knowledge management solutions and tools that will facilitate a transformation of arable farming into competitive and dynamic knowledge-based networked organisations. By this, agriculture production will be better adapted to the changing conditions of the knowledge based economy being capable of sustainable growth, generating or maintaining more and better jobs and greater social cohesion. Vision results will enable efficient knowledge creation; sharing and exploitation

thought collaborative activities involving the whole value chain of agri-food companies, a paradigm of networked organisations. In addition to this and, through the development and implementation of such tools, the Future Farm will also provide European Leadership, in a response to this challenging problem: safe, integrated, traceable European Food including traceability systems combined/ embedded in the other business applications and taking into consideration wide variety and richness of EU regional, national and local food products. The application of the knowledge management solutions to the rural and very specifically in the food domain will enable all European citizen consumers to benefit from and participate in the Information Society.

### Tasks for Knowledge management

As it was already mentioned, over the next 20 years, rural Europe will have been radically transformed in terms of the distribution of people and of economic activity within its regions. These changes are inevitable and many forces conspire to bring them about. The common and future position of each important driver can be different in reality; in many cases two drivers can stay against each other and their future influence on Agri-production and food market depends on regulations and common policy. For example:

- Food quality and safety ↔ Food requirements for growing population
- Growing requirements for food ↔ Renewable energy production technologies
- Renewable production energy demand ↔ Demand on more environmentally friendly production

To be possible to overcome these problems, it is necessary to define new methods of farm management which will look for optimal solutions in changed conditions. As it was already mentioned in this document, the main decision has to be provided at the level of single farm. For instance: the decision about production in regions/countries etc. Could it have a negative influence on market? - if all farmers change their behaviour at the same time, it could have a negative influence on the market (for example, two or three years ago, a large orientation of all farmers lead to a deficit of food on the world market).

## Vision of farm of tomorrow

### 2013

It is expected that the process of WTA negotiation will be closed during this period and a common agreement about free market with food and agriculture product and about subsidies systems will be defined. Also in the year 2013, it is expected a CAP reform in which new regulations will be introduced. But both of these facts will not have direct influence on farming till 2013.

Currently, the aim of the CAP is to provide farmers with a reasonable standard of living, to provide consumers with quality food at fair prices and to preserve rural heritage. To enable an average mid-sized European farmer to compete on the world market in a populated region with a high demand on the environment and on environmental products, these products have to be evaluated and must become part of the farmer's income. Until 2013, a revision of currently used economical instruments for managing agriculture production is expected. All these processes, which are necessary, could be delayed by the current economical crises by two or three years, but in principle, they have to start. But for the vision of farm of 2013 it is necessary to consider the current regulation of rural development policy for 2007 to 2013. It is focused on three themes. These are:

- improvement of the competitiveness of the agricultural and forestry sector;
- improvement of the environment and the countryside;
- improvement of the quality of life in rural areas and encouraging diversification of the rural economy.

For Europe, no big urbanization impact is expected until 2013. Land abandonment will slow down because of the higher prices and the return to using land more intensively. The temporary following scheme with payment for set aside of the past will disappear. In the short term period, the food safety will be increased by the wide adoption of organic farming and integrated crop management approaches. The importance of specific food production for aging populations with specific diet requirements will grow. There will be requirements for more fruit and vegetable production. And already in this period agriculture production will

need to respect cultural and ethnical diversity. The percentage of population, which requires specific products, is growing.

Influence of climatic changes in this period on production will not be so dramatic. Probably, there could be growing problems with draught in south part of Europe, which we experience already now. On the other hand, there will be growing push from public opinion on changes of agriculture practices. It is related with a current discussion about human influences on climatic changes. Other aspects, which will be subjects of public discussion, will be GMO, food safety and security problems and energy production. There will be a task for research community to provide serious research in this area, but also provide public awareness of these facts and results of research.

