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UP-SKILLING HUMAN CAPITAL FOR VALUE-CHAIN COMPETITIVENESS IN URUGUAY

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UP-SKILLING HUMAN CAPITAL FOR VALUE-CHAIN COMPETITIVENESS IN URUGUAY

Katie Freeman THE WORLD BANK

Luís Dias Pereira FAO

Leandro Bullor FAO

Viviana Maria Eugenia Perego THE WORLD BANK

Dennis Escudero FAO

Francisca Voss THE WORLD BANK

Talita Pessoa THE WORLD BANK

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Abbreviations and acronyms

AFOLU	agriculture, forestry and other land use
AGESIC	National Agency for e-Government and Information and Knowledge Society
AMPC	Australia Meat Processor Corporation
AMS	automatic milking systems
ANEP	National Public Education Bureau
ANPL	National Dairy Farmers' Association
ARU	Uruguay's Rural Association
BMPA	British Meat Processors Association
CAF	Cooperativas Agrarias Federadas
CATIE	Tropical Agriculture Research and Higher Education Center
CD	capacity development
CONAB	Companhia Nacional de Abastecimento
CONAPROLE	Cooperativa Nacional de Productores de Leche
CNFR	Comisión Nacional de Fomento Rural
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
CSLM	climate smart livestock management
CURE	Eastern Region University Center
DACC	Sustainable Management of Natural Resources and Climate Change Project
DGRN	Dirección General de Recursos Naturales
DIEA	Dirección de Estadistica Agropecuaria
ECH	Uruguayan household surveys
EPA	Economic Partnership Agreements
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FUCREA	Uruguayan Federation of Regional Agricultural Experimentation Centers
GDP	gross domestic product
GEF	Global Environment Facility
GHG	greenhouse gas
GIS	geographic information system
GMA	Gremial de Molinos Arroceros
IAA	Institucionalidad Agropecuaria Ampliada
ICT	information and communications technology
IFCN	International Farm Comparison Network
INAC	Instituto Nacional de Carnes
INALE	Instituto Nacional de Leche
INC	Instituto Nacional de Colonización
INE	Instituto Nacional de Estadística
INEFOP	National Institute for Employment and Professional Training
INIA	National Institute of Agricultural Research

IPA	Teacher Training Institute
LATU	Laboratorio Tecnologico del Uruguay
MGAP	Uruguay's Ministry of Livestock, Agriculture and Fisheries
MIA	Meat Industry Association
MIEM	Ministerio de Industria, Energía y Minería
NAMA	National Appropriate Mitigation Action
NDC	nationally determined contribution
OECD	Organisation for Economic Co-operation and Development
OLPC	One Laptop per Child
OPYPA	Office of Programming and Politics
PLS	Planes de Lechería Sostenible
PO	producer organization
R&D	research and development
RWS	responsible wool standard
SFR	Sociedades de Fomento Rural
SISU	Sistema de Información de Suelos en Uruguay
SMA	Poultry Monitoring System
SMP	skim-milk powder
SMS	short message service
SNIA	National Agricultural Information System
SNIG	National Livestock Information System
SUL	Secretariado Uruguayo de la Lana
TDM	Trade Data Monitor
UCU	Universidad Católica del Uruguay
UDE	Universidad de la Empresa
UDELAR	University of the Republic of Uruguay
UM	Universidad de Montevideo
USCC	Unidad de Sostenibilidad y Cambios Climáticos
USDA	United States Department of Agriculture
USSR	Union of Soviet Socialist Republics
UTEC	Univesidad Tecnológica del Uruguay
UTU	Universidad del Trabajo Uruguay
WMP	whole-milk powder
WTO	World Trade Organization

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Executive summary

Uruguay's agricultural sector makes an important positive contribution to the country's trade balance, having represented 74 percent of total country's exports in 2018. Meat, dairy, wool and rice are key export-oriented subsectors, which concentrated 39.6 percent of total country's exports in 2018. As such, it is strategic for the country to keep these subsectors robust and dynamic in the long run and, therefore, equipped with the necessary human capital.

The skill set that is required by a sector is a direct function of the opportunities it is expected to face. Likewise, even if the right skill set is available in the country's labor market, the sector must be attractive to skilled workers. Hence, an analysis of human capital development perspectives for a specific sector must consider as main parameters: (i) key trends and opportunities for development of the sector; (ii) the knowledge and skills required to seize the identified opportunities; (iii) the offer in terms of professionals with the required knowledge and skills in the labor market; (iv) how attractive the sector is to such professionals, vis-à-vis the opportunities other sectors may offer.

URUGUAY'S AGRICULTURE: A SECTOR IN CONSTANT EVOLUTION

Widely exposed to international markets, Uruguayan agriculture has had to adapt to international market trends for a long time. The first two decades of the current century saw a boom in crop, dairy, and beef production to the detriment of wool and ovine meat production. In 2013/2014, areas sown with soybeans peaked at 1.33 million hectares with a production of 3.1 million tons and exports totalling USD 1.8 billion.

However, as international prices decreased, cropped areas (including those with rice) have started to convert back to pastureland again. In 2017/2018 soybean and wheat areas were reduced by 28 percent and 50 percent from their peak, respectively, and land use shifted mostly towards sown pastures, particularly in farms that specialize in meat cattle.

Despite the increase in dedicated areas, cattle inventories have stabilized at 2015 levels of about 9.3 million, which suggests that there is room to improve productivity in the sector. Average pregnancy rates, weight of weaned calves, weight gain rates and ages of first pregnancy are still below what could be achieved given the country's potential.

Other important changes include:

i. Recent gains in the productivity of dairy farms, which kept production levels more or less stable even with significant reductions in land use, cattle heads and number of producers. Despite these advances, the subsector still has ample potential to keep increasing its productivity.

ii. A slump in the number of sheep and sheep-dedicated areas, which have lost ground to cattle and to forestry. Sheep flocks are now mostly confined to the northwest regions of the country, particularly to soils with lower aptitude for agriculture and forestry, which may push farmers to seek breeds and production systems more adapted to the new main producing regions.

All in all, each sector has seen its own dynamics and faces new challenges and opportunities that influence human capital needs in each of them in the medium-to long-term.

DIFFERENT SECTORS, DIFFERENT KNOWLEDGE AND SKILLS NEEDS

In terms of beef, Uruguay is provided with modern processing and refrigeration facilities that can produce meat cuts to the highest international standards and at competitive prices. The existing processing units are rather heterogeneous in size, efficiency and use of installed capacity, but in general the country does not require a major modernization of this industry and its workforce is mostly trained by its employers. Well trained mid-level managers and engineers/technicians may be difficult to attract, but thus far this has not posed a real impediment to the sector's development. However, the majority of the existing units operate considerably below their installed capacity, despite the country's potential to increase its steer production without increasing the amount of land dedicated to cattle.

On the demand side, in the next few years, global meat trade is not expected to increase at the same pace as in the past decade. This slowing down trend will be aggravated by the consequences to the global economy of the current COVID-19 pandemic. However, the market for sustainable meat and specialty (chilled) cuts may increase in some well- paying markets such as the EU.

