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ORIGINAL ARTICLE

Innovation in farming: an engaging and rewarding business model to foster digitalization

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ABSTRACT

Over the last few years, innovation has been heavily driven by digitalization. This is due to the huge developments in the field of data analysis, enabled by the introduction of new technologies. Several fields have witnessed a smooth integration of digital tools along the whole value chain, unlike legacy sectors, which still face a spread mistrust towards innovative digital solutions. This paper proposes an engaging and rewarding model, taking into account the causes hindering innovation in the animal farming sector, complemented by the validation of the motivations behind its features and the obtained results.

Keywords: stakeholders' engagement; innovation adoption; farming.

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INTRODUCTION

During the last decades, technological advancements took place at a very high pace, increasingly contaminating a wide range of sectors, including those which used to be considered technology free. Indeed, since the breakout of the Internet connection, many improvements have been achieved for what concerns the capability of managing huge amounts of data, interpreting it and automating processes to do so.

In particular, data collection and data interpretation are becoming more and more significant for processes optimization, making digitalization a core ingredient for the thriving of any sector. As an example, when considering the industrial sector, digitalization has led the 4th Industrial Revolution, with the introduction of the concepts of Industry 4.0 and Smart Factories that uprooted the traditional industrial scenario, characterized by rigid and fixed production lines (Indri et al., 2019).

Undeniably, digital revolutions require profound changes, whose implementation implies a non-negligible transition time. This is even more evident when considering legacy sectors as the farming sector is. Indeed, compared to industrial supply chains the most relevant processes along the farming supply chain are typically heuristic and based on farmers' experience, making it difficult to apply quantitative methods.

Nevertheless, digital transformation processes in farming are typically focused on the farm internal efficiency, e.g., on the productivity of the farm itself. However, extending information-based optimization to the logistics side would provide access to data across the whole supply chain enabling an easier interaction, complete product information and opportunity for innovative business models (Braun et al., 2018).

Having established the importance of digitalization as a catalyst for improvement, it is clear that participation of stakeholders is a key aspect for a feasible digital revolution. Furthermore, although new technologies can contribute to transformation, they cannot impact on an industry revolution without a business model able to map an emerging technology to a new market need (Kavadias et al., 2016).

What is missing in the farming sector is an extended adoption of innovative practices. In particular, when considering the animal farming sector, engaging the farmers is of crucial importance for the acceptance of digital processes (Michler et al., 2019). As a matter of fact, being the methods used in animal farming strongly centred around the farmers' experience, innovation is facing immense opposition: often innovations are driven by academic studies, brought on without the pressure of commercial farming, making it difficult for farmers to take solutions based on scientific findings as credibly applicable (Stamp Dawkins et al., 2011; Douthwaite and Hoffecker, 2017).

This paper proposes a preliminary business model specifically tailored for encouraging innovation adoption in the animal farming sector. In this work, the underlying causes of animal farmers mistrust of innovation are analysed while taking into consideration what has been done so far. This work is organized as follows: first an overview of the existing business models in farming is given, followed by the description of the business model choices assessment process. Then, the proposed business

model is outlined, considering it applied to a possible solution to the problem of Antimicrobial Resistance (AMR). Finally, conclusions are drawn.

BUSINESS MODELS IN FARMING

The industry of animal farming is under pressure due to a projected increase in meat demand of 50% by 2050. The industry is also under question for its sustainability due to its impact on land usage, water pollution, GHG emissions, animal welfare and antibiotics usage (Deloitte, 2017). New technologies, especially digitalization can reduce the impact of the industry helping the whole value chain and especially farmers adopt more sustainable practices (FAO, 2018). However, agriculture is among the least digitized industries compared to other sectors (see Fig. 1) due to several factors: weak margins and constant price pressure, unclear return on investment, fragmentation and lack of structure along the value chain especially at the farmers level, high average age of the farmers (Arslan, 2019), and lack of technology enablers.

