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Mandatory Livestock Traceability as a Catalyst for Knowledge Intensive Services in Uruguay

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Abstract

In 2006 Uruguay's Parliament voted to establish a system of individual livestock traceability that would initially be mandatory for bovine populations, and in future stages will encompass all domestic animals for sale and consumption. Besides attaching electronic eartags to each individual carrying unique identifier information, the system has the capacity to generate individual level databases and customized reports, with the government's compliance controls acting as completeness guarantees. The amount and other characteristics of the data being accumulated would suggest that there would be space for innovators to come up with alternative uses of those inputs to generate new lines of business or strengthen the competitive advantage of the livestock industry. This exploratory paper describes key features of two firms and a multi-member consortium that are taking advantage of the traceability system to produce valuable services to the industry and are considering ideas for future developments that would deepen the synergies. Prior to that, but implicit in the whole discussion, is the issue about the nature of the traceability system as a good. While the adoption of a strong public good rhetoric and logic was key to the successful implementation of traceability nationally, the proliferation of profitable spinoffs may bring up the issue of financing the system and dealing differently with public good and for profit services based on it.

JEL codes: 031, 033, Q12, Q16
Keywords: individual traceability, business services, genomic selection, food certification, beef production

1. INTRODUCTION

In 2 August 2006, Uruguay's Parliament passes bill 17.997, which made it mandatory for any bovine individual born or transported in the national territory to wear an electronic gadget for their identification, linked to a system of databases managed by the government. With its attendant regulations, institutions, and support service providers, this system of "individual bovine traceability" (IBT) was a step towards more effective disease control, assured tax compliance, and viable quality certification, placing the country at par with European Union's standards and qualifying it for access to top-quality EU and US import quotas. Pittaluga et al. (2013) argue that the requirements to be allowed to trade under the coveted "quota 620/481" (allows the importation of beef only from animals that have spent no less than 100 days in confinement and, eating only controlled food), and the substantially better prices it provides, triggered the exploratory efforts and generated the incentives that convinced the private sector to support the traceability initiative. As we shall see, the government's regulatory powers were somehow strengthened in this project.

For a global beef exporting country such as Uruguay, the IBT is a countrywide techno-economic innovation comparable in its scope and potential impacts to the wire fencing of land properties at the end of the nineteenth century. It brings closer to reality the fantasy of the contemporary global consumer, of tracking (or having the possibility to track) the food he/she is about to purchase to the farms where the animals were born and lived, but also to what they ate and how they were taken care of. For the growingly anxious animal health and food safety authorities around the world, IBT provides a powerful tool for prevention and outbreak control, and it also serves to curve farmers' opportunism through mechanisms of transparency that expose any deviations from health regulations. Yet, if these were the only benefits the IBT could provide, it would stay among the innovations that facilitate incremental changes in the economy and involve proportionate policy revisions. Some ongoing experiments described below, on the other hand, suggest that individual traceability may be a key component of a combination of technologies that are bringing about a qualitative change in the ways food commodities are produced, processed, traded and consumed.

Some observers start to wonder if these changes should transform the way development economics thinks about agriculture.[1] Traditionally, agriculture was the laggard sector from which economic planners could only expect as positive development contributions its occasional influence to keep down the prices of wage goods or, for certain periods, the export revenue from sales of unsophisticated goods (e.g., Ray 2002, especially chapter 10). Although agriculture had not been totally de-linked from the technological advances of the late twentieth century and beginning of the twenty-first, the repercussions of the latter had been mostly gradual and largely restricted to improving output-input indices for goods of an unchanging nature.[2] But is this also true of an innovation such as IBT? More specifically, is it possible that a wide-ranging technical and institutional construction with the characteristics of IBT may generate effects that transcend its original purposes and catalyze farther-reaching transformations conducive to valuable development outcomes? This question raised by the implementation of IBT in Uruguay makes it a case of great interest in a broader research program on the potential of "Knowledge Intensive Services in Natural Resources Based Industries".

The present case study of the livestock industry in Uruguay is organized in five sections besides this introduction. Section 1 is devoted to characterizing IBT as a techno-economic innovation. It describes its significance for the beef-producing chain, the technical and institutional aspects of the system, and the international experience with IBT systems. Section 2 recounts the establishment of the IBT system in Uruguay. After summarizing its milestones, it then characterizes the decisions that public authorities faced, and the political economy behind the chosen solutions. Among others, it discusses the nature of the "good" created and the financing mechanism chosen. Sections 3 and 4 examine two very different offshoots from the implantation of IBT. The first one reflects private sector responses to the new regulation, demand for advisory services and abundance of data. The second represents a much more substantial innovation, which sustains the expectation that IBT will contribute to the advent of a new "intelligent agriculture", and that it will open new opportunities for technologically sophisticated industries. The ongoing project is identified in this document as "the Hereford experiment" and involves the integration of IBT with genomics for the genetic improvement of Hereford populations. Section 5 wraps up the chapter with some tentative conclusions.

[1] Unless otherwise stated, we will use "agriculture" in the North American style, where it includes the livestock sector and not just the production of vegetables.
[2] This is disputable as a factual generalization. It may be true, for example, of soybean, but not of beef. To some observers, beef is already a knowledge-intensive commodity.

2. CATTLE IDENTIFICATION AND TRACEABILITY

The World Organization for Animal Health (OIE) defines an animal identification system as "the inclusion and linking of components such as identification of establishments/owners, the persons responsible for the animals, movements and other records with animal identification", and animal traceability as "the ability to follow an animal or group of animals during all stages of life" (both from OIE, 2006, as quoted by Bowling et al., 2008).[3] Interestingly enough, Uruguayan official dissemination materials distinguish between product and process traceability: with the first one representing the more limited possibility of reconstructing the trajectory of the animal from its birth to its harvest, while the second comprises the former and adds the collection and systematization of information on how the animal was produced and its health record. The Uruguayan authorities describe the first as a spreading global standard and the second as the space for differentiating the Uruguayan beef and for making it known for superior quality.