Hence, Uruguay has the opportunity to improve the productivity and efficiency of its cattle production systems. Additionally, there is also an opportunity to explore the market for sustainable beef and even the "Uruguay" brand,[1] despite the country's already good positioning in the international market for beef. All options imply more productive and efficient primary production systems, which in turn require knowledge and skills concerning the whole value chain as follows:

i. **At primary production level:** there must be a capacity to develop and implement more productive and efficient systems. Knowledge and skills development will need to focus mostly on cattle breeding and pasture management, as well as on carbon (and other) inputs or pollutant lifecycle assessment. A good understanding of such systems is needed amongst agronomists, subsector technicians (service providers) and producers. Additionally, the development and continuous improvement of production systems will become more efficient as their monitoring and evaluation systems become more developed. A cohort of professionals with capabilities in the production systems described above, as well as in digital technologies could enhance producers', organizations and public sector information systems in addition to enabling faster continuous improvement of production efficiency and value.

ii. **At processing level:** the country is generally well equipped in terms of capacities for meat processing and packaging. However, as the level of automation in slaughterhouses increases, more professionals with automation knowledge will be needed. Some producers' organizations and slaughterhouses can also continue to invest in the certification of their meat. As such, the sector will also need: (i) capacity to adapt the existing cattle traceability system to collect and treat information that is needed for certification and improved information to consumers/ buyers; and (ii) capacity to provide technical assistance services to producers for the adoption of certified production systems.

1 As mentioned in Chapter 2, seizing opportunities concerning the change in demand profile for beef in large and sophisticated markets, such as the European Union or the United States of America, is to a large extent conditioned by trade agreements. Options regarding such strategies should be assessed taking this into consideration.

iii. **Market positioning:** should the country move towards greater use of meat certification, multidisciplinary teams need to work with producer groups and slaughterhouses to agree on the set of standards and labels that best fits target markets and Uruguay's production systems. Depending on the nature of the labels, these will consist of nutritionists, food scientists, experts on feeding and pasture management, soil scientists, ecologists, economists, and communication marketing experts.

The dairy sector is more vertically integrated than the beef sector. Cooperatives process a large share of milk and assist their members in improving their farming systems. The main milk processors are equipped with top-quality technology to produce a large variety of dairy products. In addition to the large factories that process almost all the milk that is produced in the country, Uruguay has around a thousand farm-based dairy-processing units (producing dairy products such as cheese and *dulce de leche*).

Owing to its large production and the small size of its domestic market, the country has specialized in the production of high-quality powdered milk. However, increased production in China, the main trade engine for powdered milk, may mean that the country will no longer be such a strongly reliable importer. In turn, the demand for cheese and organic dairy products should increase in some markets, namely the European Union and the United Kingdom. Some Uruguayan players may seek to seize these opportunities.

In sum, the sector is already on a clear path towards greater primary production efficiency and productivity. This work will be continued and new opportunities can be explored (e.g. organic powdered milk production). Hence, the main options for dairy, as for beef, revolve around more productive and efficient primary production systems and exploring new high-value-added markets. Required knowledge and skills are described below:

i. **At primary production level:** in addition to the opportunities and needs identified for beef, an additional opportunity specific to this sector is the cost-efficient automation of the milking process, which may be key to attracting younger generations to the farm.[2] There is scope for continuous public support for production systems development in partnership with producers' organizations, as has been done in the past. Research institutions and producers' organizations can also be responsible for vocational training of automatic milking systems (AMS) maintenance technicians.

ii. **At processing level:** the country already has very advanced dairy plants and is able to export high-quality differentiated products when demanded. Should organic dairy products (e.g. powdered milk and cheese) enter the dairy plant's product mix, these factories will need staff with knowledge on organic certified processes ("from farm to package"). They will also need to build on existing capacities to adapt the national cattle traceability system to collect and treat the information needed for certification. Smaller units can be assisted in developing higher-value-added dairy products, such as specific cheeses.

iii. **Market positioning:** differentiation of dairy products can only happen to a limited extent and Uruguay will need to continue working towards efficiency along the value chain. Nevertheless, some opportunities

2 This is particularly true for family farms which are expected to run mostly with family labour.

for new market positioning for high-value Uruguayan products may materialize in the form of organic powdered milk and specialized cheeses. Unlike what happens with meat, there are some well-established labels or labeling systems of which Uruguay can take advantage, namely organic certification and geographical indications. Producer/industry organizations – either with their own dairy plant or for example an association of cheese producers – would mostly need professionals with knowledge and experience in labeling and certification schemes, dairy product production, management, and communication and marketing.

The wool industry in Uruguay is rather mature. Wool transformation is concentrated in four industries that produce wool tops and that operate with mature technology. These industries are not expected to invest further in processing, given the international trend to trade on greasy wool rather than tops and to vertically integrate production in a few countries. Nevertheless, institutions such as Central Lanera or Secretariado Uruguayo de la Lana (SUL) can deliver high-quality services to the value chain, from market intelligence to advisory services on production technology, as well as advanced wool analysis.

This set-up provides the country with an important competitive advantage to address the increasing demand focus on finer wool used for garments, possibly with some niche markets for "sustainable wool" becoming more significant in size. The recent land use trends in Uruguay that have concentrated sheep production in regions with poorer pastureland provide a further opportunity to shift from predominantly mixed-purpose breeds, such as Corriedale, to fine-wool specialized breeds such as Merino, which are better adapted to poorer pastureland. However, these breeds – usually suited to arid climates – require adaptation to Uruguay's humid conditions. Knowledge and skills required to face these challenges are described below:

i. **At primary production level:** there must be a capacity to assist producers in changing their production systems to match changing market demands. This means that the country needs available knowledge in sheep breeding and pasture management for efficient high-quality wool production. The capacity for adoption of Responsible Wool Standard (RWS) or similar certification may further increase the value and competitiveness of Uruguayan wool. This requires the training of agronomists, subsector technicians (service providers) and producers capable of developing and implementing such production systems. As in any other subsectors, professionals with capabilities in digital technologies can contribute to enhancing existing information systems and accelerating change.

ii. **At processing level:** The top industry in Uruguay has little room for growth. Additionally, the technology for wool tops is mature – it produces high-quality tops with environmental certifications – and specific knowledge on wool selection and mix is developed by each firm.

iii. **Market positioning:** Uruguay is not a producer of woolen consumer goods and therefore its value-chain players do not have agency on demand. It is important that value-chain actors, such as processors and national institutions, continue to be alert concerning new market trends and transmit these to wool producers in time for them to adapt their production systems.

Uruguay's rice productivity places the country on par with the most advanced rice producers worldwide. The subsector players in the country have heavily invested in research and development for primary production. Likewise, Uruguay is equipped with sophisticated technology in terms of milling and is currently investing in a "last generation" rice mill, despite being somewhat constrained by the lack of available maintenance services in remote rural areas. Absenteeism of production-line workers as well as inefficiencies in terms of transport infrastructure and logistics/fees at the port, are pointed out by industry representatives as the largest constraints to increased competitiveness.

