



Danish farmers and businesses in the food industry are well-positioned to benefit from the rapid development within data collection and processing.

The term *Big Data* covers the use of data that are created in many different contexts. The more companies excel in Big Data, the better they perform on objective measures of financial and operational results. Researchers from the MIT have found that companies in the top third of their industry in the use of Big Data were, on average, 5 per cent more productive and 6 per cent more profitable than their competitors.

Agriculture and the rest of the food sector are already producing huge amounts of data. The reasons include a high automation level and regulatory requirements, e.g. documentation of food safety when Danish manufacturers and sales channels provide food to consumers. However, there is a leap from possessing very large quantities of data to exploiting it through data-driven business development.

At the same time, competitors on the global markets are constantly getting better too. The Danish food industry therefore has to be ready to develop new business models and find ways to ensure enhanced value creation in production and in the products or services. It can either be through smarter production methods, product delivery, or by incorporating greater value in the products so they can be sold at higher profits. Similarly, agricultural production and the development of the Danish raw material base are essential for growth opportunities throughout the value chain in the food industry.

#### Cattle, pigs, poultry, consumer health

In preparing this report, DTU has identified a number of promising projects in cattle farming, pig farming, the poultry industry, and consumer health. The ideas are beneficial all the way round — both for Danish farmers, for the food industry, consumers, and the economy.

At the same time, it is important that efforts are coordinated, and that it occurs in interaction with the overall 'generic' research in Big Data. Only in this way will the best solutions to the given problems be found, while smart solutions in one area can spread to other areas.



Work on the report has identified that the effort should be organized in three main stages:

The starting point should be a focus on business development. The prerequisite for a project to succeed in the later stages is that there are prospects of favorable business impact for the industry actors. The second and third stages should address the exchange and integration of data across the value chain from farm to fork and the development and integration of the main elements of the Big Data tools (see box below). The fourth and final step should tackle the challenges of data security and privacy, which will inevitably arise in connection with many of the projects. How do you ensure that unauthorized persons do not gain access to sensitive data? And the opposite: how do you ensure that the relevant parties are given access?

### Big Data tools

In the report, DTU has outlined the main elements of the Big Data value chain:

- a. Data acquisition technology
  - i. Through sensors
  - ii. Existing data/records
- b. Pre-treatment of data (early stage)
  - i. Data reduction
  - ii. Only saving relevant data
- c. Data storage technologies for intelligent storage
- d. Preparation of data (late stage)
  - i. Data heterogeneity and integration challenges
- e. Data analysis
  - i. Automatic structure
  - ii. Data analytical tools and algorithms
- f. Visualization and decision

#### How to proceed

In other words the report identifies that the potential by exploiting Big Data in the food sector is very large, but at the same time that the task is complex. This leads to five recommendations:

## Recommendation 1:

### New research and development projects

The report's main recommendation is to launch projects within the 11 problem areas identified in the sector development project in cooperation between DTU, industry, trade associations and authorities. This applies to problems relating to pigs, cattle, chickens and milk across the value chain, i.e. in herds, processing, equipment manufacturers, retailers and relevant authorities, including the Danish Veterinary and Food Administration.

Examples are:

- Projects at herd level among pig, cattle, milk and poultry producers. These include real-time monitoring of food and drug consumption
- Projects in slaughterhouses and dairies, where data is collected on sty and stable level. Also, promotion of new scanning methods and automated cuts (by robots), new dairy products of a highly consistent quality, as well as early intervention against threats to the health and well-being of animals.

## Recommendation 2:

### A framework for closer co-operation on data

Value-added work with Big Data requires close cooperation between knowledge institutions, businesses across the value chain, organizations, and authorities as there are many aspects in research, development, testing, regulation, and organization that are interdependent and interlocking. Therefore, it is essential to have a national cluster where all relevant actors pull in the same direction. DTU must help to develop a cluster with Big Data and data driven business development in animal health and food quality and safety.

DTU must strengthen its efforts with regards to orderly conditions for the production of, access to, storage, and use of data, so that confidence-borne contractual relationships with external partners can be maintained. It implies, e.g., to ensure that DTU simultaneously can work with industry on the use of corporate data and/or the sharing of data and can provide scientific advice to the authorities responsible for enforcing EU and Danish industry legislation.

## Recommendation 3:

### Strengthen 'generic' research in Big Data tools

The use of Big Data in the primary and secondary industries of the agri-food sector can have positive effects on cattle farming, pig farming, the poultry industry, and consumer health. However, the sector development project demonstrates that it is in the cross-sections of

data across each of the value chain elements that the most valuable business insights can be found. Still, the exchange and co-production of data requires the solution of a number of technical challenges. As a consequence, it is necessary to combine any efforts to use Big Data for business development in the agri-food sector with a strengthening of 'generic' research in Big Data tools.

In this light, it makes sense for DTU to establish a center 'without walls' for research into Big Data, data science and data-driven business. The center must both focus on research which in the short term will create value to business and society, and on research which can contribute to long-term capacity building in the field. The work of the center must be based on a financing strategy developed by the relevant departments at DTU. The strategy must aim at finding funding for its activities in, e.g., Innovation Fund Denmark, Horizon 2020, or private foundations.

## Recommendation 4:

### Master education and further education

An important prerequisite for exploiting Big Data is that competencies are present in businesses and the public sector. It is widely known that the demand for engineering skills within Big Data will increase, as more companies become aware of Big Data opportunities.

In 2013, DTU established an MSc program in cyber security and in 2014 an MSc in Data Science. In addition, DTU has as one of the first universities in the Nordic countries had the opportunity to offer students and researchers access to exploit IBM's Big Data tools, IBM BlueMix and Watson. DTU will continue this development in the future to meet society's needs for new skills in Big Data. There may be a need to prioritize a selected number of specific areas and integrate Big Data more into these areas. DTU must provide further education and a graduate program which gives students skills of particular relevance to the food sector.

## Recommendation 5:

### Entrepreneurship and growth companies

DTU units that work to promote entrepreneurship and innovation must help create spin-off companies in the area of Big Data. In particular, there is a need for companies with a business concept that cuts across the many components necessary for optimal use of Big Data. Typically, this requires cooperation with companies in the food industry and in the IT sector.

An essential element of such an action is focus on student innovation. It may be in the form of business-related educational activities, such as activities that ensure more student projects in the companies.

**The project on Big Data for food**

With a sector development project approach the DTU, the Confederation of Danish Industries and the Danish Agriculture and Food Council, have identified how Big Data business can contribute to growth in the agri-food sector.

Sector development projects are one of the tools that DTU employs to cooperate with the business community and authorities to identify research and development needs in a sector or industry.

A sector development project extends from an initial identification of ideas over the lobbying in relation to private and public funding sources to specific collaborations with companies and authorities.

The result is a report on a series of interdisciplinary methodological challenges and a number of research and commercially valuable project opportunities within Big Data for sustainable, resource-efficient food production, animal health, and food quality and food safety.



**Interviewed companies/authorities/research institutions and workshop participants**

Skov A/S, SMB A/S, IBM A/S, Chr. Hansen A/S, DLG, Danpo, Danhatch, Danish Crown, Arla, Coop A/S, Oracle, Siemens, IBM, Knowledge Centre for Agriculture/Cattle-Pigs-Poultry, Oxford University, Big Innovation Centre, Connected Digital Economy Catapult, Imperial College of London and the Danish Veterinary and Food Administration.

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