The different demands for the food safety – food security – energy production will require increase link between research and production. The transfer of new knowledge and methods to production will start. New approach called Knowledge Bio Economy (KBBC) will address major challenges beyond growth and employment:

- The growing demand for safer, healthier and higher quality of food;
- The increasing risk of epizootic and zoonotic diseases like avian flu, and food related disorders, such as obesity, and the need for successfully preventing these;
- Threats to the sustainability and security of agricultural and fisheries production resulting in particular from climate change.
- The growing demand for sustainable production and use of renewable bio-resources for eco-efficient products;

The process of farm diversification will continue and generally we can define three types of farms which will dominate over European agriculture:

1. Multifunctional farms
2. Large-scale industrial farm production of food or energy
3. Farms with focus on specific production like bio production or production of foods for specific groups of consumers

### **Multifunctional farms**

The main characterization of this farm will be to support energy efficient production, ecologically friendlier, to play a social role in countryside, to form the countryside, non-production functionality like tourism and protection of cultural heritage. This multifunctional farming will be the main direction of farming in less favoured areas, but also in tourist destination, mountains, coastal zones etc. The key issue for multifunctional farm will be the economical sustainability; to create an honest and open dialog among small number of farmers and big majority of EU citizens in other jobs. Without agreement of all society and without an economical valuation of non production role of farming sector it will be difficult to guarantee the economical sustainability of multifunctional farms. In typical tourist destinations it will be probably easier to introduce multifunctional farming, because the role of farm sector will be important for landscape and will be easy to generate a profit for farmers. Typical examples are for example Austrian Alps.

### **Large scale industrial farms**

The focus of this farm will be on introduction of newest results of research in the area of KBBE, but also using of new decision supporting systems and precision farming. This type of farm already exist in some new member states, but also for example in north of Italy. The existence of this farm will be important for Europe to guarantee the food security. With the future growing demand for food worldwide, it will be necessary to guarantee European competitiveness. It is expected that till 2013 this type of farm will be subsidized, but the level of subsidies will decrease. The main border for production of this farm will be given by such standards like standards coming from the Water Framework Directive and also standards for food quality. The demand for food quality will probably grow more from the side of retailers, then from political decisions. So, the importance of economical instruments will grow. This type of farm can also play an important role in bio energy production in future, but to guarantee the protection of environment and food security, there will be necessary to define exact rules for bio energy production. An important issue for this farm will be also guaranteeing their long-term sustainable production; the main issue will be the soil protection.

### **Farms with focus on specific production**

The role of farm with focus on specific products like bio products will grow. The demand will be stimulated mainly by people with higher income, but also with people focused on alternative life style. The focus will be mainly on fruit and vegetable, but also on other crops. It will grow with growing population originated from other cultural conditions.

It could be expected, that at this time there will be two types of farm with focus on specific production. First will be around large agglomeration to supply fresh product to urban people or people from urbanized rural areas (villages around large cities) to guarantee fresh and high quality production. The second part of farm will belong more to multifunctional farms which will be managed by people with alternative life style or will be focused on tourism and other part of activities.

The main border for production will be given by quality standards. Also here it could be expected that standards given by consumer organization will be more and more important, then standards given by politicians. This will have strong an influence on activities during production and on ICT solution. So, the role of traceability tools and direct communication with consumers will grow.

Due the fact of specific of production, we could expect a complicated discussion, if this kind of production will be subsidized in the future. On the one hand, this production is environmentally friendly and negative environmental influences are minimized, but on the other hand, the main consumers will be people with higher incomes.