Despite the subsector's efficiency, as global competition increases, rice areas are receding giving place to other crops and pastureland, and concentrated in the most productive areas. Additionally, international demand and trade regulations are shifting the processing of rice (and value addition) to importing countries. Hence, efforts must be made to (i) keep the efficiency and competitiveness of the value chain, and (ii) provide efficient alternatives for land use changes in less-competitive areas. Related required knowledge and skills are described below:

i. **At primary production level:** despite the impressive development in terms of varieties and associated production systems, research can still continue seeking for instance, to decrease the production cycle duration – and consequently irrigation costs. Rice research capacities at the National Institute of Agricultural Research (INIA) should therefore be maintained. Rice production areas have potential for high-value crops due to water availability. In the wake of decreasing areas being sown with rice, the use of these irrigated areas should be reassessed and incentives (e.g. support for improved irrigation infrastructure) provided for a transition to high value generation per hectare and per drop of water. Such studies and investment strategies require multi-disciplinary teams comprising agronomists, economists, water/irrigation engineers, water management and governance experts.

ii. **At processing level:** there is a limited number of rice mills in the country and the industry is showing a tendency for further concentration (seeking economies of scale). Apart from sophisticated equipment maintenance and plant management capacities, which need to be generated through formal education and experience in the sector, workers at processing level will still be trained on the job by the industry.

iii. **Market positioning:** rice demand for specific varieties and quality is normally established through well ingrained cultural preferences that are difficult to change. However, Uruguay may seek advantages in terms of market positioning through strategic trade agreements that reduce barriers to key importing countries and regions such as Peru or the EU. Likewise, Uruguay's competitiveness may change if various logistics costs and inefficiencies are resolved. Knowledge of agricultural sector needs by port managers and law makers will be important to drive changes that will benefit the sector.

KNOWLEDGE NEEDS ARE COVERED IN TERMS OF FORMAL EDUCATION...

Most of the skills identified as key for the continuous development of the subsectors under analysis are covered by the more than 120 undergraduate and postgraduate degrees related to the agricultural sector, in both public and private institutions. Furthermore, new trends in terms of subjects of study have been generally

incorporated into the curricula, particularly those related to climate change, as increased importance is being given to the use and management of agrochemicals, the sustainable management of natural resources, as well as animal welfare.

In addition to the sector's specific education offer, there is a wide range of university degrees on subjects such as economics and management, as well as in industrial and electronic engineering, which are equally essential for the development of an innovative agricultural sector. However, the curricula of these degrees tend not to have many references to the agricultural sector and the offer is rather centralized in Montevideo.

... BUT MORE CAN BE DONE IN TERMS OF TRAINING

Lately, more importance has been given to vocational training and short courses. Short duration courses for people with low education levels have started to play an important role in formal non-university training, with MGAP and producers' associations offering professional training both for technicians and producers.

However, the offer of professional education and non-university training depends on the degree of organization of the subsector. Subsectors that are more vertically integrated through producers' organizations, such as dairy or wool, offer training [3] on specific production systems clearly geared towards the development needs of the value chain. In other subsectors where the value chain is not integrated in the same way, as in the case of beef, capacity development opportunities are less specific and not always available.

THE SECTOR NEEDS TO BECOME MORE ATTRACTIVE TO EDUCATED AND YOUNG PROFESSIONALS, PARTICULARLY TO WOMEN

Despite the current educational and training offer, the sector still has a much lower share of workers with secondary and tertiary education than the other industries in the country, particularly at the farm level. Overall, the overwhelming majority of workers in the sector (more than three quarters) have primary education as their highest level of completed education. Only 3 percent of workers have completed university or an equivalent tertiary education degree, and about 0.3 percent have a postgraduate degree.

Workers in primary agriculture are more than three times more likely to not have completed any level of formal education than workers in agribusiness (10.6 vs. 3.3 percent). Conversely, workers in agribusiness are 1.6 times more likely to have completed secondary education than those in primary agriculture. Besides formal education, around 10 percent of workers are estimated to have received some form of technical training – 14 percent at secondary production level and less than 8 percent in primary agriculture and livestock production.

Finally, as in many countries, in Uruguay the population working in the agriculture sector (primary and secondary production) is predominantly male. Young people and particularly women who work in agriculture tend to take on more cognitively intense jobs, often service related, which is in line with the expectations of a generation which, on average, has a higher level of education than previous ones.

Data suggest that Uruguay's encompassing academic system is not adequate to ensure high levels of human capital in agriculture and that the sector needs to be better at creating jobs for and attracting young skilled workers.

Digital technologies are an important tool that could be leveraged to enhance human capital efficiency as well as to contribute to human capital formation. In particular, they can contribute to human capital efficiency to

3 Apprenticeships, on-the-job training, coaching for producers, etc.

increase the competitiveness of Uruguay's agriculture and agribusiness sector, by complementing labor through productivity-enhancing services. Furthermore, they themselves can also be a driver of human capital improvement, modernizing agriculture extension and advisory services by ensuring that workers with the right skills are hired for the right jobs through digital job-matching platforms.

Digital technologies, however, need a conducive environment and a set of minimum conditions to deploy their full potential: from basic information and communications technology (ICT) accessibility and penetration issues, through supportive policies and programs for digital strategies, to the development of technical skills among the labor force. Uruguay is ahead of the curve on many fronts, but there is still room for improvement, particularly in terms of: (i) access to venture capital funds, accelerators, and incubators for digital agriculture; (ii) the promotion of digital functional literacy and skill combinations associated with greater adaptability; and (iii) the establishment of pull factors for tech jobs in agriculture and agroindustry.

OPTIONS FOR GENERATING ATTRACTIVE OPPORTUNITIES FOR YOUNG AND SKILLED ENTREPRENEURS AND WORKERS

Policies and investment in the agriculture sector need to provide incentives for the changes that will enable seizing new opportunities in each subsector and that can potentially help create job opportunities for a younger and more educated generation. Mechanisms to provide such incentives are normally divided into four main groups: (i) taxes and subsidies; (ii) property rights (e.g. cap and trade); (iii) regulation; and (iv) voluntary schemes (e.g. payment for environmental services, labels, certification and corporate social responsibility).

Some of these instruments have proven to provide opportunities for coupling capacity development interventions with incentives for change as exemplified below:

- **Taxes or tax breaks imposed on or offered to those who do or do not comply with certain prerequisites.**[4] These are options often used to change incentives in terms of environmental conservation. For instance, Norway and Denmark use these tools to incentivize the adoption of plans that make a rational usage of fertilizer and pesticide. Specific vocational training curricula and courses can be developed to equip professionals with the right knowledge and skills to manage their production systems so as to benefit as much as possible from tax breaks. However, experience has proven that it is difficult to design systems for taxes and tax breaks that allow all types of farmers to introduce the desired positive change in their systems, or provide a clear enough incentive for farmers to reskill.
- **Regulation (and its enforcement).** Uruguay has experience in this field with tools such as the *Planes de Lechería Sostenible* (PLS). These tools have helped to improve the quality of water resources whilst increasing dairy farm productivity. They have also constrained producers' associations and processing units to equip themselves with the technical capacities to assist their members and suppliers in formulating and complying with such plans. The downside in terms of attracting new workers, is that regulations apply to all producers and industries, rather than targeting innovative, entrepreneurial individuals. They may be effective in forcing new skills into the sector – and in some measure rejuvenating it – but they do not necessarily provide incentives for a new generation of workers and entrepreneurs to join the sector.

4 Although as a principle, it is important to start by removing any distortions that may incentivise undesired practices (e.g. tax exemption for chemical fertilizers).

- **Support for – and when needed, regulation of – the development of quality and environmental voluntary schemes with the participation of a large diversity of stakeholders.** Support for the creation or adoption of labels, brands, certifications or geographical indications in products such as cheese or meat means generating clusters of excellence where new production systems are developed, tested, evaluated, and deployed. Support can also be provided in the case where skills such as marketing and communication or information systems management need to be further mainstreamed into the sector. New labelling, certification, and environmental norms compliance systems are often led by young and well-trained entrepreneurs and provide an incentive for the creation or reinforcement of producers' organizations around the common objectives associated with the adopted scheme. This can also provide an opportunity for less organized subsectors, such as that of meat cattle, to strengthen their organizations. These organizations may bring future benefits that go beyond creating skilled jobs, for example, increased bargaining power from the associated producers.