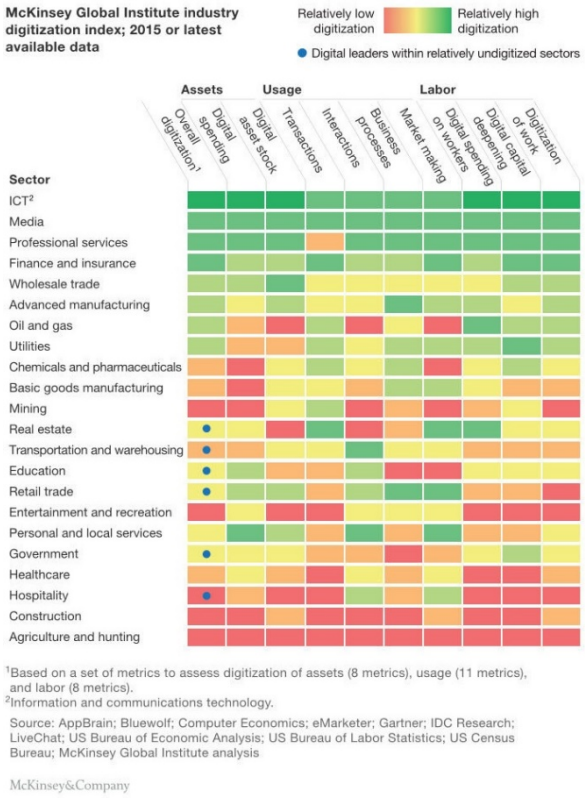

Fig. 1. Global industry digitisation index (McKinsey, 2015).

Indeed, digital technologies have the potential of integrating digitally driven methods in the agri-food system. However, the risk of leaving behind emerging economies and rural areas during the process of digitalization is very high due to weak infrastructures and connectivity, ICT education, affordability, and institutional support (Trendov et al., 2019).

Farmers are often pushed to adopt more sustainable practices but left alone to face the uncertainties related to the adoption of innovative practises from a financial and technological point of view (Olum et al., 2020; Diederen et al., 2003). For these reasons, innovative actors in the field are promoting and adopting models which engage and reward the farmer in adopting innovative methods (Zabala et al., 2017). In this loop are often involved actors such as investors and insurances.

Furthermore, data transparency and the almost complete absence of data sharing are two of the most relevant open issues in the animal farming industry. Especially regarding antimicrobials usage, there is a lack of digitized, portable, and almost real-time data and information. Among the causes of low data traffic there is the sensitive ownership notion. Despite the spread of this concept in several other sectors (e.g., mobility and health), farmers are currently concerned about data usage, visibility, transfer, and price discrimination (Lynch et al., 2017). A possible solution to the described issues is evolving towards a participatory market model implying value distribution among different actors. To achieve a network model, a linear closed model must be overcome, putting farmers into action rather than reducing their role to mere data providers and buyers of services generated by themselves. It is pivotal that farmers act as data controllers, being empowered to allow data usage from third parties. Therefore, there is the need to establish trust and collaboration to allow collected data to be open, available and high quality while ensuring data privacy and ownership when combining public and private data (Bahlo et al., 2019). It is worth mentioning that when considering the precision agriculture market, expected to grow to reach USD 5.5 billion by 2021, the actors who have a say in it are mainly big players of agriculture innovation, Bayer (now including Monsanto) as an example. Relying on huge investments, the agriculture digitalization sector is held by big names (Roland Berger, 2019).

The prevailing innovative Business Models (BMs) in the field of farming can be summarized as follows (Berlin et al., 2017):

- *Subscription model*. Monthly/annual fee to access product or service (Tzuo & Weisert, 2018). The customer has continuous access to the offered product while becoming more valuable to the provider the longer it uses it (Campbell, 2019). The farmer can easily try out a potential solution on the farm and just terminate the subscription, should the benefits not be satisfactory.
- *Pay-Per-Use*. Payment based on the amount of usage; it requires service usage quantification (e.g. through sensors) and is often linked with environmental benefits and the increase of a product life cycle (Bocken et al., 2018). Offering

pay-per-use agricultural equipment and services can lead to economic advantages for the farmers, while ensuring cost transparency (Desikan, 2016).

