

Benefits of integrated Information systems for farmers, advisors and vertical and horizontal chain partners

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Abstract

The food insecurity situation is effected by global warming, population growth, focus on bio-energy, low technology acceptance, unfavourable policies, sustainability criteria, changing natural risk-situation, subsidies etc. Sustainability-, agriculture-, forestry- and environmental targets belong together and influence each other. Therefore we need **new types of ICT based land management**, covering protection of land and biodiversity, ensuring sustainable management based on multipurpose use of land, optimising economical benefits and taking into consideration land use potential and its carrying capacity. **ICT technologies**, integrating **science based expert data, easy to use software** and manageable **precision farming technologies** will be essential to achieve sustainable bettering. Large and small farms must have access to know-how, equipment and technologies to optimise food production processes to reach nutritional- and/or biomass targets.

We summarize subsequent the benefits of integrated technologies where farmers, advisors, contractors, supply chains, industries and consumers are integrated:

GIS gives detailed information on **size and location of fields** - base for calculation and logistics. Farm management tools allow **cultivation planning, documentation (also GLOBALGAP), nutrient- and CO₂-balance, cost calculations** and provide information for trust centers or farm advisory services.

Logistic solutions with central and mobile GIS systems allow planning of complete regions and serves **farmers, food-industries and contractors**. **Meteo-data** allow better decisions. **Business-plans assist cooperation with banks and insurance companies**. Machine interfaces allow the set up of **precision or virtual farming** solutions for groups of users, to do **statistical analysis** for regions or countries and a possible **upgrade with forest- or environmental caretaking** solutions. **Risk management** solutions can help to better defining and measuring farmer's integration into environmental caretaking. We will show solutions and discuss the requirements – technological and organizational - to use these technologies.

THE OVERALL CONCEPT - “AGROffice”

is, to support farmers or foresters – in the future I use the item “farmer” for farmers and foresters - and their horizontal and vertical chain-partners with new ICT technologies that allow them to work better, to lower costs, to increase benefits and also to lower environmental impact or increase the natures capability to lower natural risks. This means beside detailed know how of farmers or their chain partners needs, a detailed know how of the nature and their capabilities as well as an overall organisational structure and concept is necessary, either already available or to be set up. The farmers worldwide must be enabled to work for the production of food for 10 billion people after 2050, for sustainable and CO₂-neutral bio-energy as well as for environmental caretaking and natural risk management.

TECHNOLOGIES BEHIND – “WinGIS + applications”

are after a development cycle of nearly 15 years including thousands of installations in more than 20 countries an

- object-oriented and hybrid raster- (images) and vector- (polygons, lines, symbols, text etc.) GIS (Geographical Information System) named WinGIS that beside the location and the link of an object to a database with an internal or external database also enables the use of

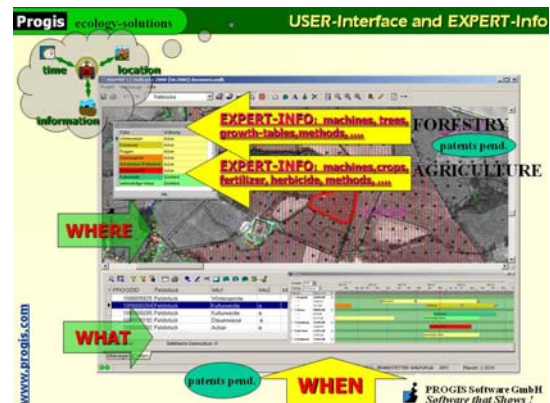
- an SDK (Software Development Kit) to link any database with AX-technology to the GIS component as well as develop with tools customized user-interfaces that allow an integration of time and activity management as well of an expert information system.
- Since 2009 in cooperation with Microsoft, their worldwide available Bing maps (www.bing.com) – also other maps can be used instead or crunched – are linked to the system and allow to work in any country worldwide immediately. Also a Google maps interface is available.
- Further around 20 applications are supporting agriculture, forestry, environmental caretaking and risk management as well as the integrated chain-partners.
- Last but not least we also so to speak work as a system integrator and link existing other technologies to the system: Samples are weather stations, mobile equipments, RFID technology, GPRS or UMTS communication etc.

USER INTERFACE

The key target was to develop a user interface that allows the farmer or the advisor or on the mobile equipment also the tractor driver easy to learn and to use the interface that was improved to a 4D-GIS with the 4 elements hybrid geography, a database, time- and activity management and downsize-able expert information.