## **2020**

### **General vision of farm of tomorrow**

By 2020, the current food production methods will be unable to meet the worldwide food and energy demands of the growing world population and it will also have an influence on European farming sector. The food security will be a problem as larger parts of the world populations will start consuming at present developed countries' levels. We can't afford unsustainable production with the growing human population. The demand for food increases requirements for a better utilization of results of



research and for new management methods. Combined with advanced bioprocess engineering, the development of high performance crop plants is a key for this vision to become a reality. Crops will serve as factories for enzymes, amino acids, pharmaceuticals, polymers and fibres, and will be used as renewable industrial feedstock to produce bio-fuels, biopolymers and chemicals. Green biotechnology will be employed since conventional or smart breeding alone will probably not be able to provide the required increase in performance. It is anticipated that already by 2020, in addition to the then mature gasification technologies, the conversion of ligno-cellulosic biomass by enzymatic hydrolysis will have been a standard technology opening up an access to large feedstock supplies for bioprocesses and the production of transport fuels. Research breakthrough in the second generation of bio-fuels derived from lignocellulosic material will make bio-fuels production more competitive and without using food material. The medium term influence will be to have food products with higher nutritional values, reduced chemical contamination and more advanced traceability systems. In this period, the average age of populations will continuously grow. This generation will be more active than previous senior generations and will require specific diets. It is expected that the percentage of ethnic groups in Europe and US will increase. They will have an influence on specific requirements of agriculture and food production. Investments in high-value crops, high quality food products and new technologies in crop production will be the case in the medium term. In the medium term, the need for more food and for energy from crops due to the high prices of fuel will also boost R&D in Europe and worldwide.

In the medium term, climate change could benefit agriculture of higher latitudes by enabling the introduction of new crop varieties, increasing yields and expanding areas of land under cultivation. In certain lower altitudes, it will be probably necessary to focus on varieties that are more resistant to draught.

The new standards and regulations will require a strong cooperation with WTO, but also with food producers and markets. New standards will combine market requirements for food, with requirements for energy, but also the environmental

protection. Currently, it is difficult to judge the result of the CAP reform. There is a demand that subsidies should be made available for specific innovative investments and experiments aimed at increasing environmental performance of the farm, such as resource-saving technology (energy, water, etc.), renewable energy technologies, low emission stable systems, etc. With the CAP reform, national strategy will also be changed. It is expected that there will be a shift from direct payment to supporting environmentally friendly production and food safety.

The success of all measures to reduce the environmental problems and mainly to reduce the climatic changes effects will be revealed. Any success or failure will affect directly the farming practices and management of the farms leading to more agro-environmental measures taken by the states. By 2020 and further on, the effects on the climatic change will be clear and it is believed that more worldwide treaties will be enforced. The first environment valuation programs will start and failures will lead to restructuring and changes; as the environment is not a local or regional or national problem, this question has to be taken on a higher platform and must be discussed on a worldwide level. The economical instruments will strengthen reflect issues, such as healthy production, food safety and environment protection. Agriculture will largely adopt new collaborative models which will support not only sharing of resources, but also of knowledge. In the medium term, partnership agreements will be more widely used and will be specialized in different sectors, such as the production of energy crops where local industries will produce oil and bio-fuels as well as in other agricultural sectors mainly for industrial crops.

Diversification of three basic types of farm from previous period will continue and differences mainly between first two types will be deeper. In some way, diversification inside the third group will continue there and both directions will in some way converged to the first two groups.

### **Multifunctional farms**

The adaption to environmental production will continue, but it will strongly depend on valuation of ecological parameters. The guarantee of sustainability of multifunctional farms will be

necessary on the base of public dialog to pay their non-production role. The main paradigm will be a non-extensive production with focus on greenhouse effect. The main task will be to produce food in a sustainable way which meets the consumer's demands. The target will be a balanced use of agricultural products. (between food & bio-feed stocks, bio-energies), farms will produce their own fuels decrease their dependence on energy sources. Important parts will be of multifunctional farm tourism and consumptions of products directly on the farm.

### Large scale industrial farms

Large scale industrial farms will guarantee European food security. Because the subsidies for this type of farm will be dramatically reduced, it will be necessary to discuss all standards of production which will be required from this type of farm. It is clear that there will be needs for such standards like water protection or CO<sub>2</sub> production, but it is necessary to take into consideration that too strong regulation, if applied only in Europe, could destroy this important group of farm. In any case, there will be growing demand from consumers for guaranteed food quality also.