Regardless of the mechanisms used to directly incentivize change, and therefore new capacities in agriculture subsectors, it is fundamental that the country keeps supporting its innovation systems with long-term sustained financing. In addition to the existing public–private partnerships (e.g. technological centres and INIA work with producers and producer organizations (POs)), new jobs and programmes can be financed to introduce desired changes in the subsectors. Such arrangements can also be used to develop curricula for coaching trainers and producers on the productions systems that are to be incentivized.[5]

Similarly, incentive schemes for the installation of young farmers have proven to help rejuvenate the sector in some regions of the world (e.g. European Union countries have provided support for the installation of young farmers and retirement of older generations throughout several European Community framework programs). Such programs may help younger, better trained entrepreneurs to access productive land, a prerequisite for for the access to the remaining policies by a share of their potential beneficiaries.

Finally, infrastructure investment such as the modernization of irrigation may also enable some farmers to adopt more advanced and knowledge-intensive systems. As was seen during the agricultural commodities boom in Uruguay, more capital-intensive production systems can generate job opportunities for skilled workers, not only at farm level but also in companies providing services to the sector (precision agriculture and machinery companies, irrigation equipment and service providers).

Other issues that prevent youth from joining the agricultural sector, mainly in primary production, are poor infrastructure in rural areas, lack of services and the tenancy of farms by an aged population. Investment in infrastructure and services in rural areas, tax benefits for people living in rural areas, or programs for early retirement of farmers may be key to enable the success of other attempts at rejuvenating the sector in Uruguay.

5 Training courses on systems with clear specifications whose adoption can be certified (and compensated) are likely to be more effective in terms of promoting adoption of new practices and technologies. If well supported in their development, POs are usually good vehicles for training and also good creators of jobs for young graduates.


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Introduction

BACKGROUND TO THE STUDY

Uruguay's agricultural sector is an important source of revenue, contributing 74 percent of the country's total exports in 2018. Despite being an engine of Uruguay's growth, the agriculture sector is perceived by many in Uruguay as lacking high-quality employment. The average age for a family farmer in Uruguay is 50 years old, and Uruguayan youth view the sector as void of opportunity. Large concentrations of youth are studying information technology, and fewer are graduating with degrees in agronomy, with the perception that higher quality jobs exist in the information, communications and technology (ICT) sector than in the agriculture sector. In addition, traditional exports have grown less attractive in past years. Dairy, one of Uruguay's main exports, has seen the impact of the drop in the international price of milk on the viability of businesses in the sector. This fact, coupled with the perception that traditional methods of dairy farming imply drudgery and hard physical labor, makes the sector unattractive to Uruguayan youth.

Uruguay needs to invest in human capital and innovation to enhance the perception of its agriculture and increase the competitiveness. The emergence of new and cutting-edge technologies related to ICT and spatial planning, coupled with the aging population of Uruguay's agriculture sector, makes it a crucial time to invest in the future of Uruguayan agriculture. There is a clear need to develop human capital to train agricultural professionals (researchers, agronomists and technicians) to lead the next generation of technology and innovation-driven agribusinesses. This can be done through leveraging Uruguay's existing expertise to develop new training curricula to prepare farmers and professionals for next generation challenges, including how to leverage technology and innovation to make the sector more productive and higher in value, with an overall more sustainable footprint.

OBJECTIVES

The objective of this work is to identify ways to upskill human capital [6] and make Uruguayan agricultural value-chains more competitive. The report looks at opportunities for increased key value chain efficiency and at the skills that are required to seize such opportunities. Finally, it suggests some options for fostering a process of continuous development and up-skilling in the agricultural sector in Uruguay.

6 This report adopts the definition of *human capital* from the OECD: the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being (OECD, 2001). As such, this report considers human capital as an intangible asset with no clear measure. By *up-skilling* the report understands any action that increases human capital as previously defined.

VALUE-CHAIN ANALYSIS

Within this context, the World Bank and Uruguay's Ministry of Livestock, Agriculture and Fisheries (MGAP) developed a joint piece of work to examine human capital in the agriculture sector, with a particular emphasis on industrial processing. Given the extensive work of the Office of Programming and Politics (OPYPA) of the MGAP on efficiency in primary production, the focus of this work is specifically on efficiency in the industrial areas of priority value chains. Value chains were selected by OPYPA in collaboration with MGAP. Value chains with the highest potential for improvement in industrialized processes were prioritized.

A Uruguayan firm, CPA Ferrere, was hired to lead an in-depth value-chain analysis on selected value-chains. This research included value-chain mapping, key informant interviews, technology analysis and benchmarking against frontier producer countries. The following report summarizes and synthesizes the more detailed work of CPA Ferrere, OPYPA and the World Bank.

STUDY STRUCTURE

Chapter 1 provides an overview of the agricultural sector in Uruguay, based on secondary data collected from official sources and surveys. Chapter 2 builds on this overview and provides possible development scenarios for the four selected subsectors, as well as the main drivers for such scenarios. The analysis in this chapter is based on the report by CPA Ferrere (2020) and complemented by the original analysis of trade and agriculture statistics as well as interviews with key informants. Chapter 3 identifies key human capital development priorities, focusing on human capital needs in the four prioritized value chains, on the provision of education and formal and informal training for sector workers in Uruguay, and on the identification of gaps that could be filled by public policies and investment. Chapter 4 suggests how digital solutions could help enact some of the changes identified in the previous chapter, both by enabling productivity gains and as promising tools for the promotion of human capital upgrade in the sector. Finally, Chapter 5 concludes the study and suggests ways forward in terms of development paths, associated policy themes and development of human capacities.


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Chapter 1
Uruguay's agriculture at a crossroads

1.1 A FUTURE DEPENDENT ON TRADE, MACROECONOMIC TRENDS AND INCENTIVES FOR FARMERS TO INNOVATE

Uruguay, an agriculture commodities powerhouse

Uruguay's agricultural sector has a strong export drive. Representing 8.4 percent of the country's GDP[7] in 2018, it contributed to 74 percent of country's total exports in the same year (DIEA, Estadísticas Agropecuarias, 2019) and is crucial to keeping the country's trade balance. However, during the last decade, the sector has lost relative weight in total GDP,[8] after peaking at 12 percent of GDP in 2011 (DIEA, Estadísticas Agropecuarias, 2019).