FARM MANAGEMENT – “DokuPlant”

It is based on an expert system that can be developed and sustainable maintained by local agricultural experts and contains all machines and their costs and efforts per area (ha, acre etc.), all pesticides with their chemical active substances, all organic and inorganic fertilizer with their nutrient contents as well as all the crops and varieties. Further based on this content all the activities during a year or a crop season have to be foreseen in all details for all crops, e.g. to grow maize needs step no 1 a tractor and a plough, step no 2 a tractor with a fertilizer equipment linked and NPK fertilizer and so on. The average farmer or advisor can just use the expert info; the upgraded user can maintain expert data himself and modify them according his use.



This allows planning all details with a click on a polygon on the map – representing the field and either to be drawn on the raster-map or with GPS points to be imported – and select a crop – with all the details of the expert information in background. The rest is just output. Besides planning during the year, all the done activities have to be recorded, either with manually input or with a link to mobile equipment.

On output following possibilities are foreseen for a field or for the complete farm: Calculation of costs, returns or contribution margins, calculation of nutrient balances (or also energy- or CO₂ balances), documentation of all activities and transfer of the data (or part of them) to chain partners or to a trust centre (see later), sending a subsidy claim to a ministerial IACS system (EU(27) only) or to any other host computer and creating a thematic map.

What can be done for a single farm can be managed on one PC for many farmers with advisors. It allows also comparing anonymously crop statistic of different farmers.

Naturally the advisors also know the use of fertilizer, pesticides or seeds etc. for their regions; several advisors can be bundled to a region and many regions to a country. A new ICT based advisory system can be set up – details see later.

FOREST MANAGEMENT – Forest-Office

Beside agriculture also forestry can be managed – this in two forms: Farm forestry as a part of the a.m. management just that the time is not 6 months but 80 or hundred years and the activities are managed as part of the existing expert system.

Further a detailed forest inventory and forest management application is available – Forest-Office - that manages in a plot based or even statistical based manner any forest enterprise or many of them with an advisory tool.

Local growth tables are available and must be managed once per country by local forestry experts. Based on the measurements on location like habitat data also wood data, e.g. relaskop measurements for volume per stand and growth per stand and their later input (manually or digitally), lots of output for compartments or for the complete forest enterprise can be done like: inventory and reserve, growth data, planning data, grouping on areas, graphic output for age and sort distribution, any thematic map, age distribution, general description of sub-department, tree sorts, quality distribution, harvest categories, age distribution, growth acc. sorts and age, quality distribution, volume per region, general descriptions, harvesting plans, damages per type and region, planned sanitary cutting etc.

OTHERS – Community-GIS and PipeGIS

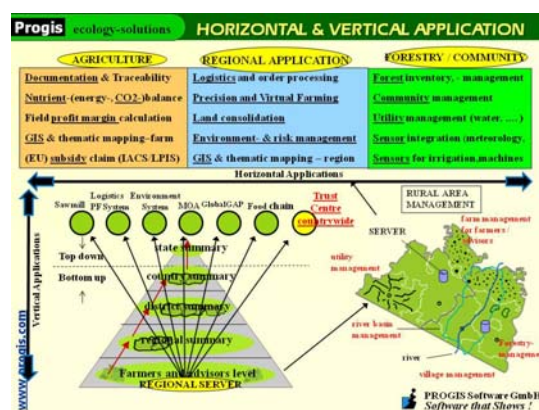
Beside the agriculture and forestry applications further are available for community management as well as pipeline management to be able to cover complete rural areas on demand.

HORIZONTAL INTEGRATION

As the farmer is in many cases not working alone but in cooperation with neighbours or in cooperatives, an intelligent ICT solution has also to reflect the so called group needs and the integration of the farm management system or parts of it into these group needs. Naturally large farms can be seen as “one owner horizontal integrated fields” that also can use the successive applications resp. technologies. Important during the development cycle was the setup of the technology in a manner that also small farms can be integrated and benefit from these new and exciting technologies with the help of a service provider.

LOGISTICS – Logistic centre and mobGIS

is the – GIS based - know how of all the locations of different fields integrated in a control centre that guides the machines and/or trucks to a field with GPRS/UMTS communication to a mobGIS. The local driver can answer with a push of a button that he got the contract “Where to go and what to do” and later on responds when he finished his works: e.g. how many sugar beets put for later pickup. The update frequency is software depending, in practical work we use 30 seconds what is more or less online. When the central GIS knows where e.g. the sugar beets (sugar beet was the first project, today it is open to ALL crops) to pick up goods, it sends another contract to a pickup machine and this machine invites based on the knowhow of how many tons to be loaded, two, three or four trucks that are linked with e.g. a TomTom routing tool. When the truck is loaded, mobGIS transfers the dataset into an RFID that is located on the truck and the truck drives to the



factory that get a just in time delivery of let's say 100 trucks a day – and not 50 or 150 because both would cause problems. Crops and data are then unloaded!