- *Pay-per-performance*. Payment based on the performance obtained. It requires the definition and monitoring of some performance metrics. Business risks are entirely on the service provider, which realizes a gain only if the service level meets contractual thresholds (Glas and Kleemann, 2017).
- *Asset sharing model*. Finance investment in the product by selling extra capacity to others. This BM fits within the sharing economy model and has already been adopted in different agriculture contexts such as the farm machines sector.
- *Door-opener model*. Offer the connectivity and the hardware for free and then sell services developed upon it. This is a common approach in the new digital servitization trend, as well as within Industry 4.0 since it helps to increase customer value (Huikkola and Kohtamäki, 2018).
- *Bundling/Service enhancement*. Provide the product or service together with already existing ones, increasing their value and allowing for an increased fee. This BM aims at gaining a strategic competitive advantage within the market (Chiambaretto and Dumez, 2012).
- *Freemium.* Offer the basic features of a more complete service of portfolio of services, so to gain market share; monetize from further paid services (Gu et al., 2018). This BM is made possible by the exploitation of farms data, which allows to offer a service without additional financial compensation from the farmer.
- *Platform model*. Gather data and share them with 3d parties to open additional revenues. This BM creates value by facilitating exchanges between two or more stakeholders, supporting entrepreneurs in reusing and combining available data sources to provide value-added services (SIAL Paris, 2016).

The following examples for *platform model* in agriculture can be found: Climate Fieldview by Bayer, Nevonex by Bosch and Agrirouter by DKE-Data, which connects field farming equipment machinery manufacturers. The most successful example of business model disruption and farmer engagement is Indigo Ag (Mitchell, 2019), the most well-funded AgTech startup, which employs a massive data-gathering apparatus and uses a network of partners of big farms to experiment digital technologies to improve yields. The strong points of their revolution are (i) their ownership, since the farms which donate their data become shareholders of the company, and (ii) their engagement campaign for regenerative agriculture, Indigo Carbon (Spiegel, 2019), where farmers get paid to adopt sustainable practices.

METHODS AND DATA

The hypothesis lying behind the choices for the business model has been validated by stakeholders directly involved: investors of the farming sector and farmers.

Financial investors have been interviewed regarding the relevance of the topic for the financial community and the possibility of interaction between farmers and third-party companies. The interviews have been carried on telephonically, and minutes of each of the phone calls have been transcribed by a member of the team. A basic skeleton-questionnaire was followed but keeping it flexible to allow for impromptu conversation topics and unforeseen topics.

Three interviews were carried out with investors and collaborative investor networks. Note that the interviews have been performed with the aim of obtaining an informed view of the farmers main concerns and needs, without an intent to perform a specific analysis.

Farmers, instead, were asked to fill out a survey, presented in the form of a multiple-choice online questionnaire. This option was not always feasible and was substituted by telephonically contacting the farmer and filling out the questionnaire ourselves. In many occasions we held preliminary phone calls with farmers to gain a first contact before sending the questionnaire. Moreover, in order to guarantee unbiased results and cover a wider section of the market beyond the knowledge of the authors, as well as to gain the confidence of farmers, the survey has been distributed mainly by veterinarians and agrarian consultants. This strategy for the distribution of the form has been suggested by some farmers, knowing the spread mistrust among their community. The survey has been distributed along with a brief authors' presentation document explaining the research aim of the data collection.

The total number of distributed questionnaires (mainly in Italy) was 100, with an overall number of responses amounting to 47, i.e., less than 50%. This low response rate was partially expected, given the reasons that led the form distribution mode. It is noteworthy that given the obtained number of answers, the results should be considered as a tool for helping the authors defining the proposed business model.

The questionnaire was designed using neutral wording that would not influence the answers of the farmers. The first part was aimed at defining the size and type of farming; the second part investigated the awareness of farmers in regards to technological solutions and their current level of adoption; the third and final part proposed key aspects to be possibly considered for our business model outline, in order to evaluate the impact that such features would have on the adoption of technology.

RESULTS AND PROPOSED BUSINESS MODEL

The interviews with investors all provided insightful information, confirming the desire of involvement of investors and big corporations in a more sustainable approach to farming, which can be achieved by resourcing to technological solutions.