It could be expected that the energy cost will grow in this period again, so, there will be also an open question of energy production.

### Farms with focus on specific production

The differentiation to two types of farms with specific production will grow. The first group of farm will be focused on a delivery of high quality of food, which will be produced by environmentally friendly methods, vegetable and fruits, or foods for people with specific cultural or dietetic requirements to bigger percentage of population. These groups of farms, with respect to their specificity, will converge more and more to industrial farms. This group of farms will have extremely high requirements on new results of research and will be base for knowledge based economy. Also, there will be extremely high requirements on ICT, mainly on monitoring, but also on a very precise production management. Also marketing and real time delivery will be important.

The second group of farm will be focused on the consumption of products on the farm. The

requirements will be mainly for the management of quality of production.

### 2030

The global food production has to grow by 50 per cent by 2030 to meet the increasing demand of growing population. Massive efforts are required to maintain fertile cropland. Demand for animal protein may increase, triggering massive investments into genetically modified food, aquaculture, and stem cells for meat production without growing the animal. Seawater agriculture on desert coastlines could produce bio-fuels, pulp for the paper industry, and food for humans and animal bio-fuels, while absorbing carbon and reducing the drain on fresh water. In the biggest part of Europe, urbanization and land abandonment will result in more concentrated production in urbanized areas and a reduction of the production in less favoured areas. A long term strategy is necessary to solve the impacts of raising energy prices like increasing field areas or increasing production of bio-energy from agriculture.

However, the net benefits of climatic long-term are less certain. Particularly, in lower areas, droughts and desertification will create significant social challenges in some of the world's poorest economies. Areas such as Siberia, Scandinavia and Canada will profit from global warming.

The key issue will be also the food quality. A long term influence will be on the intensive use of traceability systems in the food supply chain and this will be compulsory for all farmers producing food stuff and to the retailers. The focus on aging population and health will be a major requirement of food production. There will be an important shift in composition of production in direction of vegetable, fruits, fish, chicken, etc. The percentage of ethnic groups will grow further. Around 2030, ethnic groups could comprise a major portion of the European population. This will influence food and agriculture production. There will be a complete change of economic instruments which will influence the production. The main focus will be on removal of distortion of the market but a support of healthy and environmentally friendly production, and a support of world wide food security. In the long term, partnership agreements will be more 'mainstream' where local industries will be closely connected to the region, and farmers will sell their

products directly to them, securing prices in disposal of their production. The agricultural production will be horizontally and vertically integrated.

Biotechnology will be an important pillar of Europe's economy by 2030, indispensable to sustainable economic growth, employment, energy supply and to maintaining the standard of living. It will be increasingly used in labour-intensive sectors, e.g. industrial processing, pharmaceuticals, agriculture and food. The increasing demand of energy will keep prices high and support the demand for bio-fuels. Therefore, the investment interest will continue. In this period, if the oil reserves estimation is correct, it is expected that some oil reserves will be depleted and this will worsen the supply of energy. Thus energy prices will increase and investment in Renewable Energy Sources and biomass produced by the farms will be enhanced. A new dimension of farms will also take place, such as pharmaceutical crops, industrial crops as well as high quality and safety food. A research in agriculture for new and advanced agricultural commodities will be needed to keep raw material supply at low cost. The trends of the previous period will be maintained and funds will be available for research in the sector. If the climatic change scenarios are verified, strict measures have to be adopted. This will be an important driver for farms to change practices and management to more environmental friendly direction. A worldwide valuation of ecological performances with rules like "who has to pay how much for whom", taking into consideration the impact of environmental caretaking for local, regional, national, continental or worldwide influence.

Efforts to enhance the environmental performance of agriculture will play an important role. Social and political pressures for increased environmental standards are expected. Resulting policy tools, whether positive (subsidy based) or negative (penalty based), if substantial enough, could play a major role in shaping future agriculture. On the other hand, the cost of dealing comprehensively with the above set of environmental issues would be many times greater than the public funds currently available through the main policy programs. It may be that public funds continue to play a marginal role in protecting or enhancing the

rural environment. No dramatic increase in environmental regulation governing agriculture is expected.