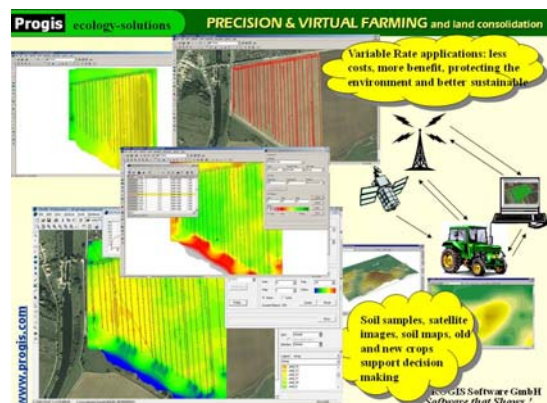
In the same manner as a contract can be send from a control centre to a mobGIS, a farm management tool, DokuPlant, can send a contract to the control centre that manages the use of machines. Suddenly we see how farm-management tools, control centres and mobile equipment can work integrated together. In a small farm structured region, the control centre will be driven by a local service organisation, e.g. a chamber, a machine cooperative etc., large farms will run this centre themselves or cooperate with smallholders.

PRECISION FARMING - WinGIS based PF tools

Precision Farming is, based on lots of detailed data of the soil, the variable rate application with m² detail for fertilisation and spraying on the fields. The technology needed is on one side the input of e.g. soil lab results, Rapid Eye satellite images with chlorophyll data or using data of the Sebal field look model or any other information that might help to define better where should be fertilized/sprayed how much (soil maps, crop rotation, ...), further the defining of maps – a WinGIS job - that show the variable rate application and transfers it to the server that forwards a precision farming contract towards the mobGIS system on the tractor. There, with a blue tooth interface, a standard tractor console can read the data and trigger the fertilizer or sprayer equipment with the map content. After finalising the work the information “what has been done” is registered and sent back via server to the farm management tool where it can be embedded. The technology of transferring maps is working, the ISO/CAN buses makes the interfacing not yet a 100% plug and play but coming closer to it. The key question stays: “Based on which field information the decision of the variable rate application is done?”

VIRTUAL FARMING

Is the integration of several small plots – small and bad shaped – to a larger plot that can be easier maintained with machinery. The cost difference might be 50%, 100% or more depending on size and shape. When it is possible to protocol with precision farming the costs and later on also the earnings per m², we can also define how much farmer A or farmer B gets in return, precise calculated. In Germany we are running the first test cases with excellent results and also acceptance of the farmers based on significant cost reduction. You can run in such a manner one or several activities on a field. Pre-condition is a contract between farmers. They might be organizing it by themselves or the government sets incentives and is supporting it with land consolidation units.



LAND CONSOLIDATION – WinGIS and Z-GIS-application

is the optimizing of bad structures (fields far away from the farm, bad shaped, to small, bad infrastructure etc.) to better ones and is normally supported by government. The Lower Austrian government is using WinGIS and a Z-GIS-application for land consolidation throughout the country. The data are gathered digital from a large cadastre system and are managed within WinGIS and Z-GIS with all details that are needed. After finalising a project the accepted results are stored back to the cadastre system.

The huge advantage is: Variants can be calculated “on the fly” in front of involved farmers; the acceptance is high, fast decisions and visualized information supports the results. A significant cost reduction of land consolidation as well as a faster project cycle could be reached.

ENVIRONMENTAL AND RISK MANAGEMENT - FOMUMIIS

More and more people start to understand that agriculture and forestry are producing more than food and wood only. Clean water, fresh air, nice landscapes, less risks, sequestered CO₂ or better recreation possibilities are only some samples of the many benefits the nature produces. In general those benefits are economical, ecological or socio-cultural. With nearly ten billion people on the globe after 2050, human society will demand more multiple products and services from the – sustainable managed - global resources, but it has to be clear that services can't be free of charge and someone has to pay the real costs of the technical production without any degradation, staying within the natural carrying capacity. FOMUMIIS is an expert tool where experts describe the needs of information to be gathered on the field and then it is calculated the weighted capacity of single landscape elements against some predefined targets. Farmers can optimize the model due to their work and increase to capabilities.