Technology-wise, there is a range of solutions for identifying and tracking animals (Wogerwerf, 2011). Those go from mechanical (e.g., tattooing), to electronic (e.g., ear tags, ruminal boluses, and injectable transponders), and biometric (e.g., nose prints, DNA profiling, and iris or retinal scanning). Electronic systems appear to be the best suited to current needs and are used in countries that have the most developed identification and traceability systems, although needs and solutions may continue to evolve. Systems based on electronic gadgets rely on Radio Frequency Identification (RFID) devices that are currently manufactured in accord with ISO standards on technology definition, use, and equipment testing (the International Committee on Animal Recording, ICAR, is the international registration authority, overseeing the establishment and eventual expansion of coding rules and individual identification numbers). RFID technology provides reliable data that is unlikely to be tainted by reading error in the field, or problems in transmission or temporary storage.

RFID devices are available as ear tags, ruminal boluses and injectable. For meat traceability, injectable transponders present the inconvenience that they are hard to locate and extract for final disposal at the abattoir; while boluses are the safest against fraud but, as we will see, are

[3] Similarly, Uruguay's "traceability law" defines it as "el proceso por el cual, mediante la aplicación de dispositivos de identificación individual con código nacional, el ingreso de un animal a la base de datos oficial y registro de movimientos, cambios de propiedad y demás eventos productivos y sanitarios relevantes en la vida del mismo, es posible obtener un informe de toda su historia, desde el nacimiento hasta su muerte." (Law 17.997, of 2 August 2006, Art. 1).

less suitable than ear tags for farm automation, food safety and user-friendliness (these and other dimensions are appraised in Wogerwerf 2011). The RFID transponder (which can remain operational without its own source of energy as it uses only energy provided by the reading device) does not carry any substantial information about the animal or its past and current owners and relatives, but is the link between the animal and the databases that provide storage, consistency and usability to large amounts of information (e.g., avoiding repetition of ID codes in different animals, or addition of incomplete or miss-read data).

Regarding the databases needed for a traceability system, two types are relevant. First, a database for animals is necessary that links individual animal identification information to owner and possibly other information. These databases may be owned by the government, private or mixed type organizations; and it may be possible to maintain databases at the farmer level. To preserve the integrity of the data, a second database should have records of the ISO-compliant RFID tags being produced, to eliminate the risk of identical identification codes for different animals somehow entering the system. As a result of regulation negotiated internationally, the databases may be managed by the government or by private suppliers, in which case manufacturers' codes replace country codes.

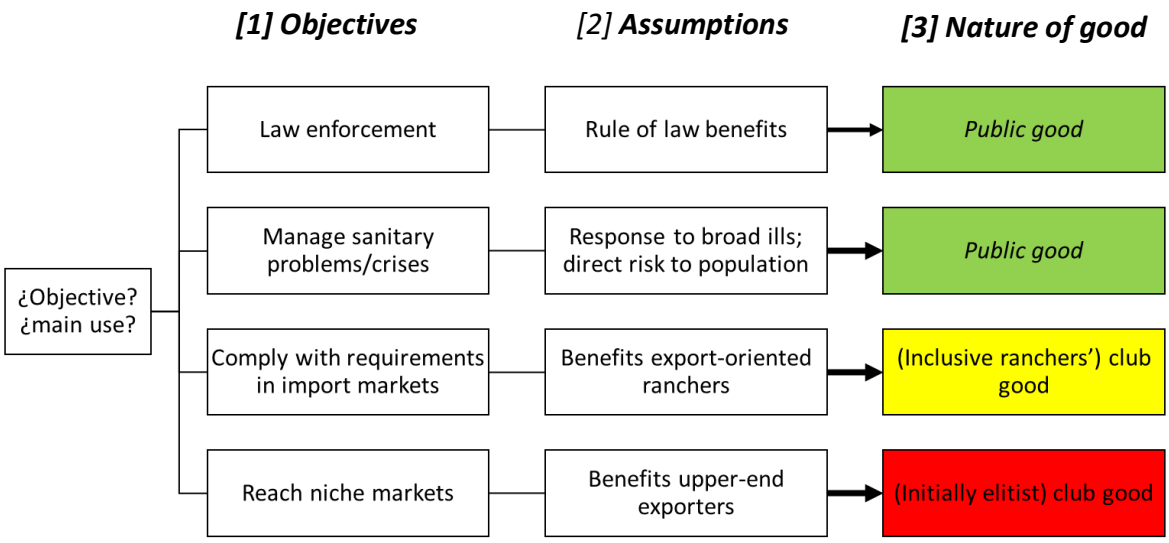
Moreover, the different public policy challenges, technical capabilities, and socio-economic structures determine variations in the structure of the platform, the specific data that is collected, the mandatory or voluntary nature of systems, and the structures that are the support of the platform. Thus, for example, while the EU has opted since the 1990s for mandatory participation of cattle producers in most sub-systems, the United States has traditionally run its systems on voluntary participation. As of 2008, individual cattle identification was mandatory in Australia, Botswana, Brazil, Canada, the EU, Japan, Namibia, South Korea and Uruguay (Bowling et al. 2008; the list was not meant to be exhaustive).

The main purpose which an identification and tracking system seeks to achieve is also reflected in its technical and institutional characteristics. For centuries, people used marks on animals' bodies to signal ownership. Tattooing and/or some other tangible ornament were good enough to meet producers' and authorities' need for centuries. In terms of tracking animals, until recently the technologies used would only support "group" traceability, and typically had little use beyond the gates of the slaughterhouse. Nowadays, uses and technologies have pulled each other upwards, with the result of IBT systems becoming multi-purpose platforms that have no single economic function.