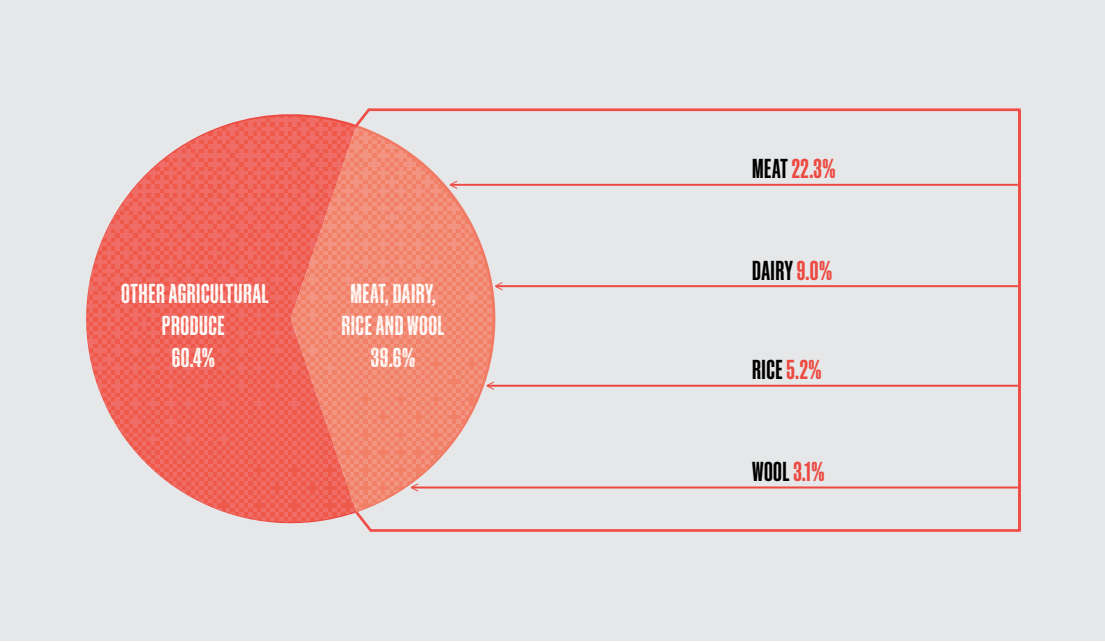

Figure 1
Share of agricultural exports by subsector in 2018

Source: Authors' elaboration based on MGAP-DIEA (2020).

7 Primary sector and agribusiness contributed 5.6 percent and 2.8 percent of total GDP respectively.

8 Between 2011 and 2019, it was displaced by the construction sector (+2.2 percent) and other services (+3.98 percent), the latter being mainly health services (1 percent) and real estate, business and rental activities (1 percent).

Livestock captures the most important share of total agriculture GDP, exports and land use. Meat, dairy, wool, alongside with rice are key export-oriented subsectors with robust weight over the total agriculture and livestock GDP. They comprised 39.6 percent of the country's total exports in 2018 (see Figure 1). Together, they represented 50 percent of total agricultural GDP in the same year (DIEA, Estadísticas Agropecuarias, 2019).

Soybean, maize and wheat also account for a high share of agriculture GDP. Soybean is the most important export crop (46 percent of total crop exports and 9.4 percent of total sector exports) and accounted for 12 percent of agricultural GDP in 2018 (DIEA, Estadísticas Agropecuarias, 2019). Maize, wheat and barley represented 8 percent of total sector's GDP in the same year. Finally, the fruits and vegetables subsector, less export-oriented, accounted for 10 percent of total sector's GDP in 2018 (see Figure 2).

Fast land consolidation has contributed to Uruguay's transformation

In less than two decades, the average farm size has increased by more than 20 percent in Uruguay and Argentina and almost 40 percent in Paraguay. The last agricultural census (DIEA, Estadísticas Agropecuarias, 2019) registered 44 781 farms in the country, showing a 21.6 percent decrease compared with the previous agricultural census in 2000.

Land concentration was led by large companies that acquired 47 percent of total land marketed between 2000 and 2018 (DIEA, Estadísticas Agropecuarias, 2019) as well as by the Instituto Nacional de Colonización (INC).[9] The segment between 0 and 500 hectares comprised 90 percent of total land acquisitions and 38 percent of total acquired area. The growth of the land market started in the early 2000s and reached a peak of more than 850 000 hectares marketed in 2006. In 2007 the land market was regulated by law no 18.092[10] prohibiting companies' ownership of rural land. Between 2008 and 2009 the area of land marketed reduced from almost 700 000 to 300 000 hectares; it remained stable until 2013 when a further reduction occurred. In 2018 a total of 159 000 hectares were sold, in line with the last 5-year average (DIEA, Estadísticas Agropecuarias, 2019).

The current average size of crop farms is 457 hectares in Uruguay (DIEA, Estadísticas Agropecuarias, 2019). Nineteen percent of the country's 2 600 crop farmers own more than 500 hectares and cover around 70 percent of total cultivated areas. The growth in productivity in farms can be illustrated comparing 2018/19 agricultural yields with the past 7-year averages for the main crops (Figure 3).

Along with land concentration, a new asset-light business model gained momentum in Uruguay, based on land-lease, flexibility, scale and networks and probably accounted for most of the agricultural expansion in the period. The number of lease contracts increased by 123 percent between 2000 and 2018, more than doubling the land available under lease, from 400 000 in 2000 to 1 116 000 hectares in 2008 (DIEA, Estadísticas Agropecuarias, 2019).

Large farm efficiency has allowed the sector to thrive with relatively small subsidies. Producer Support Estimate expressed as a percentage of gross

9 The INC is the land administration agency of Uruguay. Its main objectives are to help increase agricultural production and the welfare of national producers. The INC has priority on the acquisition of farmland if the farm surpasses a certain size thresh old. Depending on the administrative region of the country, this minimum land size from which the INC has priority on the purchase ranges from 100 to 500 ha. Land acquired by the INC should preferably be given on long-term leases to families made up of young people and children of school age, as well as to organized small producers, who are already carrying out associated land uses (INC, 2020).

10 https://legislativo.parlamento.gub.uy/temporales/leytemp5969983.htm

farm receipts is less than 5 percent, which is significantly lower than the OECD average of 18 percent (OECD, 2019).

Agriculture in Uruguay is shifting away from the trends of the last decade

The Uruguay commodity boom saw soybean plantations grow from 13 901 hectares in 2000 to 880 000 in 2011. In 2013/2014, sown areas peaked at 1.33 million hectares with a production of 3.1 million tons and exports totaling USD 1.8 billion (DIEA, Estadísticas Agropecuarias, 2019). During this period, other main crops such as maize, wheat and sorghum also increased in area and production, as they started being incorporated in rotations with soybean.

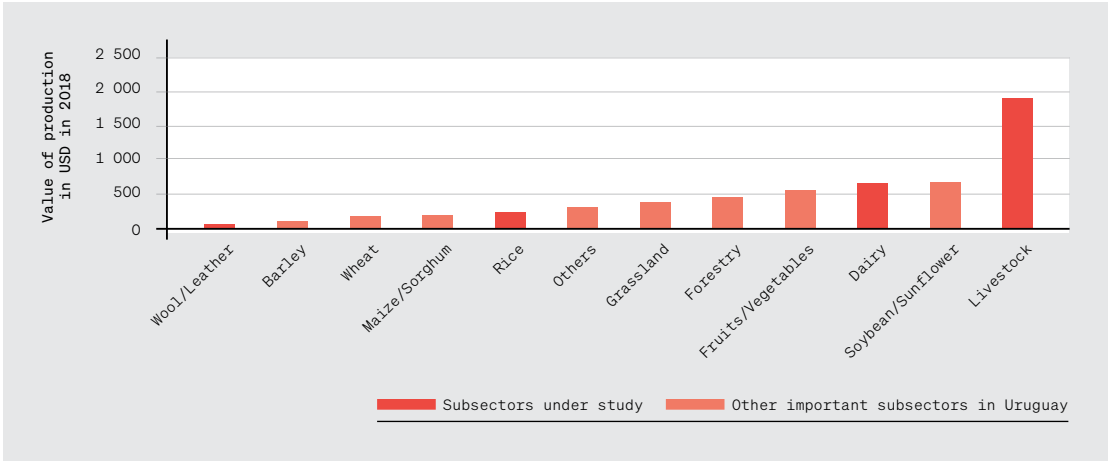

Figure 2
Agricultural GDP by subsector in 2018

Source: Authors' elaboration based on MGAP-DIEA (2020).