Regarding the questionnaire sent to farmers, most of the participants in the survey were small-sized farmers (>70%), hence the results are considered to be consistent with the original aim of the research, which was to study and promote the adoption of technology in farming on a smaller scale. Out of the whole sample, only 44% was aware of the introduction of new regulations on mass animal treatments in 2022, but 61% had already considered technology-based solutions.

Information regarding the adoption of technology solutions can be seen in Fig. 2.

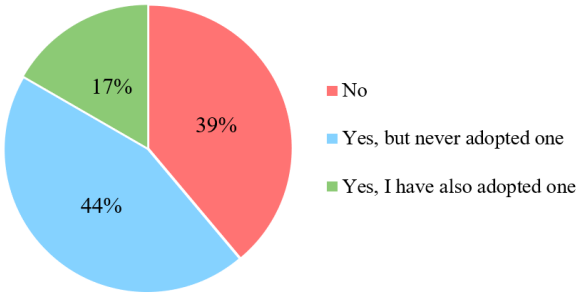

Fig. 2. Question: "Have you ever considered adopting technological solutions?".

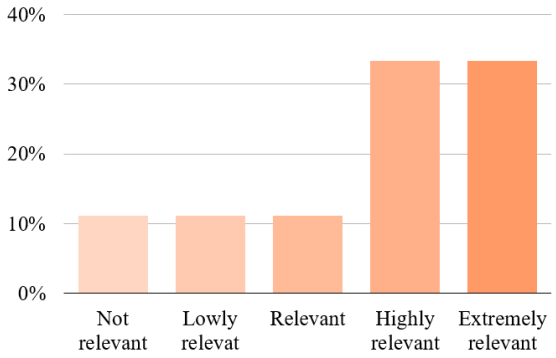

Fig. 3. Question: "How relevant is for you, together with the technical aspects, the economical safety of an investment of this sort?".

It turns out that 44% of participants had considered such an investment, but never followed through, mainly because of the high implementation costs and the complexity of such solutions, as expected from the research that has been carried on about the topic.

The economical reliability of an investment has been reported as important by 67% of the participants of the survey (Fig. 3). 72% expressed interest in a solution where they would not require paying for an initial investment, but only based on the services received (Fig. 4). In terms of data usage, the topic was considered relevant for 72% of the sample (Fig. 5).

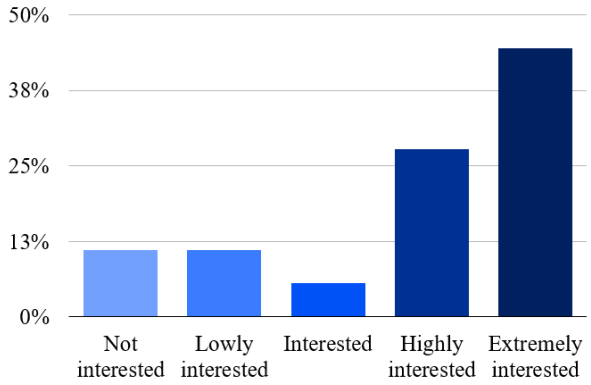

Fig. 4. Question: "How interest would you be in trying a solution if you had to pay only for the services received, without any initial investment?".

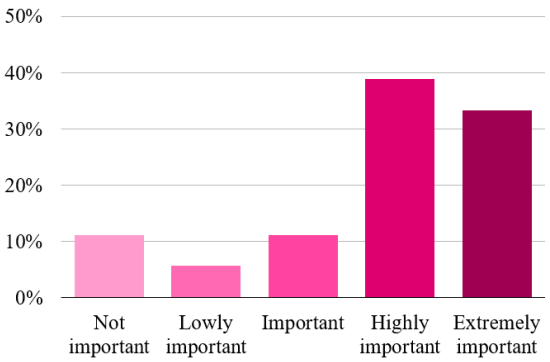

Fig. 5. Question: "How important is data management for you?".