Typically, traceability systems -- like other public structures -- are set up or strengthened in the aftermath of some crisis, and cattle-related crises most frequently involve the spread of disease. Australia and Japan tightened or drastically reformed their systems (as early as in the 1960s, and as recent as in the 2000s, respectively) in response to epidemics of brucellosis, tuberculosis and BSE (bovine spongiform encephalopathy). In other cases the objective being pursued adds fighting thievery and smuggling to disease prevention and control that, with tax compliance, are the set of typical "public goods" justifications for an IBT system. However, there are other potential uses of IBTs that do not fit the usual definition of "public good", even if they are still valuable from a development perspective. Hobbs et al. (2009) provide a thorough discussion of the various ways of setting up traceability infra-structures, their benefits and investment requirements; in order to assess in each configuration the nature of goods created by them. We present a simpler schema which suits the purposes of this article.

Figure 1 aims to synthesize these considerations: the first set of boxes (first column, "Objectives") enumerates the four main justifications for the IBT, which can also be read as four possible objectives of the policy. The second column states some assumptions that influence the analytical nature of traceability as a "good". The third group of boxes put labels on traceability (public, club good with qualifications or plain club goods), for each combination of objective-assumption. It shows that for two often-mentioned justifications for the IBT ("preserving and enhancing market access in high value markets") the benefits largely accrue to a specific group of producers that could justifiably be asked to bear the financial burdens. This position on the matter is, however, questionable since the interest of the producers and the government need not be opposed and a public good function may be let to justify the implicit subsidy.

Figure 1: Is the IBT a public good? Purposes, assumptions and system's nature



Source: Author's elaboration.

Law enforcement and disease control yield benefits that usually are non-rival, non-appropriable, and non-excludable. These "goods" must be financed with tax revenue, since it is well-known that the price mechanism breaks down when there is the possibility of free riding. [4]

The access of all or some farmers to niche or quota markets, the genetic improvement of races or the whole animal population, or the use of IBT data to optimize the use of resources (including making a more sustainable use of them), are examples of "goods" that have positive externalities but may exploit IBT functionalities for the benefit of a sub-set of market participants.

[4] Provision of these goods also needs policing, since they can soon become the object of abuse. Rivalry is made clear by warnings in the SNIG's site: "El sitio de internet www.snig.gub.uy está diseñado para ser utilizado a través de las interfaces y en las condiciones descriptas y establecidas en los instructivos correspondientes. Se advierte a los usuarios que el uso de programas diseñados para automatizar el acceso a datos del SNIG puede perjudicar la performance del sistema. Los administradores del sistema determinarán a su criterio cuando este tipo de prácticas configura un uso abusivo del mismo, y podrán tomar medidas que restrinjan temporalmente el acceso de aquellos usuarios responsables de las mismas."
https://www.snig.gub.uy/portal/hgxpp001.aspx?2,1,783,O,S,0,MNU;E;28;1;16;7;MNU, Accessed 28-Dec-2014

Put differently, there are activities made possible by IBT that are public goods. There are others that are not but could merit public support if they demonstrate that they have positive externalities. The difference should be important when designing policies and regulations for the platform.

To complete the description, the traceability system may track the animal just until it enters the gates of the slaughterhouse, or it can be linked to animal and beef quality data from harvesting and processing, and/or may serve to certify the origins of the cuts and pieces prepared for wholesale distribution and consumption –Uruguay's choice. These "extensions" may be created mostly with marketing considerations in mind or to fight tax evasion (or both). Some authors (Paolino et al. 2014) see the hand of Multi-National Corporations (MNCs) behind these developments, including in the whole process of defining standards and certification practices, as means to achieve full control of global value chains. Alternative perspectives highlight and emphasize the role of consumers' concerns.

3. IDENTIFICATION AND TRACEABILITY IN URUGUAY

Until the early 2000s, Uruguay only had group traceability, generated by a system built on annual sworn affidavits supported by large paper forms, and which continued to rely crucially on hot-iron marks as proof of ownership. The "technology" was essentially designed to keep track of the stock of animals, and in particular to fight thievery and smuggling. This pre-ICTs registration system managed centrally by the Dirección de Control de Semovientes (DICOSE) was created by executive order of the incipient military dictatorship in 1973. Though it looks too cumbersome today, it allowed the country for a long time to have reasonably good regional and national cattle statistics that were used and useful for policymaking, and provided group traceability the European Union recognized as safe and reliable.[5]

Catalyzed by the 2001 outbreak of foot-and-mouth disease (FMD), with its associated loss of markets and assets, the industry and government agreed to speed-up the deployment of mandatory identification and traceability systems as a means to recover the country's tarnished reputation and regain access to the most demanding markets. Despite imminent elections in 2004 the Sistema Nacional de Información Ganadera (SNIG) was approved with support from the whole political spectrum. The period from 2004 to 2006 was one of making decisions on some technical and economic issues (e.g., choice of transponder device; financing responsibility), importing and pilot testing of the devices with farmers who joined a voluntary traceability scheme, and defining the conditions for the upscaling of the systems to the national level. The country arrived at this point prepared with state capacities and political determination to advance traceability as a national emblem. Inputs (material and otherwise) necessary through the implementation process were surely more accessible in a country that has a centuries old livestock industry (and a vibrant, export-oriented software industry) than one that has neither. The series of "consultation" meetings held between authorities and stakeholders, which helped to achieve consensus on key features of the system that was to be put in place, confirmed Uruguay's reputation for inclusive democratic policymaking.

Bill 17.997 from 2006 dictates the compulsory registration of identification data for all cattle born within the last six months and/or being transported in the territory; and regulates the creation, coding, control and storage of individual animal's identification numbers; providing a schedule of

[55] Approval of Uruguay's group traceability by the EU was obtained in 1998.

deadlines ending in 2010 for full compliance. The final text of the bill reflects input received in the public consultations, on broader design issues (e.g., on the voluntary vs mandatory option) as well as on more specific implementation choices (e.g., including recording of time and place of identification, time of its inclusion in the system, types of animal's movements to be recorded, treatment of small groups, and recording of ownership from the time of registration onwards). From the perspective of the growth of business services, these consultations and agreements are an early and important stage at which the shape of spinoffs starts to be determined by the standards being set.

