Data collection methods used in the Beef Data and Genomics Programme (BDGP) and the development of restful API's for recording herd data

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Abstract

The Beef Data and Genomics Programme is a scheme approved by the EU to reduce greenhouse gases caused by cattle in Ireland by breeding more sustainable and profitable animals.

The BDGP requires participants to complete various surveys on animals in their herd, such the docility of the animals, calf birth size, calf vigour, dam milk-ability, and the departure reasons of the sires and dams that have left the herd.

Various recording mechanisms have been made available to record this data by ICBF which includes scannable paper forms, data recording screens for mobile and desktop devices, and a simple API system to allow data to be submitted from 3rd party software applications.

ICBF are also developing a Restful API system that will allow JSON formatted data to be transferred between the ICBF database and other systems over the internet. Authentication is provided via the transfer of tokens using the oAuth 2.0 protocol.

This system will allow for real-time read and write access to the farmers' data stored in the ICBF database and will be made available to 3rd party software providers for the benefit of the Irish farmer.

Keywords: data recording, bdgp, api.

Introduction

There is an established need to collect farmer recorded data on animals in large volumes which can then be used in genetic evaluations. A scheme such as the Beef Data and Genomics Programme has various requirements where the farmer must record this data on his herd in order to be compliant with the terms of the scheme.

Also required is the need to provide the IT systems that will be capable to take advantage of the many advances in technology that has taken place in recent years, and to make it easier to collect accurate data from various sources and make it available to the farmers when they need it.

Over the last few years, ICBF has provided various data recording paper on online forms to collect information from farmers for the Beef Data and Genomics Programme, and most recently an API system has been developed that will allow third party devices used by the farmer to read and write animal data to the ICBF database.

Beef Data and Genomics Programme (BDGP)

The Beef Data and Genomics Programme is a six year scheme approved by the European Commission and launched by the Minister of the Department of Agriculture, Food and Marine, Simon Coveney TD in 2015.

The programme provides up 52 million per annum to the suckler beef sector to deliver accelerated genetic improvement in the National herd and improve its environmental and economic sustainability ("Coveney launches 300 Million Euros Beef Data and Genomics Programme", 2015).

In 2017, the scheme was expanded to make it available to new applicants.. ("Creed Announces Re-Opening", 2017).

There are six requirements to the scheme:

1. Calving details - In addition to the statutory requirements for tagging and registration; for each calf, a calving ease survey must be provided along with the tag number or the AI code of the sire.

2. Surveys - Applicants will be required to complete survey forms on cows, calves, and stock bulls on the holding. Survey forms are supplied by ICBF. See Table 1 for information on the data collected.

3. Genotyping - Applicants will be required to take a tissue sample from animals selected for genotyping. The amount of animals that are to be sampled will be at least equivalent to 60% of number of calved suckler cows on the farm in 2014.

Table 1. Information on the data collected as part of BDGP requirements 1 and 2.

Trait	Description	Data format
Sire	The tag number or AI code of the calf	
Calving ease	The calving ease score of the calf	4pt scale
Calf birth Size	The size of the calf at birth	5pt scale
Calf vigour	The vigour of the calf at birth	5pt scale
Calf docility	The docility of the calf at 5 months	5pt scale
Calf quality	The quality of the calf at 5 months	5pt scale
Calf scour	The number of occurrences of scour at 5 months	0, 1 or 2+ occurrences
Calf pneumonia	The number of occurrences of pneumonia at 5 months	0, 1 or 2+ occurrences
Dam docility	The docility of the dam	5pt scale
Dam milk-ability	The milk-ability of the dam	5pt scale
Dam departure reason	The reason for the dam leaving the herd	List of departure reasons
Stock bull docility	The docility of the stock bull	5pt scale
Stock bull functionality	The functionality (feet and legs) of the stock bull	5pt scale
Stock bull departure	The reason for the stock bull leaving the herd.	List of departure reasons

4. Replacement Strategy - For applicants using a stock bull, there must be at least one stock bull on the farm on a particular date that is genotyped 4 or 5 stars on the Terminal or Replacement index. The applicant must ensure that a percentage of heifers or suckler cows are genotyped and are four or five stars on the replacement index on particular dates detailed in the scheme's terms and conditions.

5. Carbon Navigator - All applicants must complete the Carbon Navigator in the first year of the scheme. The Carbon Navigator is an online farm management package produced by Bord Bia and Teagasc. In subsequent years of the scheme, applicants must update this information using forms provided by ICBF.

6. Training - Applicants must attend a training course in the first year of the scheme.

The source of the above requirements is the Department of Agriculture, Food and Marine, Terms and Conditions, 2015. There are currently 23,500 herds participating in the scheme.

Requirement 1 and 2 of the BDGP scheme requires the farmer to complete various surveys on the animals in their herd that are eligible for the scheme. Paper forms and a web application have been made available by ICBF to record this information.

BDGP Data Recording

There are potentially 550000 eligible calves born to BDGP participating herds each year. Due to the high volumes of animals, and the number of traits that are recorded against each animal, the forms have been produced so that the information can be extracted via a scanning process.

Paper forms

To ensure that the scanning process is as accurate as possible, each form developed requires the farmer to simply circle or mark a specific value for each trait on each animal. Also, each animal listed on the form has its tag number rendered as a 2D barcode. This helps to avoid data being lost due to a tag number being read by the scanning process incorrectly. Overall, this approach has allowed for very high accuracy rates of around 99.7% across all traits collected.

