



AGRICULTURAL KNOWLEDGE: LINKING FARMERS,
ADVISORS AND RESEARCHERS TO BOOST INNOVATION

AGRILINK'S MULTI-LEVEL CONCEPTUAL FRAMEWORK

THEORY PRIMER: 5) DIGITALIZATION OF AGRICULTURE
AND BIG DATA

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AgriLink

Agricultural Knowledge: Linking farmers, advisors and researchers to boost innovation.

AgriLink’s multi-level conceptual framework
 Theory primer: 5) Digitalization of agriculture and big data

The elaboration of this Conceptual Framework has been coordinated by **The James Hutton Institute**, leader of AgriLink’s WP2.

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This document presents the multi-level conceptual framework of the research and innovation project AgriLink. It is a living document.

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It has gone through a transdisciplinary process, with implication of both practitioners and researchers in writing, editing or reviewing the manuscript. This participation has been organised within AgriLink’s consortium and beyond, with the involvement of members of the International Advisory Board of the project, including members of the Working Group on Agricultural Knowledge and Innovation System of the Standing Committee on Agricultural Research of the European Commission.





Theory Primers

The purpose of the primers is to provide AgriLink consortium members with an introduction to each topic, which outlines the key points and identifies options for further reading. The primers have also served to demonstrate the wide range of expertise in the consortium, and to highlight the specific research interests of consortium members. Primers are intended to act as a **foundation for academic journal articles, and an early opportunity for collaboration between consortium members.**

5) Digitalization of agriculture and big data

Author: Cristina Micheloni

1.0 General Overview of the Approach

1.1 Summary of the Approach

In general, “big data” is quite an issue in various sectors, but it has not received the same level of attention within agriculture as some other areas (e.g. genomics). On the other hand, increasingly more data are now available in the agricultural sector that could be used in a much more systematic way than has been done hitherto. However, different than for other sectors, there are many different data holders like remote sensing data, digital soil maps, data of various authorities in the agricultural and environmental field, farmers’ data (for example, sensors on modern tractors and harvesters) etc. that hardly communicate with each other.

In all fields of application, the use of ontologies and controlled vocabularies to describe metadata is state of the art. Standardised data formats are used or are under development. These formats are applied to stored and published data sets. The best choices to publish the structured data are international repositories. In case of less structured data sets the assignment of Digital Object Identifiers (DOIs) is one of the standard procedures. Often, systems to publish DOI data sets are operated institutionally. The current situation shows that a lot of activities are running but they are mostly not aligned. The compilation of used ontologies, controlled vocabularies, running repositories, provided access interfaces and data publication policies is the first step to overcome this issue. As the next task, the harmonisation of data formats and access interfaces should be started.

As with other areas in life sciences, the recent advent of inexpensive high-throughput technologies promises to revolutionise agriculture. It is now possible to measure almost anything imaginable and in only few hours we can collect vast amounts of data using all kinds of different approaches. We can fly drones over large crop fields loaded with a multitude of cameras, install sophisticated sensors to monitor livestock behaviour, access publicly available satellite images and monitor current crop prices; all from the comfort of a desk in an office that can and probably will be remotely located. The challenge, however, remains: how can we make sense of the data? Realising the value of the data collected and how this can be translated into applicable knowledge is at the heart of the Big Data revolution.

Most of the devices that are now available to growers, agronomists and scientists have been developed in a bottom-up fashion focused on specific issues first and only looking into the data they generate after the initial prototypes are already available to the users.

Service provider perspective (commercial and academic)

Data-driven added-value services in the agricultural sectors is emerging as an opportunity for the development of businesses and spin offs. Many of these opportunities are focused on specific areas of expertise such as image capturing services, crop modelling, irrigation scheduling, etc. In most of these examples the focus is on decision-making support and best-



practice advice. One of the major challenges for service providers is the access to affordable high-quality reliable data. This point is particularly relevant to the costing of the services and the impact this has on the adoption of novel approaches by the end users (i.e. agronomists and farmers). The development and maturation of new technologies greatly depends on a dynamic and resilient service sector. In many examples the research community will be the early customers of this sector which in turn is driven by access to public funding in the form of research grants.

End user perspective

End users in relation to big data form a very diverse set. Two are companies (developing equipment and tools for use on farms) and the farmers themselves who could make use of data-driven tools to optimise on-farm solutions.

Communication between and within layers of industry, from data generators to end users, is extremely important and necessary to maintain a focus on big data in order to keep industry involved through funding and interest in future developments. Industry can be seen in several layers: on the one hand, companies (in collaboration with the scientific community) need to develop new equipment. On the other hand, farmers need easy-to-interpret daily management tools which are consistent, reliable and which are a good investment. Farmers don't need background information on how the data are collected and analysed, but rather tools that provide solutions which can be used in their everyday routine.

In-between are advisers, who on one side can make use of big data for their own update and skills improvement and on the other can mediate the use of big data and digital services for farmers.

1.3 Key references (3 to 5 maximum)

See below.

1.4 Brief history of how the theory has developed and been applied

Big data is not a theory but a state of art: they became available in the last 5 years in agriculture sourced for several purposes and by several means: climatic data for pest and disease management; production data for certification schemes; geographic data and management data for precision farming and for CAP schemes...

In last years the awareness of such a huge availability led to the attempt to use them, facing in one side the problem of data compatibility and interoperability (very low) and, on the other hand, the request of infrastructures in rural areas in order to make use of the opportunity as well as the need for farmers training and informations that often the "usual" farm advisers do not have.