After negotiations, it was decided that transponder devices were going to be distributed by the government at no cost to the producer, marking the triumph of the "public goods" discourse. The fact that the traceability policy followed the FMD outbreak reinforced the view among producers and market analysts that traceability was mainly a government's response to a health threat which is normally a government's responsibility under the public good framework.

Figure 2: Solving the government's problems?

Source: MGAP information leaflet.

The third important milestone in the deployment of a comprehensive and mandatory IBT was the inclusion of beef processing and packing in the broader traceability scheme. While every IBT system has to have specific provisions for "termination" procedures (i.e., removal of identification numbers to avoid inaccuracies in the databases and to minimize risks of fraud), few countries link IBT data to measures of beef quality taken during the processing. The Sistema Electrónico de Información de la Industria de la Carne (SEIIC) had a slightly longer trajectory than animal traceability in the country, and was motivated by the complex pricing schemes of the industry and the government's suspicion of elusion/evasion in some establishments. The system of "cajas negras" (black boxes), as it is called, draws quality and weight information on the animal's pieces at six points in the transformation process. It complements IBT that follows the animal only until the gates of the packing establishment, and together they make it possible to achieve certification of desirable process characteristics almost until the retail stage; which represents a comparative advantage in competing in top quality market segments.

There are some additional bibliographic sources on the history of the IBT in Uruguay (see Paolino et al 2014), but they tend to discuss a reduced set of the platform's functions,[6] and then they miss the complex picture of actors, their interests and the outcomes. The angle most frequently adopted is one emphasizing the economic interest of producers and beef-packers in accessing price-superior market segments/quotas via certification. This perspective understands upgrading in Global Value Chains (GVCs) as vertical integration (see Paolino et al 2014) and/or expanding the national component of aggregate value added.

As it was argued in the previous section, the IBT system, as a multipurpose technology attracts interest from different quarters. Animal health authorities, for example, are and will remain interested mostly in expanding or strengthening features of the platform that are functional to the detection, localization and fight against a disease outbreak, which includes specifically highly accurate georeferencing and tracking of animals in territories. Tax authorities, on the other hand, may not care much about the past or current location of a group of animals if they

[6] There are few published studies about meat traceability in Uruguay. MGAP and the Inter-American Institute of Agricultural Cooperation (IICA) (2009) contains a complete description of the system; Barrios, et al. (2010) analyze meat traceability using economic analytical tools; Pittaluga et al (2013) examine the building of the traceability systems as a case of policies designed and implemented as public-private collaboration.

can confirm who sold them to who and when, whether their movements square with customs office records and regulations, etc.

This broad functionality of the platform will be related to the opportunities or constrains encountered by innovators that may need the platform to evolve in directions that are not of interest or high priority to more powerful actors/users.[7] If one looks at the IBT platform (including the beef processing industry), the stakeholders indeed contribute and benefit differently (see Table). That constitutes a political-economy configuration that will in one way or another influence the platform's shape and functions in the future, and will determine future market structures and functioning of KIBS. We examine below some of its implications for one of the most advanced innovative outgrowths of the IBT –"the Hereford experiment".

More generally, the multifaceted nature of the traceability system makes it hard to appraise as public policy instrument, as it could be seen as pursuing various goals at the same time. In that position, it is likely to disappoint those concerned with specific goals, who may always find the room for improvement that seems available when one misses tradeoffs. As illustrations, goals and their watchers may clash regarding confidentiality, scope of data required from producers or processors, or intellectual property of results from joint ventures. Relevant tradeoffs in the evolution of the systems could show up between cost and accuracy (or completeness), use as enforcement tool versus voluntary compliance, epidemiological versus other research, centralization versus farm-level exploitation, etc.

[7] Indirectly, one of our interviewees identifies Uruguay's relatively high "tax morale" as a factor contributing to the successful implementation of IBT and black boxes, when he speaks of difficulties encountered in countries of Central America coming from producers' expectation that the system will be used for more aggressive tax enforcement tactics.

Table 1: Actors of the traceability system in Uruguay

Actor	Contribution	Benefits	Risks
Producers	Compliance with laws and regulations (not cost-free; transponders subsidized); reveal information	(Externalities, public goods): disease prevention; reduced losses to thievery; more transparent trading with processors Means to professionalize production (data, technicians)	Could have been charged with cost of transponders
Processors/packers	Compliance with laws and regulations (not cost-free) Reveal information	Improved conditions for valuable certifications	May exert political pressure if it feels the system to be biased in favor of the ranchers
Innovators	Development projects	More/better information	Obstacle: poorly defined confidentiality
Government – Animal Health Agencies	Confidentiality	More/better information	Would like to link it more effectively with health-related data but may complicate fieldwork
Government – Tax Administration Authority	Confidentiality	More/better information	Would like to link more effectively to accounting data?
Government – Productive Planning units	Policies, reforms, strengthen the system	More/better information	Would like full access to data and expansion towards economic, ownership, taxable bases data
Scientific Community	Opportunities for new, production-relevant innovations	Key new information	Would like full access

Source: Author's elaboration.

This study does not attempt to establish where the greatest benefits of IBT are going to come from but whether the introduction of IBT has generated new business opportunities around and beyond the natural resources-based industry (which will eventually mean the appearance of new or reformed key players). In particular, we try to ascertain whether there are promising, technology-intensive services companies that may be contributing to transform the technological landscape in the country, and that have grown based on and thanks to the transformations in the livestock industry brought about by IBT.

4. BEYOND COMPLIANCE – "VET+" FIRMS

The construction and functioning of the traceability system was bound to create a demand for technical services, from producers and possibly other actors in the livestock chain. The need would be felt first with regard to complying with new regulations. Moreover, the regulations "created" new specific actors (known as "operators"), needed to ensure that the information that goes into the databases meets integrity standards. To achieve that, the databases have security controls that authorized firms or technicians are allowed to bypass after getting the necessary permissions and some mandatory training.