The first large project was set up in Austria with the national railway organisation where local farmers on their steep forests work with the target to protect with their forest – growing bushes, no clear cut etc. – that stones fall down on the rails and might hit a train. Experts described the tasks and the farmers get paid for implementation. New projects together with UNIDO are ongoing.

Based on this examples, millions of new workplaces within rural areas can be setup in the next years and farmers will have beside food/wood and energy and third leg to stand on, environmental caretaking and risk-management. We have just to set up targets for the benefit of all of us.

VERTICAL INTEGRATION

The farmer is also linked within his chain of suppliers and buyers, complexity of agro-chain management compared with a producer of a car is much more complex because of the enormous different structures of farmers (1 ha till 100.000 ha+) and buyers (single person till food-giants) or suppliers (also one-man shows till giants).

CHAIN MANAGEMENT

The behaving of large market partners is mainly driven by their own interest – you farmer have to enter your data in my homepage. The Minister in Europe started this with IACS subsidy systems. The farmer has not yet really a chain management technology with IT nor is able to handle many homepages of buyers or suppliers or public players to enter information about always the same field: where he is buying seeds and fertilizer and where he is getting subsidies and where he is using pesticides and where he needs services and where he is selling all or part of it to one or more buyers.

This has to be handled by an intelligent farm-management-system that distributes the information that the farmer wants to share to different market partners. DokuPlant has embedded such a possibility, that the farmer/advisor defines, who will get which information.

TRUST CENTRE

Instead of sending the different data to many users, all data can be sent to a so called trust centre that manages the access rights to the data. One IT centre for all chain partners, setup with new cloud computing technologies. An ideal model will be a trust centre that is managed by a consortium of market partners country by country and where partners define bilateral who gets which information and the Ministry can act on a legal base to have access to the information in a worst case scenario. Such a shared trust centre will reduce the costs for every market partner to a reasonable sum.

OPEN SPACE NOTARY'S OFFICE

In a second step several partner can agree to build on top of a trust centre a so called regional or country wise “open space notary’s ICT” that is owned by the summary of all farmers.

SYSTEM INTEGRATION

SITE ANALYSIS AND SOIL MANAGEMENT

As base for precision farming precise soil information will be needed; for that the intensive cooperation with soil-labs is necessary. Beside labs also the cooperation with data sets coming from satellite (Rapid Eye and their chlorophyll maps or the Sebal Model from NL) will enhance the recommendation data sets. The better the data, the better the PF results.

AGRO METEOROLOGY INTEGRATION

Weather stations are today able to measure for one microclimate all important weather data incl. also soil moisture data and transfer them via GPRS (offline data-storage also available) into e.g. WinGIS for further processing. Based on expert models decisions about spraying can be done very precise and farmers can be informed via SMS where to spray when and what. The focus is on reduction of sprays per crop season and so reduction of environmental impact. Weatherstation models can be together with advisory services set up countrywide and normally have a ROI of 1-2 years at the most.

ENERGY AND CO₂ BALANCE

Every work of farmers is involved with energy and/or with CO₂; when a farm management system like DokuPlant counts every step, the energy/CO₂ impact of this step (e.g. driving a tractor with a plough or fertilising so many kg NPK per hectare) can be counted by standard data out of an expert dataset. If one counts all activities on the field you are able to calculate a CO₂/energy balance on the field. The same is valid for a farm, for a region or for a country. A control can be done easy with statistical sampling.

Such a model gives the possibility to calculate incentives for farmers that work with a positive CO₂ balance, e.g. they increase the wood stock or they increase the humus content in the soil or they use logistics and run less km with a tractor per hectare or they use precision farming and use less pesticides or fertilizer per ha.

BANKS AND INSURANCE INTEGRATION

To plan for a farmer what he will do at his fields during the next three years gives with some added data a business plan for banks as a base for financing. To know from the farm management system where how many hectares of which crop is growing, gives a data set that easily can be distributed to an insurance company and is base for the policy. Also the control of fields in a catastrophe scenario can easily be maintained with a mobile PC, a GIS and the farmers field data.

In 3rd world countries that all need to start better farming today and do not want to be depending on permanent help, insurance is a must for getting financing and financing is a must for getting started farming. At the base of all is having better information as also insurance cannot start without having better information. The integration of better information, (micro-) financing, insurance and farming is a must to be able to start a modern farming. Without this it will not be possible!