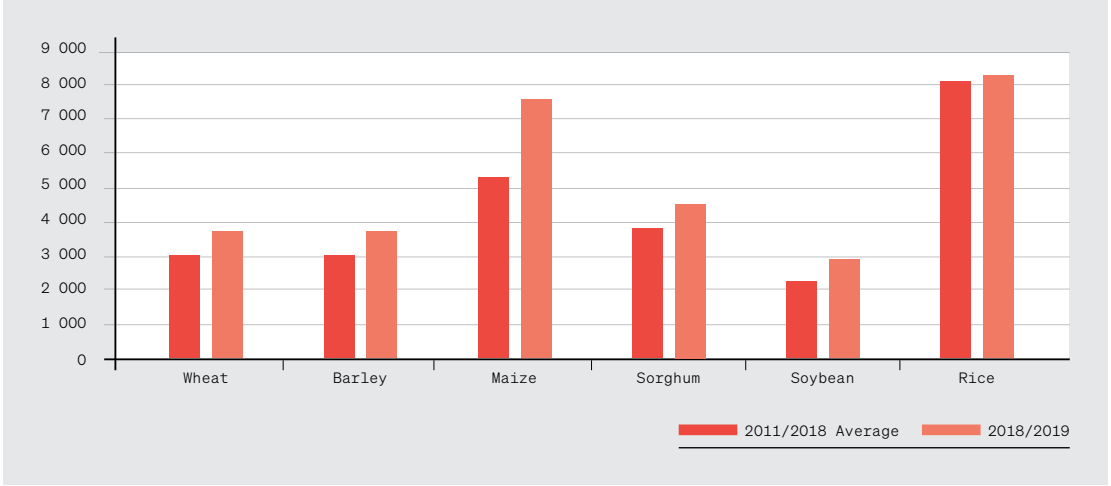

Figure 3
Key selected crops: 2018/19 yields and 2011/12-2017/18 average yields (kg/ha)

Source: Authors' elaboration based on DIEA, Estadísticas Agropecuarias (2019).

Despite recent large increases in scale and efficiency in crop production, cropped areas have decreased in the past years. The business model of big firms served by land-lease, agricultural machinery service providers, flexibility and networks started to retreat, leaving Uruguayan individual farmers with their land to exploit. In 2017/2018 soybean and wheat areas were reduced by 28 percent and 50 percent from their peak, respectively (DIEA, Estadísticas Agropecuarias, 2019).

Pastures, which have always occupied the largest share of Uruguay's agricultural land, are again increasing in area. Uruguay registered 14.4 million hectares of agricultural land in 2017 (FAO, 2020). While arable land accounted for 17 percent of total agricultural land in 2017, land under permanent meadows and pastures occupied about 83 percent or 12 million ha (FAO, 2020.[11] In recent years sown pastures have continuously increased in area, reaching 2.55 million hectares in 2018. This increase in improved pastures is more noticeable in farms that specialize in meat cattle, as shown in Figure 4. The area under forest cover has also been increasing considerably, mostly by fast-growing species used for paper pulp production, one of Uruguay's key exports.

The number of livestock units increased by 8 percent from 2011 to 2016 and seems to be stabilizing at the 2015 level of about 9.3 million (Figure 5). The growth in the early years of the decade was mostly due to a large increase in the stock of breeding cows (*vacas de cría*). The number of heifers (*vaquillonas*) and steers (*novillos*) has reduced and the number of calves has fluctuated around 2.7 million since 2013. The reduced number of 2- to 3-year-old animals is due to surges in live animal exports in some years that have been occurring since 2010 as a form of arbitrage with domestic meat processors.

Dairy farms have not been increasing in number of heads or farm size, despite historically having the largest proportion of their area sown with pasture. The sector has seen important gains in productivity, which kept production levels more or less stable, with significant reductions in land use, cattle heads and number of producers. This is described in more depth in the next chapter.

Sheep stocks and dedicated areas have also been losing ground to cattle. The number of sheep heads has been reduced, first during the agricultural boom and more recently with forestry expansion. Flocks have been confined to the northwest regions of the country, particularly to soils with lower aptitude for agriculture and forestry (Figure 6). This is causing a shift in the choice of breeds in the country, where the Corriedale, which is well adapted to rich soils, is losing its predominance to Merino Australiano that is better adapted to poorer soils. This may have impacts in terms of the wool–meat equation, as further detailed in the next chapter.

In sum, during the past years, livestock products have become more attractive in terms of external demand and profitability as world crop prices decreased, directly affecting land use choices in Uruguay. Additionally, the contraction of the Argentinian economy and consequently the decreased interest and the capacity of Argentinian investors in keeping crop production in Uruguay – which has higher unit production costs – also led to lower investment from Argentinian entrepreneurs in the crop sector of Uruguay and to a change in land use to pasture. The new land use regulation in the country where land use and soil management plans are required also contributed to this new scenario (Figueredo, 2019) as well as a number of complementary policies that are still in place today (see Annex 1). The immediate results in agriculture are that (i) new

11 By contrast, only 262 500 ha were irrigated in 2017, 4.5 percent of which were irrigated pastures (12 000 ha).

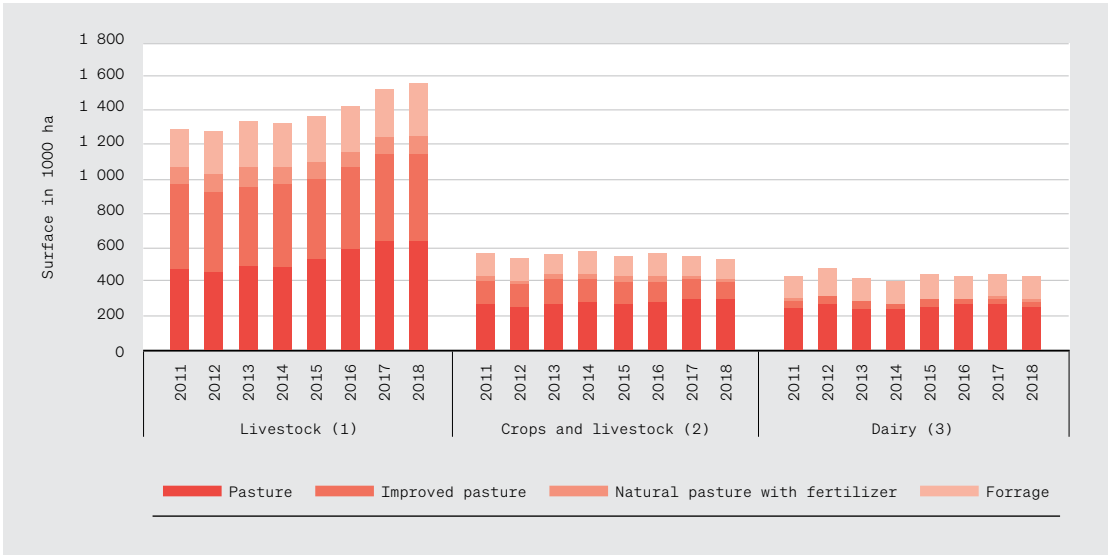

Figure 4
Surface of sown pasture

Source: Authors' elaboration from DIEA, Estadísticas Agropecuarias (2019). Notes: 1 – up to 2 hectares of cropped land and no dairy; 2 – more than 2 hectares of cropped land and no dairy; 3 – with dairy.