Actors of the traceability system have specific roles that, although shared with others of similar or different line of business, are distinctively assigned to them. While the owner of the animals is responsible for registering vaccinations and health treatments applied, and the ministry's field workers are responsible for reporting field audits, health and death events, the trained operators typically report (i.e., upload data) on registration status, movements, change of ownership and intermediated transactions. These trained operators are qualified to get reports from the SNIG database, from the data they or their principals have submitted. Other actors in the chain can also request those access rights and take advantage of the information that gets generated on an ongoing basis.

All this implies that producers and their services providers can now make decisions based on more extensive data, and data that is more safely stored and less prone to errors. It is not surprising then that some of the first agents to see opportunities to expand their business were those already serving the producers; namely, agronomists and –specially—veterinarians.

One of such examples is "TrazUR", a small agricultural services firm whose head (a Doctor in Veterinary Sciences) has been in the activity for over 35 years; until 2006 as a free-lance consultant, and since then as Technical Director of a traceability "one-stop shop" of sorts.[8] To some extent, TrazUR illustrates the situation of similar firms once the country moved to mandatory traceability, although its specific characteristics may be closer to those of the more entrepreneurial variety of services providers.

[8] All data on TrazUR is from its website (http://www.trazur.com.uy) and personal interview with Dr. Hugo Estavillo, founder and Director, conducted on 26-November-2014.

The transformation and growth of TrazUR was triggered by the demand from existing customers that realized that a by-product of the SNIG was a rich database that contained valuable information on their own businesses which could be exploited to enhance economic outcomes. The customers demanded software to make sense of the data, and thus begun TrazUR's software-producer line of business in 2007, precisely at the beginning of IBT implementation. Today's TrazUR staff amounts to just six: two IT experts, two communications and marketing, an executive assistant and the Director who oversees the whole shop but also provides the veterinary expertise. Temporary work is hired for field data collection, and along with permanent employees and directors they generate the supply of services and goods which is essentially captured by the following enumeration:

Table 2: TrazUR's traceability-related services

○ Diagnostics of traceability status of the establishment
○ Field readings and case-by-case research in the SIRA databases
○ Lost ear tags and "observations" by system administrators
○ Research and resolution of "observations"
○ Analysis and adjustment of the establishment's official documentation
○ Individual traceability forms
○ Periodic control of individuals and their traceability. Preparation of sworn affidavits to report to DICOSE
○ Date planning of strategic controls for the establishment
○ Traceability management advice and cattle purchase controls
○ Training of owners and staff in
○ Recording during physical, health, nutrition, reproduction controls
○ Queries on SIRA and DICOSE sites
○ Shipping reports from INAC's site
○ Livestock management software
○ Traceability readers
○ Electronic and mechanical scales
○ Good practices in livestock management
○ Other
○ Periodic weighting and recording in management software
○ Readings during sanitary controls
○ Periodic reports to owners, partners and middle managers

Source: Author's elaboration.

The need to collect data in the field for compliance with the regulations has been the key factor pushing for the rapid dissemination of mobile readers, and with them a lot of tasks that used to be time consuming and prone to error are now done more effectively and efficiently. From

TrazUR's experience, these are some of the tasks that have benefitted the most from using standard readers and the firm's proprietary software:

- Sorting out animals to be sold from different owners
- Record and use of data on "failed" pregnancies
- Record and use treatment information and link it to weight of individual in the field
- Alerts for animals not meeting a condition (e.g., minimum permanence before movement; Hilton quota restrictions, etc.)
- In artificial insemination, record data on "services" and use for diagnosing pregnancy aptitude based on individual's history
- Sort animals by age (eligible for quota 481)
- Assessment of seller's stocks before a transaction
- Vaccinations, separate vaccinated from others

The firm recognizes that compliance-related advisory services comprises more than half of the income from sales of services (the company also sells traceability hardware and software), and that those shares are a reflection of producers' still cold attitude towards IBT. In view of that, their strategy is to sell "compliance" services as a way of "getting past the gates" ("traspasar las porteras") of the establishments. They allegedly avoid the "hurried consultant" syndrome, which they characterize as unconcerned with generating rapport and focused on "delivering the goods". Their preferred interactive model requires that the advisor puts himself in the shoes of the advised, helps the latter to see farther into the future, and lays out alternative management strategies. Besides a more philosophical justification, Estavillo asserts that the interactive approach is required by an environment in which producers still do not see the whole set of possibilities opened by IBT. Being practical people, producers need to be shown the practical advantages of IBT if they are going to incorporate more and better data in their management decisions and/or to achieve some forms of automation. He adds that a smaller but still important cause of the enduring skepticism is the insufficient government investment in education of stakeholders about ongoing innovations and the benefits they entail.

TrazUR works on the premise that traceability-related businesses are a growth industry. On one hand, the lifting of barriers to bone-in ovine meat exports to the USA will raise the stakes for moving to full mandatory traceability of ovines. The process will probably begin with voluntary traceability of those ready to start earlier, but it will soon have to become mandatory at national level. Still related to agriculture but revealing creativity and expansionary perspectives, Estavillo

commented briefly on ideas/plans (at unknown state of development) to articulate technologies and set up systems to serve private or public customers in the business of identifying (already being done) and tracking potentially dangerous agricultural inputs and equipment, especially those banned from use in certain areas or having to comply with handling and disposal regulations. Integrated with GPS technologies, flights of pesticide-spreading airplanes, or final disposal of potentially contaminating fertilizer or herbicide containers, could be detected and the possible misbehaviors punished. The power of georeferencing combined with principles of traceability appears to open important opportunities for innovative businesses, even if in some respects those look as “more of the same”.

Indeed, traceability looks growingly as a combination of principles and tactics that need to be customized for: (a) optimizing data collection in harsh or unusual environments; (b) ensuring two-way communications between data collectors and databases, and the recurrent uploading and reporting over relatively long time horizons; (c) tagging individuals where that might raise ethical or other concerns. Considering the similarity of logical structure, it does not surprise that Uruguay has already experimented or is experimenting with traceability schemes for such diverse functions as hospital garbage disposal, handling of paper-bound clinical records, or reducing errors in caviar processing at the sturgeon farms in Río Negro.