THE NEW ORGANISATION MODELS

Old org-models have setup on many different organizations with exactly defined targets, many of their activities where done parallel. To mirror an integrated system like our nature in an ICT environment we need integrated models and users that are able to share information. Public and private user’s needs have to be taken into consideration. In the time of tyrannosaurus GIS systems just government bodies

had them, now farmers and foresters also want to use them and the time is here for the use of intelligent applications like above mentioned.

NEW ADVISORY CENTRES

We know that a good advise pays off; in Europe Denmark has with 56 advisors per 1000 farmers the top, they reduce at the moment to around 45-50 but the rest of the EU has between 1-6 only. Do the Danish farmers need so much help in order not to ask if the Danish farmers are stupid? No! The understood earlier than others that one advisor supporting 3000-5000 ha pays off, economically and ecologically!

A future advisor that gets support from a powerful ICT environment and is maybe integrated in a franchise-like organisation form, working as private entity but governed by a public-private driven umbrella will be THE new advisory service form. Why we should further not think about agro-bioenergy-food-environment techno parks that support complete chains?

BENEFICIARIES

An integrated model has many beneficiaries. From the Minster that has better farmers to the farmers that get better tools for managing their farms or get better support by advisors till to the advisors that are embedded into a powerful tool that is permanently upgraded with data from the science. Traders, the food producing- and processing companies are as well beneficiaries as banks and insurance companies (why should not banks run an advisory concept? It would help them to use their branch offices better) or also the producers of machinery or agro-chemicals. Foresters, land managers, utility managers or environment- and risk experts will also benefit from such a intelligent maintained system. Even telecom companies could support them to be able to run their new services also in rural areas – they are needed there.

BENEFITS IN DETAIL

Not all benefits can be listed but some of them show already the power of an integrated system:

- GIS gives detailed size of the fields as base for exact calculation
- GIS gives exact location of the field for later logistics use
- Farm management allows with underlaying expert data planning and documentation
- Farm management as a tool supports e.g. GLOBALGAP's documentation needs
- Farm management allows nutrient- and CO²-balance and is a subsidy tool if needed
- Farm management allows calculations (cost, contribution margin etc.) of fields/farms
- Farm management gives access to traceability (§§) and documents sustainability (§§)
- Farm management and GIS allow the development of modern advisory services
- Logistic and mobile GIS tools allow detailed logistic planning of complete regions
- Logistic and mobile GIS tools serve farmers, food industries and contractors
- Meteorology-data integration allows better decisions – just in times of climate change
- More benefit comes from business for banks or information for insurance companies
- Machine interfaces (ISO- or CAN-BUS) allow integration of precision farming
- Group solutions allow statistical analysis for regions or even countries
- Upgrade with forestry (forest inventory and forest management or forest logistics)

- Environmental caretaking solutions allow even farmers integration into this topic
- Risk management solutions allow also farmers integration in risk management
- A trust centre allows the integration of different users of agro-information
- An open space notary's office will give benefits to ground owners resp. farmers

VALUATION OF BENEFITS

If I just assume that calculation, planning and documentation optimizes farm-management, nutrient and CO₂ balance and meteorology sensors integration lower input costs and increase growth, documentation and trust center opens new markets and logistics saves costs and a better advise saves costs and increases revenue as well as better bank and insurance cooperation saves risk as well as precision farming and virtual farming will allow cost reduction, and each counts for 10% only than we have minus 50% costs and +30% higher revenue, so a plus of 80% including lots of environmental benefits. No, this is not precise, I know! But experts tell in many single cases of the above mentioned topics that they work and count up till 30% or more.

We have in any case to calculate case by case but this rough estimation shows, the numbers that can be achieved are big.

VISION FOR TOMORROW

A Russian scientist named Kondratieff discovered, when several new sectors come together, the might boom and give a new growth wave. After 5 so called Kondratieff waves (steam engine and cotton, steel and railway, chemistry and electrical engineering, petro-chemistry and automobile and 5th the information technology) one asks what is the sixth wave. Four sectors are in the pole position: informatics again, biotechnology, health and environment.

I am sure that the next wave will be agriculture, forestry and environment- and nature-based-risk-management. Why? Big parts of environment are linked to agriculture and forestry that covers big parts of our Earth, 50% of the health is coming from good food and clean environment, biotechnology shows also to agro-forestry and last but not least informatics – I think that I could show some of the interesting possibilities of the future.

What is fiction, what is available today? ALL of the mentioned applications and technologies are available today, they wait that the farmers and foresters accept the challenge and start using it, for the many benefits they produce! When you will start?