The important question, which is till now open, is if agriculture production is subsidized, and what agriculture production will be subsidized. The final decision will depend on a discussion of member countries. The final decision is not clear, but it is expected that financial incentives should be available for farmers who produce according to sustainability criteria because they bear additional costs (compared with unsustainable production) which will not directly be paid by consumers. In the transition period until 2030, the incentive should increase with the degree of implementation of such criteria.

It could be expected that due to the requirements on quality of production and also on the environmental friendly production on one hand, and on the other hand in increasing of demand for the high quality food, vegetable and fruits, and also growing demand for special production, the conversion of two types of farms to two main groups will continue and in the final stage we will have two basic types of farms:

- Multifunctional farms
- Industrial farms with focus on high efficiency and high quality of production

### **Multifunctional farms**

The focus will be on efficient agriculture from an environmental and socioeconomic point of view. The role of farm will depend on a public dialog and a valuation of non-production goods. The focus will not be only on production, but also on landscape and cultural heritage. The landscape is one of the most commonly cited of the multifunctional characteristics of the agriculture sector. However, the impact of agriculture on landscape has not always been positive. This will be changed and agriculture will play important role in forming of landscape. Rural viability via agricultural employment will be one of the multifunctional outputs of agriculture. There is expected a link between agricultural employment and agricultural production, but part-time farming, diversification of income sources of the farm household, and the development of non-agricultural activities in rural areas, will mean that agricultural employment and



rural development are much less inter-dependent than in the past. There will be also other values as historic buildings and associated cultural heritage values in rural areas.

### Industrial farms with focus on high efficiency and high quality of production

The main requirements will be to produce enough food and energy in a sustainable way which meets the consumer's demands. The farms will have to respect strict regulations, but also will need to produce effectively. There will be necessary to find a balance between restrictive methods like the regulation and standards on one side and an economical stimulus like subsidies on the opposite side. The requirements to produce a high amount, high quality and environmentally friendly will demand new methods of management and also an application of new scientific results. A research in agriculture for new and advanced agricultural commodities will be needed to keep raw material supply at low cost. The trends of the previous period will be maintained and funds will be available for research in the sector.

## Demands for Future Farming system

### Demands from external drivers

For suggestion of functionalities and interrelation of the future knowledge management system, the previous analysis has to be considered. The basic principles of interrelation could be expressed by next image:

If this scheme is studied deeply, we can expect the following transfer of knowledge:

#### Climate changes

- Macro to level – Global trends in long and short time
- Farm to Micro level – regional forecast, decision about crops, application of pesticide, herbicide, fertilisation
- Micro – to farm level – local forecast, local changes, alert situation