While the head of TrazUR could be considered an innovative entrepreneur, by choice or path dependence, his firm looks likelier to grow by expanding to existing markets with similar goods than to generate the innovations that create new markets by altering the definition of the good. That said, the firm seems poised to take on new challenges and, in the livestock and beef industries their approach to business services is at least proactive and creative; the movement towards greater internationalization is being considered but the approach is very cautious.

To sustain the growth, the firm and the sub-sector may have to find ways to sidestep, or work with the government to address, design issues at the regulatory level. In fact, our source seems to speak for more than himself when he observes that the regulations that support the traceability systems were produced by legalistic officers with no field experience. A first mistake is noticed in the inclusion of too many details in a law (which can only be changed by another law requiring majority of votes in Parliament) as opposed to leaving them to administrative decrees (likely to be introduced faster and to be technically stronger). As an example, the law stipulates that ear tags have to be removed right before leaving the port, while there are buyers interested in carrying individual identification forward into the destination country. Similarly, the

authors of the law were most concerned with being labelled unsafe by countries scared with recent disease outbreaks, so they felt they were acting as prudent public servants when dictating that individual bovines that are found without any of the two ear tags would be processed immediately and banned for exporting. However, the measure seems excessive when there are importing countries (e.g., Russia) that do not have such a requirement and are satisfied with pre-traceability national standards. Our informant argues that these flaws of regulation are not major obstacles for business today but could create problems if allowed to persist.

A SPINOFF FROM SPACE

IEETECH (Innovative Efficient Engineering Technologies) is an incipient player in the field of information technologies applied to the livestock industry, but it comes with outstanding proof of its drive, expertise and ingenuity. In 2013, Victoria Alonsopérez and a partner founded the firm, to supply Chipsafer, described as "a platform that can track cattle remotely and autonomously". The invention, which was motivated by Alonsopérez unease about the late and inefficient response to the outbreak of FMD in 2001, earned her the International Telecommunications Union Young Innovators Competition and the Best Young Inventor Award from the World Intellectual Property Organization (WIPO). In 2014 the Inter-American Development Bank selected IEETECH as the Most Innovative Startup of Latin America and the Caribbean and the MIT Technology Review Spanish Edition selected her as the Innovator of the Year.

Chipsafer combines GPS technologies and mobile network facilities, by donning each animal with a transmission device ("a necklace") that instantly conveys position information to the central hub, and from there to the client's preferred mobile device. The budding company has patents for the invention, self-defined as a value added system, and is working to add temperature to the information that is automatically captured in the field and transmitted to the center. In addition to unusual and unexpected movement—which are the basis of the alerts subsystem today—the animal's temperature will provide data for a more precise characterization of its current (or past) situation, and therefore it will allow producers to make better decisions.

Since all the animals' data are associated to their unique identification number in the IBT system, Safesearch adds indeed to the bases for analysis of herd's behavior, improving the informational base for running ongoing operations as well as for undertaking retrospective research. On the other hand, the value of the systems and data analysis services that IEETECH

can provide depends on access to other data associated with IBT identification available in public and also in private repositories. (Not surprisingly, the main use of the product so far appears to be in fighting thievery, and owners of expensive exemplars to be the main buyers; which are understandable outcomes, but point more to a law enforcement than a productivity and growth challenge).

It is worth noting that Ms Alonsopérez did not have a sector-specific background when she came up with the ideas for her invention. In fact, with an Electronics Engineer degree from Uruguay's public university, she had moved on to the space technologies field (which still today seems to be her passion); taking courses at the International Space University, and extending her global networks and the recognition for her work. Notwithstanding, she has plans for IEETECH's growth (expanding staff from three to seven partners and employees; looking for other profitable services based on the technologies it exploits and data that they generate).

The Safesearch story highlights a feature of the introduction and commercialization of new applications in thriving industries: as they unveil new business opportunities, these can be seized earlier by previous-technology service providers, taking advantage of their deeper knowledge of the field, or by tech savvy entrepreneurs with main expertise in other sectors (and even other planets...), but ready to think "out of the box" and trespass specialization barriers). This should be taken into account when pondering over policies to incentivize innovation. As a side note, Ms Alonsopérez regrets the cold reception and slow progress in an attempt to collaborate with one of the Institutos of the school of Engineering of the public university (to develop additional "sensors" to transmit data upwards from the animal), which prompted her team to drop the partnership and buy the needed services from a small local company made up of alumni from the same university.

5. THE HEREFORD EXPERIMENT

Perhaps the best illustration of the qualitative change introduced by universal IBT is the Hereford genetic improvement initiative, jointly undertaken by the Hereford breeders society, the main national agriculture business association (Asociación Rural), the Ministry of agriculture, livestock production and fishing (MGAP), the main agricultural research institute (INIA), the leading basic science research institute (Instituto Clemente Estable), and the Universidad de la República. The initiative (henceforth, "the Hereford experiment") seeks to integrate traceability with recent advances in genomics to accelerate the selection of most food-efficient and best beef quality Hereford studs. According to participants, the consortium originated with INIA researchers taking a proactive role, building on a history of collaboration with the breeders associations and the broader sector.[9]

The key underlying assumption of the initiative is that integration of IBT with genomics can deliver, first, more food efficient cattle populations, which means also that there are lower methanol emissions and water use. Second, genomic selection can also be steered to improve beef quality. Meeting both objectives (efficiency and quality) will strengthen the country's standing as exporter of top-quality beef that is produced with environmentally sound techniques; and all that while strengthening the economic equation for the industry.

Participants agree that this was a high-powered initiative. A sign of that is the fact that a Minister of Agriculture that has been a champion of the modernization and technical upgrading of agriculture took it as his personal responsibility to remove bottlenecks and generally to create favorable conditions for the advancement of the initiative.[10] The following pages describe the "experiment" in some more detail, bring out the specific role of IBT in its gestation and architecture, and investigate the political economy factors that explain its fast and so far successful implementation.