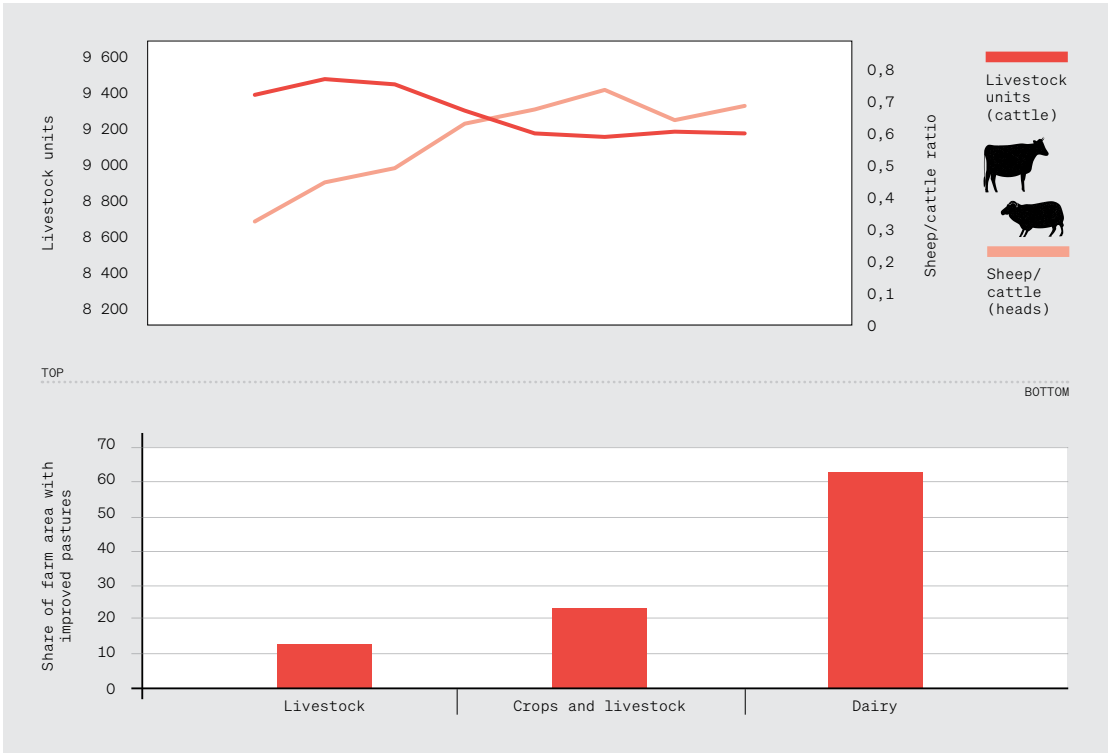

Figure 5
Evolution of sheep and cattle herds, 2011-2018 (top); share of farm area with improved pastures, by farm type (bottom)

Source: Authors' elaboration from DIEA, Estadísticas Agropecuarias (2019).

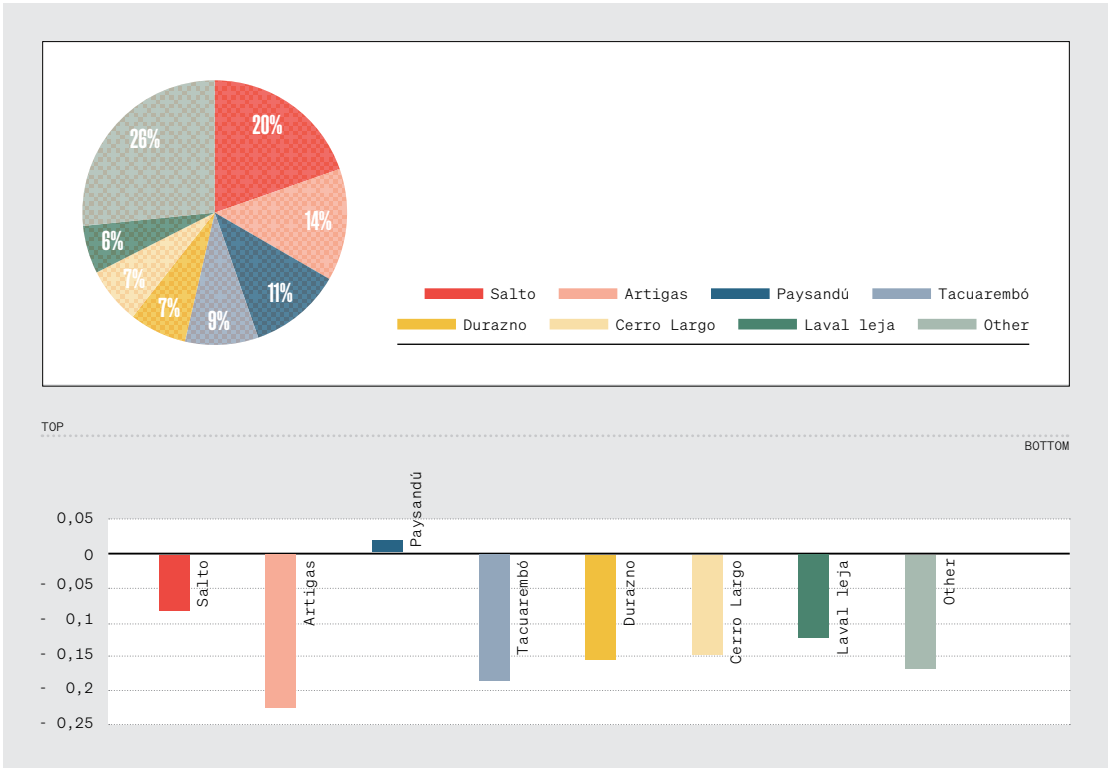

Figure 6

Share of sheep flock per region (top); percentage change in the number of sheep head, 2011-2018 (bottom)

Source: Authors' elaboration from DIEA, Estadísticas Agropecuarias (2019).

sown pastures are mostly used for beef cattle; while (ii) areas dedicated to dairy farms and sheep flocks continue to recede, the former pushed by efficiency gains and concentration of production in efficient farms. The effects in terms of contribution to agricultural GDP are illustrated in Figure 7. It is important to note that the reduction in dairy contribution to GDP in 2014 is mostly due to a decrease in unit prices, rather than quantities.

This recent transformation has left pockets of agricultural engineers and former skilled employees of big firms that cut their technical teams who were now available to develop new agriculture ventures, if enabled through well designed financial products and access to land. Agricultural service providers are seeking partnerships with landowners creating new schemes and co-sharing risks on the land previously leased and becoming available (Figueredo, 2019). Such opportunities and incentives provided to entrepreneurs may shape the agricultural scene in Uruguay in the next few years.

Finally, trade agreements will also be determinants in shaping the future of agriculture in Uruguay. While the country is part of Mercosur, it is not part of the trade agreements of recent years (CPTPP[12] or EU-Japan EPA[13]) that are expected to contribute a significant part of agricultural trade flow increases.