#### Demographic

- Macro to farm level – changes in demand on amount of food

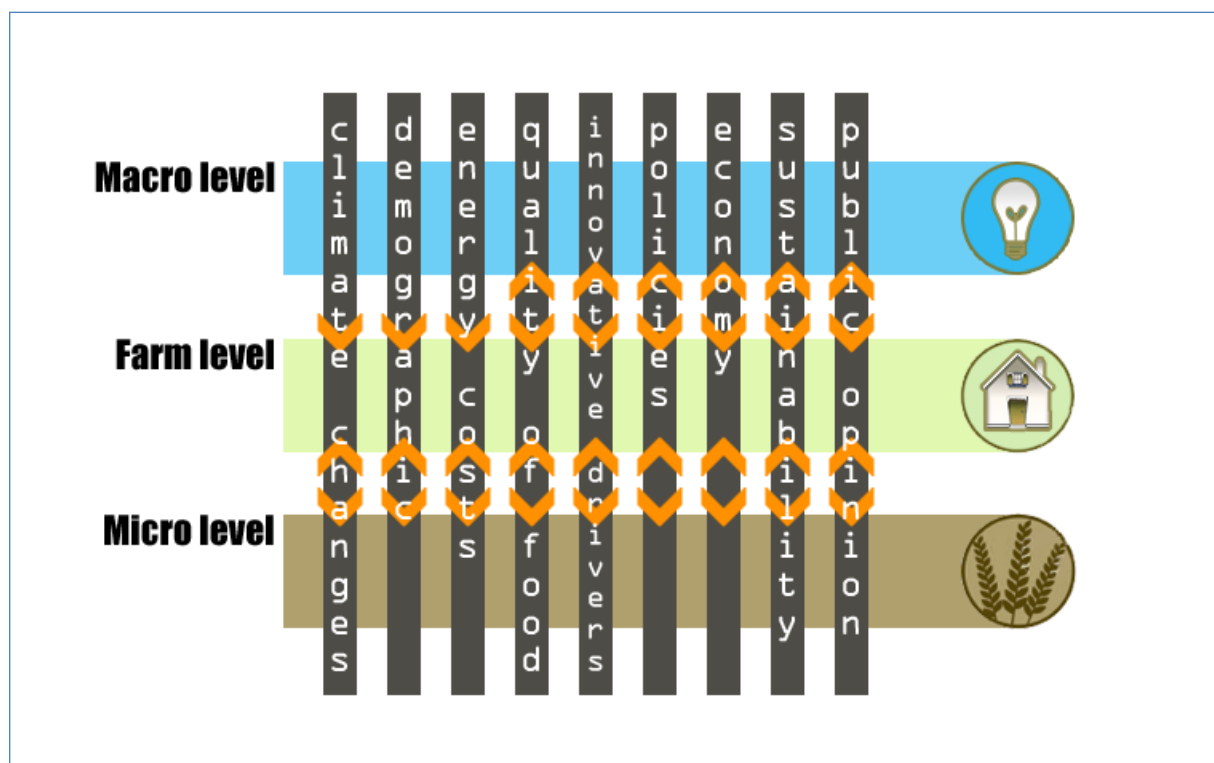


Figure 1.

- Farm to Micro level – selected methodology of production
- Micro to farm level – yield monitoring

#### Energy cost

- Macro to farm level – cost of energy, demand on bio energy
- Farm to Micro level – selected crops, selected methodology of production
- Micro to farm level – yield monitoring

#### Quality of food

- Macro to farm level – prices, demand on quality
- Farm to Micro level – selected crops, selected methodology of production
- Micro to farm level – yield monitoring, traceability
- Farm level to Macro - traceability

#### Innovation

- Macro to farm level – new crops, new methods of work
- Farm level to micro - new crops, new methods of work
- Micro to farm level– data for research analysis
- Farm to macro level - data for research analysis

#### Policies

- Macro to farm level – regulation, subsidies
- Farm level to micro - selected crops, selected methodology of production
- Micro to farm level– traceability, evidence for subsidies
- Farm to macro level – traceability, evidence for subsidies

#### Sustainability and environment

- Macro to farm level – regulation, valorisation
- Farm level to micro - selected crops, selected methodology of production
- Micro to farm level– traceability
- Farm to macro level - traceability, evidence for subsidies

#### Public opinion

- Macro to farm level – changes in public opinion, public requirement.

- Farm level to micro - selected methodology of production
- Micro to farm level– traceability
- Farm to macro level - traceability

## Visions of knowledge technologies

### 2013

There will be majority of European rural areas covered by broadband and the majority of farm businesses will adopt ICT technology as tools for farm management. The growing demand on decision support systems will be in all three types of farm. The application of ICT in the agricultural sector would have a beneficial effect on the appropriate use of resources and keeping of profitable agriculture. Increasing precision input applications, appropriate genetic material and automation would lead to more sustainable farming systems and permit farmers to conform to the definitions and rules of sustainability. The key strategy will be to provide effective knowledge transfer to as many people as possible, through a range of services, and to meet the diverse knowledge and information needs of our customers and stakeholders.