When we speak of the "experiment" we will actually be referring to the initiative to combine the functionalities of IBT with processes of genomic selection, with the purpose of improving the biological food conversion rates and beef quality indices of Hereford populations at large. The

[9] Participants have pointed to Daniel DeMattos as the spark that ignited the engines to get the experiment going. DeMattos is an agronomist by training, with a trajectory at INIA and an extensive knowledge of the beef cattle-growing industry.

[10] As reported by Dr Elly Ana Navajas, Senior Researcher in the Biotechnology unit of the Animal Breeding and Genetics area of INIA.

"experiment" label is appropriate because, despite its ex-ante viability, the initiative is not guaranteed to succeed as it rests crucially on the collaboration of private and public actors, among themselves and with each other. In other words, being strongly "technological", the initiative is not just expected to align hardware and software but it must also create institutional links among key players whose coordinated actions are critical for success.[11] At the same time, the initiative is broader than the ANII project, which represents not much more than the financing contract between the agency and the consortium.

The idea of combining the strengths of IBT and genomics may have emerged early in the process of deploying the former at the national level, possibly inspired by the Irish experience. In the late 1990s, Ireland decided to establish a new infrastructure for genetic improvement, built on the animal identification and traceability systems that had to be put in place to comply with European disease and quality control regulations (the paragraphs below are based on Wickham, 2011). To achieve that, substantial national and EU funds were committed and supporting institutions were established. In particular, besides the Department of Agriculture Food and the Marine (DAF), two institutions -- the Animal Health Ireland (AHI) and the Irish Cattle-Breeding Federation (ICBF) -- were formally established and assigned specific functions. They are good examples of modern public-private partnerships, for oversight and implementation of an effective and efficient system of identification and traceability.

The Irish traceability databases have been designed to facilitate rapid access, high levels of data integrity, minimal duplications and low costs. Particular care was taken to avoid duplication in data generation, as its costs tend to fall on the producer. Thus, the ICBF holds all data of relevance to cattle breeding in Ireland, which is obtained from about nine different sources. It is interesting to note that systems built with substantial investments and technical skills were not immune to problems resulting from coordination failures. For example, Wickham regrets the decision to collect only dam (and not sire) data, which limits the usefulness of databases for animal breeding purposes (Wickham, 2011). With strengths and weaknesses, these precedents seem to have provided a roadmap to the use of IBT for genetic improvement, and one advanced system that can be looked at for guidance in designing Uruguay's own.

The Uruguayan "experiment" consists in a set of activities intended to (a) improve the genetic pool of Hereford stud bulls with respect to food conversion rates and consumption-relevant

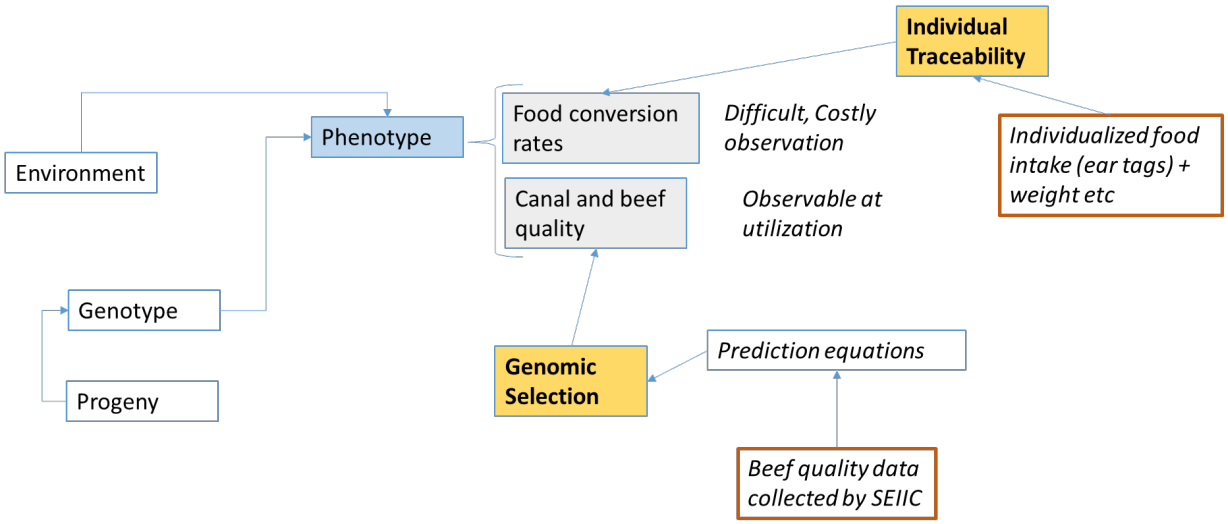
[11] To get a sense of the significance of the initiative, the Sociedad de Criadores de Hereford has 130 "cabañas" in its program of genetic assessment of traced animals, and 170 in the general, race improvement program.

quality traits; (b) facilitate the integrated use of the infrastructure for animal identification and traceability with processes of genetic improvement of bovine herds, and (c) ensure the necessary coordination of relevant public and private players to achieve the previous.

Especifically, the Hereford project focuses on two animal characteristics of significant economic value: the rate of conversion of food and water into bovine beef, and the quality (technically defined) of the resulting meat from a final consumer's view. Those two also happen to be "moderately heritable" and hard and costly to measure (e.g., "the canal", which is the aggregate quality index for bovines, can only be measured accurately once the individual animal is processed). The promise of genomic selection involves the use of molecular "markers", spread out through all chromosomes (the genome) to predict genetic merit of animals vis-a-vis the phenotypic characteristics of interest.[12] The use of predicted merit for reproductive purposes is selection. What genomics brings into the picture is enhanced selection that takes advantage of accumulated knowledge about the links of genomes to desirable phenotypical traits. By means of statistics tools, it is possible to estimate the effect of each "marker", and to also estimate prediction equations for each desirable productive characteristic, estimating a genomic value for each animal. Training populations are groups of animals for which there are observations and measurements of the characteristics of interests, as well as on genotypes. The combination of production data, genealogy/progeny data and genotypic data is powerful to animal's genetic value accurately, but the statistical model also makes it possible to estimate a genetic value without one's own phenotypical or genealogic data. The IBT and the black boxes of the SEIIC can speed-up processes and augment the impact of the experiment very substantially (see Figure 3).