Regarding the willingness to share data with research institutes or universities, we obtained the results reported in Fig. 6. A different situation was presented in regard to sharing data with insurance companies or other commercial organisations: a breakdown of the responses can be seen in Fig. 7.

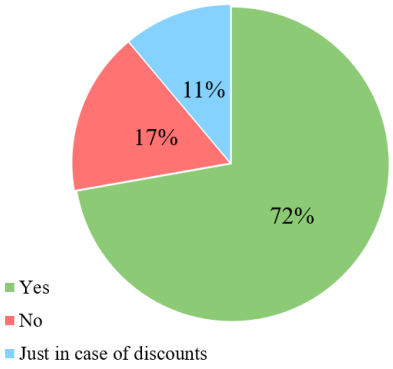

Fig. 6. Question: "Would you be willing to share your data with research institutes and universities?".

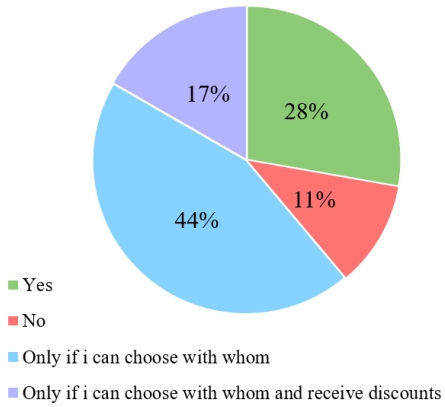

Fig. 7. Question: "Would you be willing to share your data with third-party companies?".

These results provide a first validation of the general assumptions behind the choice of the proposed business model. A lack of awareness of regulatory and technological advancements as well as the economic uncertainty, is hindering adoption in animal farming business. Thus, the choice of a *pay-per-performance* model allows the farmers to avoid sustaining initial investments and build trust clearly connecting the benefits received with the service payment. Concerning data usage and sharing, farmers value data as a truly relevant topic, however they are willing to provide it for research purposes without expecting returns, allowing us to build partnerships with universities and institutions to develop and improve our offer. Regarding data exchange with third-party companies and insurances, our choice to empower the farmers by allowing them to control the data flow seems to be even more important than expecting something in return, signalling how the perception of control and trust is more critical than a simple remuneration.

In light of the obtained results, this paper proposes a hybrid business model, mainly tailored on the needs of small-medium farmers, for a potential solution to tackle the issues of antimicrobial resistance. It is worth noting that the authors do not set as an object of study the development of an entirely new BM, but rather the definition of a cross between existing models, with the aim of meeting the concerns of farmers and attempt to mitigate their reluctance to open their farms to digital transformation.

To provide a structured definition of the business model, we describe it through the following key elements (Johnson et al., 2008):

Customer value proposition. With our product and business model, the farmers can easily access information encapsulated in the farm's data. Leveraging monitoring data, the animals' health and performances can be boosted, paving the way to enhanced prevention allowing for punctual cure, as opposed to prophylactic mass cures. The product becomes an intermediary between the farmer and its animals, translating complex correlated data into accessible, user-friendly and thus understandable information. Without the need of specific skills, the farmer takes control of its own data, saving money and time as a result. The innovation lies in tackling the mistrust of the farming sector in technologies and academia results by clearly mapping benefits to real use cases.

Revenue streams. The digital solution is provided to farmers, who are not requested an up-front investment to enhance adoption rates. The services are then provided to be paid on a per-performance basis (some of the introduced metrics are the % of reduced animal mortality, the % of animal diseases, the % of reduced antibiotics), guaranteeing a minimal threshold level for the farmer. Moreover, user segmentation and freemium logics may be put in place to ensure advanced monetization and connected benefits in terms of user involvement and participation. Regarding the topic of shared ownership, it is the authors' opinion that this option could be of less interest to small-medium farmers, than to big ones. However, this option will be kept open, to ensure commitment and alignment of our objectives to the farmers' ones.

Key resources. The proposed product and business model rely highly on the sharing of data and information. Fundamental, in order to obtain said data, is a technological infrastructure able to collect the required information and process it, even in locations that might not have good internet connection. Moreover, a user interface is essential for the farmers to read the processed information, hence the need for an easily accessible database and application to display data. Alongside this, partnerships are an essential resource, as the aim is to share the data and incentivise it through discounts.