The specific for different types of farms will be:

- Multifunctional farms – traceability and controlling systems, subsidies management systems, quality controlling system, e-commerce systems, control of compliance with environmentally production rules, marketing tools.
- Industrial farms focus will be on precision farming, traceability, quality controlling systems, monitoring of compliance with existing regulation, access to market information, high quality machinery using advanced ICT solution, support for effective economical decision.
- Farms with focus on specific production will require mainly the tools for monitoring of quality of production and compliance with standards. Important will be also effective marketing tools to offer production.

The important aspect of technological development will be:

- Web-based off site FMIS.
- Information intensive.

- Pervasive networking wired and wireless, software as a service.
- Gain of farmers efficiency by intensive use of ICT/FMIS/web.
- Automated assisted decision making.
- Information available in time and space.
- To understand the private (farmers) and public (ministry, chamber) information need and integrate the farmers.
- To understand and document the farmers available support in environment caretaking.

The important problem, which has to be solved, will be •Availability / non availability of macro level data.

## 2020

Principles of ambient mobile intelligence will be adopted by farming sector to guarantee effective management of production but also traceability. Agriculture will require a highly educated staff. There will be a large shift from manual work to knowledge management. The main principles will be:

- Management decisions are based on accurate process data and updated external information => resulting real-time monitoring and rapid reactions.
- Service – based system => shared workload by outsourcing.
- Sensors.
- Easy data flow market <- farm => field.
- Market ⇔ development ⇔ field.
- Every task will be automatically controlled. DSS, traceability, sustainability.
- Decision models both in space and time.
- Intensive use of the latest scientific knowledge.

## 2030

Agriculture will become fully knowledge driven. This will require a full adoption of ICT. New sensors and nanotechnologies will become a part of management. ICT facilitated the development of robotics and automation now used in many industries, including the agri-food sector. New systems, such as self-milking systems for dairy cows, are being developed, as well as process automation to reduce labour and improve productivity.

## Recommendation for Future Farm knowledge management based on analysis of existing platforms and farmer satisfaction

The analysis of existing platform and also new requirements coming from external drivers analysis demonstrated that for future farming system interconnection of different part of farming systems and communication will play the most important role. From this reason the recommendation for the Future Farm project is a usage of the Service Oriented Architecture (SOA) which provides methods for systems development and integration where systems group functionality around business processes and package these as interoperable services. An SOA infrastructure allows different applications to exchange data with one another as they participate in business processes. Service-orientation aims at a loose coupling of services with operating systems, programming languages and other technologies which underlie applications. SOA separates functions into distinct units, or services which developers make accessible over a network in order to users were able to combine and reuse them in the production of business applications. These services communicate with each other by passing data from one service to another, or by coordinating an activity between two or more services. In the future farm is recommended to use SOA for integration of the Software (SW) tools and web services and to implement an idea of Open Agriculture Service (OAS). The integration and communication among the independent components of the system is based on the implementation of the Open Standards defined mainly by the World Wide Web Consortium (W3C), Open Geospatial Consortium (OGC) and Organization for the Advancement of Structured Information Standards (OASIS).

This choice provides the capability of easy access to the individual services exposed by any domain specific application wishing to participate in the knowledge management system. The framework also helps to easily provide the insertion of new services and components, and the re-use of existing blocks and services, hence a great flexibility both in the platform management, especially in the choice and integration of system components and services, and in the requirement for developers of new services, as these are loosely coupled object

oriented systems that are distributed and maintained with eventual service level agreements by the single service provider.

The approach has to be based on a service-oriented basis and these both reflect in the user view of the platform facilities and provisions, and in the approach for application providers and developers that implement new components.