The exception to this is with the sire recording, it was not possible to take this same approach with the other traits as the farmer needs to write in the tag number or AI code of the calf's sire. This handwriting reduced the scanning rate by about 20%, which greatly increased the number of forms being presented for validation to the keying personnel. As a result, sire tag numbers and AI codes are manually keyed into a web interface. Fortunately, only a relatively small number of sire recording forms are issued as this information is typically recorded at calf registration.

There are five different forms issued as part of the BDGP. All forms have a unique form number, presented as a 2D barcode to improve readability, so each form can be tracked throughout the process. Each form is issued with an addressed freepost envelope for returning the forms. When the forms are returned, they need to be sorted into batches of the same type and processed together. To aid this, each form is printed on different coloured paper.

ICBF works with the company Capita Customer Solutions (*www.capitacustomersolutions.ie*) to process the forms. Capita uses scanning software and equipment provided and developed by SoftCo (*www.softco.com*). The scanning

software extracts the recorded data from the form, and makes it available to ICBF in a data file which is loaded to the ICBF database nightly. A scanned image of the form is then archived so that it is easily accessible if required.

Paper forms are used by around 60% of the herd-owners participating in the BDGP as the primary method of recording the required information for requirement 1 and 2.

Online data recording facilities

ICBF provides an online web application for recording all information for requirement 1 and 2 of the scheme. All herd-owners participating in the scheme can log on to *www.icbf.com* using their username and password and access the Beef Data and Genomics Programme application.

As well as providing the various data recording web pages, this application provides summary and detailed information on the status of the herd in relation to the scheme requirements, as well as the information that has already been recorded.

The ICBF web application is also mobile compatible to allow the farmer to record or review their data on a mobile or tablet device. In order to make the application as accessible as possible, it has also been made available via the Android and Apple stores, by wrapping the application in an App.

Herd-owners can also record their BDGP data via other Department of Agriculture approved software providers as well as on the Department of Agriculture's own web application, www.agfood.ie. All data recorded on these other web sites are transferred to ICBF daily using various web services.

There are several options available to herd-owners to record this information online, but the majority of herds continue to prefer the paper-based option.

Herd Application Programming Interfaces (API)

There have been many changes in technologies in recent years which have increased the sources of data available. Examples of this would include the smart phone, robotics, artificial intelligence, Internet of Things (IoT) devices and sensors. ICBF also has an increasing need to communicate with other companies in real-time. For example, with genomics, ICBF transfers data to and from the Weatherby's laboratory when processing returned samples.

As a result, ICBF has been actively developing a series of APIs to exchange data with third party devices and applications, and in particular, an API is being developed to make it easy for the farmer to access and record data on his animals through devices like those listed above.

The ICBF Herd APIs are a set of web services available to software and sensor providers to provide data services to farmers. They are built using Representational state transfer (REST), the alternative that was considered was SOAP (Simple Open Access Protocol), but REST was chosen as the data transfer was not restricted to XML, and JSON (JavaScript Object Notation) could be used.

JSON was preferable over XML as it is shorter, which reduces the size of the data transfer, and it is quicker to read and write.

ICBF uses an API builder call Apigility (*https://apigility.org*) which simplifies the creation and maintenance of useful, easy to consume and well-structured APIs. Apigility structures the services according to the Hypertext Application Language (M Kelly, 2011)

specification which readily achieves the Richardson Maturity Model Level 3 (Fowler, 2010). This ensures that each resource contains relational links, and that a standard, identifiable structure for embedding other resources is used.

Authorisation and Authentication is handled using oAuth 2.0 which is an industry standard protocol for authorization. OAuth 2.0 focuses on client developer simplicity while providing specific authorization flows for web applications, desktop applications, mobile phones, and other devices (oauth.net/2).

A particularly important advantage of using oAuth 2.0 is that is keeps the farmer's authorisation details away from the client devices which are typically considered insecure. It does this with a series of unique token exchanges. This ensures that if the client device becomes compromised, the farmer's authorisation details are still safe.

The Herd APIs currently available from ICBF are listed in Table 2.

Table 2. List of Herd APIs currently available from ICBF.

Scope	Service	Methods available	Description
Herd Details	Animal Details	Read	The animals currently in the herd and their details such as birth date, sex, breed, arrival date etc.
Herd Fertility	Heat	Read|Write|Update|Delete	The heat data recorded on animals in the herd
	Inseminations	Read|Write|Update|Delete	The insemination data recorded on animals in the herd
	Pregnancy Diagnosis	Read|Write|Update|Delete	The pregnancy diagnosis data recorded on animals in the herd
Herd Evaluations	Beef	Read	The beef evaluations of animals in the herd, e.g. Maternal and Terminal Indexes etc.
	Dairy	Read	The Dairy evaluations of animals in the herd, e.g. EBI, Milk and Fertility Indexes
Herd Weight	Live Weight	Read|Write|Update|Delete	The weights data recorded on the animals in the herd
Herd Health	General Health	Read|Write|Update|Delete	The general heath data recorded on the animals in the herd, e.g. mastitis, lameness etc.
Herd Lactation	Period	Read|Write|Update|Delete	Lactation data recorded on the animals in the herd, including milk recording information. Dry off dates can be recorded and updated

Conclusion

ICBF continues to receive high volumes of quality data from farmers through paper forms, regardless of the continued investment made to provide alternative electronic methods. The number of herds using the paper forms to record data is gradually decreasing over time, but the pace of decline is slow and the issuing for forms will continue for the foreseeable future.

ICBF is currently developing a suite of API's that will allow for the sharing and recording of farmer recorded data across many third party software and devices. These APIs have many wide-ranging advantages for the agricultural industry, but the software, devices and sensors need to be put in place to interact with them. The adoption rate of these technologies remains to be seen.

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