Key processes and channels: since the solution is technology-based, having quality control and constant development is essential. A sales strategy to keep the farmers involved is fundamental to allow the spread of the technology. Talking about AMR specifically, the clear definition of performance metrics is crucial to determine the progresses and the added value brought by the usage of the solution. Moreover, a well-defined policy on the usage is essential to ensure that the product is being used in compliance with national and international regulations, as well as to avoid false declarations. As previously discussed, there is a lack of reliable data sources and sharing, leading to a limited availability of pre-built datasets. To make up for this limitation, the plan is to start with pilot installations in the framework of research funded projects, in order to gather the first batch of data necessary to enable state-of-the-art AI-based analytics. When setting up the solution in pilot farms, there can be pitfalls to be avoided and standards to be compliant with. For this reason, reaching out to champion famers is fundamental so to put forward success stories of a new business that may seem risky for many, and foster behaviour change.

Key partnerships: the first fundamental partnership is the one established with the farmers, as they are the primary customer. Moreover, for the solution to be sustainable, strong partnerships with veterinarians are essential, so that the model can be always re-evaluated and adjusted based on new information, as well as providing farmers direct access to medical help. Farmers will be empowered to have control on their data sharing beyond our service development. Third-party data transactions will be subjected to the farmers' agreement: partnerships with insurance companies and other companies involved in the value chain are essential, to ensure discounts and custom solutions to farmers who agree to data sharing. Data collected will also be made available for free to research institutions and organizations in exchange for support to the farmers and external branding for us. This helps to create a collaborative environment between research institutes and entrepreneurs with the aim of obtaining a mutual gain through synergy, while pursuing social goals. Partnership could be established with stakeholders who are aware of the addressed problem and can react more promptly and precisely thanks to the enhanced data flow. A graphical representation of the proposed model is shown in Fig. 8.

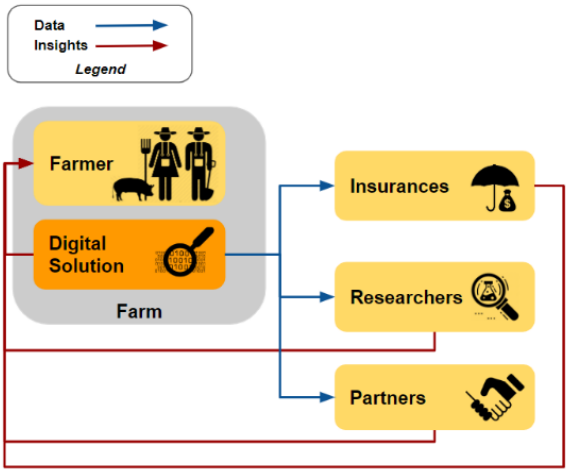

Fig. 8. Proposed business model schema.

CONCLUSIONS

In this paper we presented a business model to establish an engaging and rewarding mechanism in the farming sector. The proposed business model, applied to provide a solution to AMR, aims at facilitating the adoption of digital solutions in a legacy sector where innovation is having a hard time taking hold.

To implement a suitable model, the main causes hindering innovation have been analysed and taken into account as lessons learned in the sector. The adoption of innovative business strategies driven by digital transformation can foster the shift to both a new digital growth and an increase in operational efficiency of existing core activities. The business model proposed in this work is a key element to enable a rewarding and economically sustainable digital revolution in the farming industry.

As next step, it will be fundamental to validate the proposed business model, complemented by the fully developed technological offer, through a dedicated survey. The development of a first viable technological solution could be carried out by taking advantage of the rapid prototyping tools provided by IdeaSquare at CERN, whose network could further help the validation of some of the relevant assumptions (identified after a prioritization and categorization process). The validation of such assumptions would generate a set of hypotheses designed to be tested with actual users. Moreover, with the aim of validating the whole business proposal, we will arrange initial pilot collaborations with selected farmers willing to become early adopters.

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