A system architectural design has to be evolved from monolithic applications to more client-server oriented ones. Nowadays, a brand new architectural paradigm has to appear from the standardization of the Web Services. The Service-Oriented Architecture (SOA) is a software architectural concept that defines the use of services to support business requirements. In an SOA, resources are made available to other participants in the network as independent services that are accessed in a standardized way. Normally, the definitions of SOA identify the use of Web Services (using SOAP and WSDL) in its implementation.

In view of the project objectives – especially those that relate or influence the environment within the Future farm system – developments in the following domains will be highly relevant to the project:

- Geographic Information Systems (GIS). The intelligent use of technologies for maintaining, querying, displaying, and analyzing geographic information will be an important determinant to the project's success.
- Information Integration using XML: an important objective of this project is to present to end-users information from a wide variety of sources that can have very different types of content organisation (geographic databases, textual information, graphic content, ...) The family of technologies, that are being developed around the XML format, provide an obvious environment for developing the necessary content integration and content transformation tools.
- Robotics will play important role on farms.

It is of utmost importance for the Future Farm offer possibility of efficient knowledge management on all levels of management. In general, we can say that the ecological, technical business and legal requirements need new structures that are able to

fulfill and support the farmer's needs. As existing structures - this is valid for public structures like ministries or government driven extension services but also for semi-governmental organizations like chambers of agriculture have a tendency to move slowly as every change hurts and sometimes a change shows also a wrong structure of existing organizations. This could show us that in countries that have no structures yet technology is implemented much faster because when a new structure is set up this will be done with newest technology. The danger is given for the European structures that have been in general very effective for the farmers need during the last hundred years but are not so effective or contra productive for the needs of the future.

It is necessary to mention one risk. If all farmers use the same input knowledge and the same deterministic algorithm, the usage of such decision could lead to distortion of market. Then, two possible options exist, which could guarantee a non-uniform decision:

- To use suboptimal variants
- To use non deterministic methods for decision

## Conclusion

The future farming and also the future farming knowledge management system will have to solve many problems. Different problems will grow also in the world scale which will also influence the farming. We point out for example the above mentioned requirements on food quality and safety, and on the opposite side on the food requirements for growing population and on renewable energy production technologies. It is curious, but the production of renewable production energy could have a negative influence on the environment. Thus, any decision will be very knowledge sensitive.

The importance of biotechnology will grow till 2030 and also research will be closer to farming.

On the base of the requirements for the quality of production and for the environmental friendly production on one hand, and the increasing demand for high quality food, vegetable and fruits, and also the growing demand for a special production on the other hand, we expect that two main groups of farm will exist in 2030:

- Multifunctional farms
- Industrial farms with focus on high efficiency and high quality of production

The focus of multifunctional farm will be on the efficient agriculture from the environmental and socio-economic point of view. However, the future of multifunctional farms will depend on a public dialog and a valuation of non-production goods.

The focus of industrial farm will be to produce enough food and energy in a sustainable way which meets the consumer's demands. The quality of food will be important in Europe and it is expected, that also the bio-production will be industrialized or will become knowledge intensive. The expectation is that the industrial farm will be able to exist without subsidies, but it will depend on the level of restriction. Science will be a key driver.

In 2030, agriculture will become fully knowledge driven. This will require a full adoption of ICT. New sensors and nanotechnologies will become a part of management. ICT facilitated the development of robotics and automation now used in many industries, including the agri-food sector.

*Corresponding author:*

*RNDr. Karel Charvát*

*WirelessInfo*

*Cholinská 1048/19, 784 01 Litovel, Czech Republic*

*Phone: +420604617326, e-mail charvat@wirelessinfo.cz*

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On the architecture level of information systems we recommend to be focused on service oriented architecture which could guarantee a better connection and interoperability of future systems. It will influence use of GIS system, a better acceptance of XML standards, but also the importance of robotics will grow.

For adoption of new technologies also two horizontal issues, education and standardization will be important. Without an educated staff it will be not possible to introduce new knowledge intensive methods. The importance of standardization will grow for interconnectivity of different levels of farming knowledge systems.

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