[12] In the experiment, the molecular markers are produced in the Republic of Korea.

Figure 3: Accelerated selection through genomics and IBT



Source: Author's elaboration based on works cited.

One way in which traceability systems contribute to the Hereford experiment is by being part of the individually controlled feeding and watering of bulls. In fact, the animals' individual voluntary intake of food and water needs to be measured, something that is almost impossible in real field conditions but that can be done using automated feeding ports with RFID readers. They also permit to record frequency of trips to feeding post, time of the trips, time spent there, etc. These, and weights that can transmit data to the readers wirelessly, are all crucial to estimate the rates of conversion. Moreover, the system can assist in taking samples of animals' ADN even outside the training populations, and classifying live animals by their predicted efficiency when making selection decisions. On top of data, measurements of the individuals being observed can be collected in the farms and communicated to central databases, thus helping update and making more precise the prediction equations.

On the other hand, the system of black boxes set up in abattoirs can be used to report quality measures from the cuts, back to processing and eventually to the individual animal's records. In fact, the beef quality indices of interest are first measured in slaughtered animals that were part of the group subject to phenotypical selection. The recent work has focused on getting slaughterhouses to add a few crucial indices to their battery of indicators measured at the

individual level in the six stations in the plants (the SEIIC requirement). Samples of beef are taken to INIA's labs in Tacuarembó, generating data that can also be linked back to an individual.

This futuristic picture seems to mark the approximate external boundary of knowledge/technology intensity of firms/initiatives that have emerged as most innovative in response to opportunities created by IBT. The picture is not too disappointing. Only few countries with serious traceability systems could possibly imagine advancing in the process of integrating it with field and other environmental data, and with genomic selection, for competitiveness and ecological responsibility. Besides extending it to more animal races, the basic scheme would look viable in at least some agriculture productions where each individual is valuable and developing in natural environments is an asset in sophisticated markets.

6. CONCLUDING REMARKS

These are some of the key findings from this exploratory case study:

- The traceability systems (i.e., IBT and "black boxes") has created conditions for the transformation and/or reconfiguration of productions that were not possible before
- At a minimum level, producers can experience directly the advantages of applying available data to monitor performance or improve management practices. Given the nature of information collected and stored, modern veterinarians are at an advantageous position to see or create opportunities for learning and modernization
- The basic logic of bovine individual traceability is present in other markets, and for other goods. The firm that seemed more cautious in staying close to the original line of business turned out to be aware of growth opportunities and ready to seize them. The technical and/or institutional complexities of each market or situation will determine how long pioneers will maintain a first-comer advantage
- If the changes induced by traceability are not mind-boggling, the integration with geo-referencing seems to be already expanding the scope for businesses
- The nature of the technological package, the size of companies involved (at least in early phases) and the size of the market suggest that Uruguay's traceability services will not be substantial employment generators but may be one more contributor to consolidating a software industry
- Integrating individual animal traceability with genomic selection looks as an extraordinary "jump" (by Uruguayan standards), with potentially deep export markets and with growth opportunities. The institutional complications avoided, and the potential "win-win-win" opportunities identified are very promising advances. Uruguay may not revolutionize the markets but these advances will keep it a player in exclusive niches, without resigning being a competitive provider of less luxury goods (e.g., boned lamb meat).
- Technological advances interacting with regulations can create, expand or consolidate side businesses. Their survival and growth may hinge on decisions by major market players or regulators, which makes it advisable that their each step is taken carefully so as not to kill offshoots before they get a chance to develop.

REFERENCES

Barrios J.J., N. Gandelman, and G. Michelin. 2010. Analysis of Several Productive Development Policies in Uruguay. IDB Working Paper Series 130. Washington, DC: Inter-American Development Bank.

Bowling, M.B., D.L. Pendell, D.L. Morris, Y. Yoon, K. Katoh, K.E. Belk and G.C. Smith (2008) "Review: Identification and traceability of cattle in selected countries outside of North America", The Professional Animal Scientist 24: 287-294

Hobbs J.H., Kerr W.A. & Yeung M.T. (2009), Growing Forward. Public and private goods: The Canadian National Livestock and Poultry Traceability Program Agriculture and Agri-Food Canada, CAT: A34-13/2009E-PDF

MGAP and IICA (2009). Uruguay's Experience in Beef Cattle Traceability. Montevideo, Uruguay Ministry of Livestock, Agriculture and Fishery (MGAP) and National Meat Institute (INAC), Inter-American Institute for Cooperation on Agriculture (IICA). http://www.inac.gub.uy/innovaportal/file/6323/1/libro_trazabilidad_ingles.pdf[04/01/2013]

Paolino, C., Pittaluga, L., & Mondelli, M. (2014). Cambios en la dinámica agropecuaria y agroindustrial del Uruguay y las políticas públicas. Montevideo, CEPAL, Serie Estudios y Perspectivas.

Pittaluga, L., Rius, A., Bianchi, A., Bianchi, C., & González, M. (2014). Public-Private Collaboration on Productive Development in Uruguay. Documento de trabajo del BID, (501).

Ray, D. (2002) Economía del Desarrollo, Barcelona: Antoni Bosch, editor, S.A.

Wogerwerf, P (2011) Current tools and technologies for the identification and traceability, Presentation at Workshop on "Animal identification and recording systems for traceability and livestock development in countries of Latin America and the Caribbean", 5-7 December 2011. Santiago (Chile).