1.5 Basic concepts

1. a huge amount of any kind of data is already available at farm level but still unexploited for better/more efficient farm management.
2. causes of such unexploitation are a) low interoperability; b) infrastructural limitations; c) lack of farmers skills/informations; d) inadequate support from usual advisory services and lack of different brokers (as well as costs).
3. on c) and d) AGRILINK can analyse cases and identify areas for improvement/action

4. infrastructural features and degree of information/service provided can impact on the digital divide between rural areas and, consequently, on innovation potential.

Basically new skills and knowledge should come into the farming systems and it is not likely to be provided by the “usual” channels. The situation varies greatly among regions and it affects the potential for innovation.

Diagram

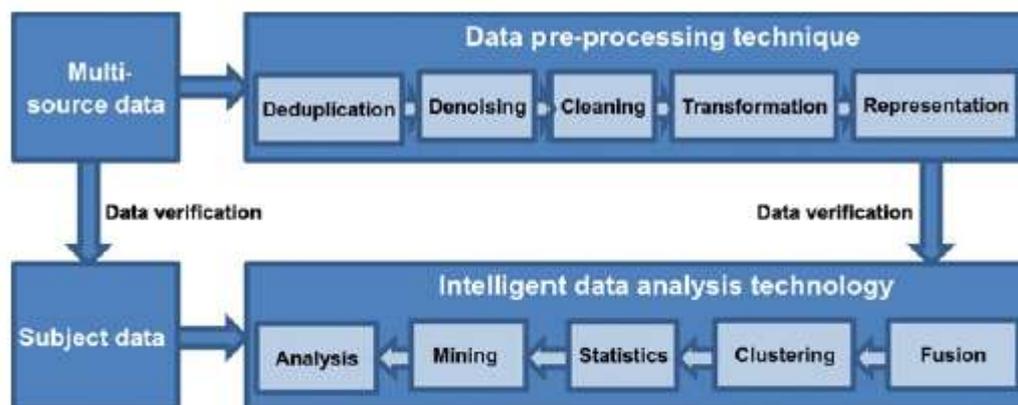


Fig. 4. The flowchart of intelligent processing of agricultural Big Data.
(Source: Li et al., 2014)

2.0 Application to the analysing the role of farm advisory services in innovation

2.1 Relevance to AgriLink Objectives

[tick relevant]	AgriLink Objectives
y	Develop a theoretical framework utilising a multi-level perspective to integrate sociological and economic theories with inputs from psychology and learning studies; and assess the functions played by advisory organisations in innovation dynamics at multiple levels (micro-, meso-, macro-levels) [WP1];
y	Assess the diversity of farmers' use of knowledge and services from both formal and informal sources (micro-AKIS), and how they translate this into changes on their own farms [WP2];
y	Develop and utilise cutting edge research methods to assess new advisory service models and their innovation potential [WP2];
??	Identify thoroughly the roles of the R-FAS (regional FAS) in innovation development, evaluation, adoption and dissemination in various EU rural and agricultural contexts [WP2];
Tangentially yes	Test how various forms of (national and regional) governance and funding schemes of farm advice i) support (or not) farmers' micro-AKIS, ii) sustain the relation between research, advice, farmers and facilitate knowledge assemblage iii) enable evaluation of the (positive and negative) effects of innovation for sustainable development of agriculture [WP4];
n	Assess the effectiveness of formal support to agricultural advisory organisations forming the R-FAS by combining quantitative and qualitative



	methods, with a focus on the EU-FAS policy instrument (the first and second version of the regulation) and by relating them to other findings of AgriLink. [WP4] .
	At the applied level, the objectives of AgriLink are to:
y	Develop recommendations to enhance farm advisory systems from a multi-level perspective, from the viewpoint of farmers' access to knowledge and services (micro-AKIS) up to the question of governance, also recommending supports to encourage advisors to utilise specific tools, methods to better link science and practice, encourage life-long learning and interactivity between advisors [WP5] ;
??	Build socio-technical transition scenarios for improving the performance of advisory systems and achieving more sustainable systems - through interactive sessions with policy makers and advisory organisations; explore the practical relevance of AgriLink's recommendations in this process [WP5] ;
y	Test and validate innovative advisory tools and services to better connect research and practice [WP3] ;
yes	Develop new learning and interaction methods for fruitful exchanges between farmers, researchers and advisors, with a focus on advisors' needs for new skills and new roles [WP3] ;
n	Guarantee the quality of practitioners' involvement throughout the project to support the identification of best fit practices for various types of farm advisory services (use of new technologies, methods, tools) in different European contexts, and for the governance of their public supports [WP6] .

2.2 How this can be applied/developed in AgriLink (2-5 paragraphs)

- we can include some cases in WP2
- at least a living lab on the topic in WP3
- specifically address the question in the survey and questionnaire of WP2

2.3 Research questions relevant to AgriLink [see the draft conceptual framework for further options]

- Who can be the innovation broker in this topic? What is its business model?
- How to bridge infrastructural differences?
- How to ensure that available data is translated into really useful and affordable tools to be used on a day-to-day basis for farmers.
- How to integrate independent datasets across different scales (especially climate data) e.g. to really inform what crops are grown at farm level.
- How to ensure that data-driven tools that seek to optimise farm management in the context of climate change do not have contrary trade-off effects elsewhere.

2.6 Potential operational problems

Technology and its use evolves very fast, there is the risk to work on situations that in 2 years time do not exist any-longer and we risk to give recommendations out of time.



References

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