12 Comprehensive and Progressive Agreement for Trans-Pacific Partnership TPP-11 (2018) between Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore and Vietnam.

13 Economic Partnership Agreements between the European Union and Japan (2019).

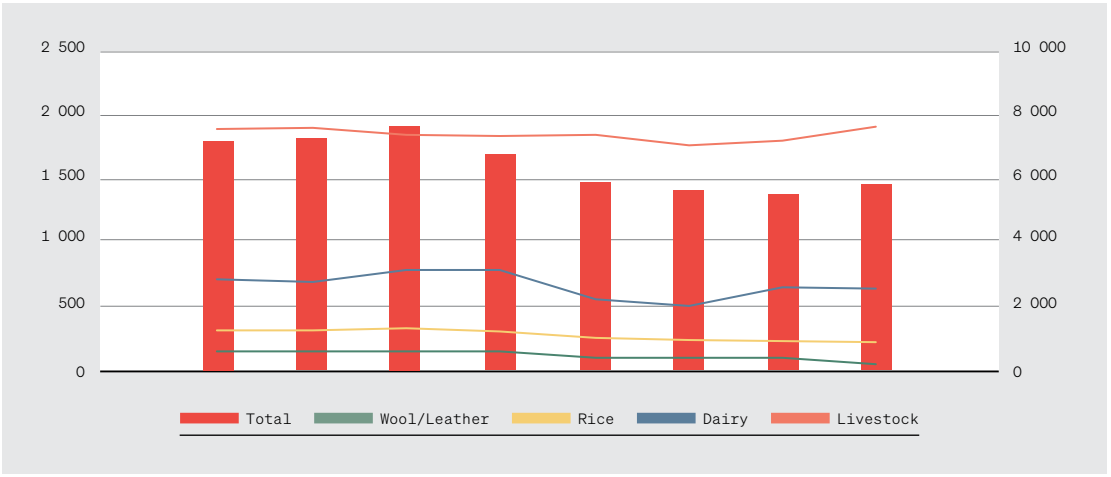

Figure 7

Agricultural GDP by subsector 2011- 2018 (left axis) and total agricultural GDP (right axis) in USD million (nominal)

Source: Authors' elaboration based on DIEA, Estadísticas Agropecuarias (2019).

Finding strategic partners will be key to harnessing competitive advantages and current positioning in export markets. Whereas it is not within the scope of this report to give a thorough market analysis, the competitiveness of Uruguayan industries such as rice and beef is largely conditioned by the tariffs imposed in some important markets and how competing exporting countries will manage to have them waved. The next chapter will make additional observations on this important subject.

The analysis above shows that the agricultural sector in Uruguay is in perpetual change and that during the next decade it will be shaped in a rather different way than it was in the last ten years. Changes will naturally occur due to international market dynamics, particularly given the significant participation of Uruguayan agriculture in international trade. In addition, the COVID-19 pandemic is bringing major changes in consumption patterns that will affect demand at least in the short-to medium-term. The next chapter will analyze in more depth the key trends in the four subsectors under examination, as well as some of the opportunities for Uruguay in a new market environment, given the current structure of its value chains. The following chapter will pick up on these trends and discuss how digital technology can help Uruguay's agriculture sector seize opportunities for greater efficiency and competitiveness, whilst identifying key skill sets that will enable such development. The final chapter provides a review of human capital in agriculture and of the offer in education and training for the sector in Uruguay. The conclusions provide some broad policy and investment options to enact change, with particular emphasis on the development of human capital in agriculture.

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Chapter 2
Selected sectors trends and skills needs

This chapter provides a quick overview of the four subsectors being studied – beef, dairy, rice and wool – for opportunities for developing human capital in Uruguay. In each case a first section will briefly describe that subsector's positioning in international markets, referring mostly to trade data and OECD-FAO (2019) forecasts. Second, each subsector is characterized at processing level, based on the study from CPA Ferrere (2020).[14] Third, for each subsector there is quick analysis of primary production from available statistical data and a few interviews conducted with key informants. Finally, a short summary is given outlining key opportunities for human development.

2.1 BEEF

Slow sector growth, contracting in Europe and expanding in Asia

Worldwide, the meat sector is not expected to grow significantly in the next decade as increases in consumption of beef in China and Southeast Asia will be moderate and the United States of America, the European Union, Norway, Switzerland and Australia are expected to replace beef by healthier meat (OECD-FAO, 2019) – see Note 1 on updated shorter/medium-term forecasts considering the Covid-19 crisis.

In terms of production, Latin America and the United States of America will contribute more than half of global growth – estimated at about 9 Mt by 2028 – as their cattle inventory has increased over the past few years. In particular, Argentina and Brazil are expected to increase their share of world meat exports, as they will also benefit from the depreciation of their currencies. Overall, Latin American and Caribbean beef exports are expected to grow 57 percent by 2028, whereas the European Union is expected to enter a downward trend as dairy breeds, which make up approximately two-thirds of the beef supply, will decrease following productivity gains in the milk sector (OECD-FAO, 2019).

This increase in production and export capacity will, in the short term, depress the real prices of beef. The real price (at 2018 prices) for beef is projected to decrease to USD 3 336/t carcass weight equivalent (c.w.e.) by 2028.

14 These summaries on agricultural products processing do not pretend to give a complete account of the CPA Ferrere (2020) report, but rather extract its highlights – the report has been published as a stand-alone publication.

Sidebar 1

Uruguay highly competitive in the international meat market

Uruguay is the 21st largest exporter of fresh bovine meat (HS 0201) and the 7th of frozen bovine meat (HS 0202) behind much larger countries. Eighty-three percent of its meat exports are of deboned cuts.

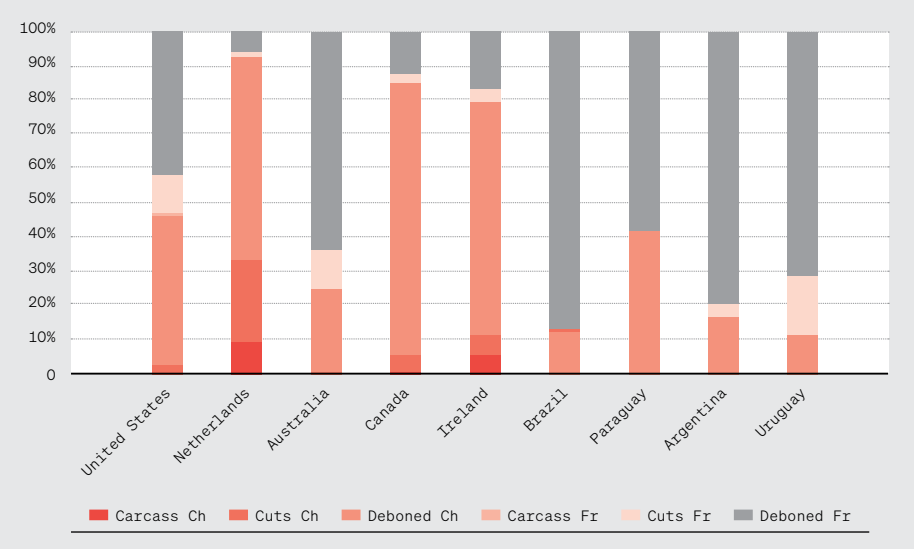

Figure 8

Share of export for different meat products (fresh/chilled/frozen, with bone/deboned)

Source: TDM (2020).

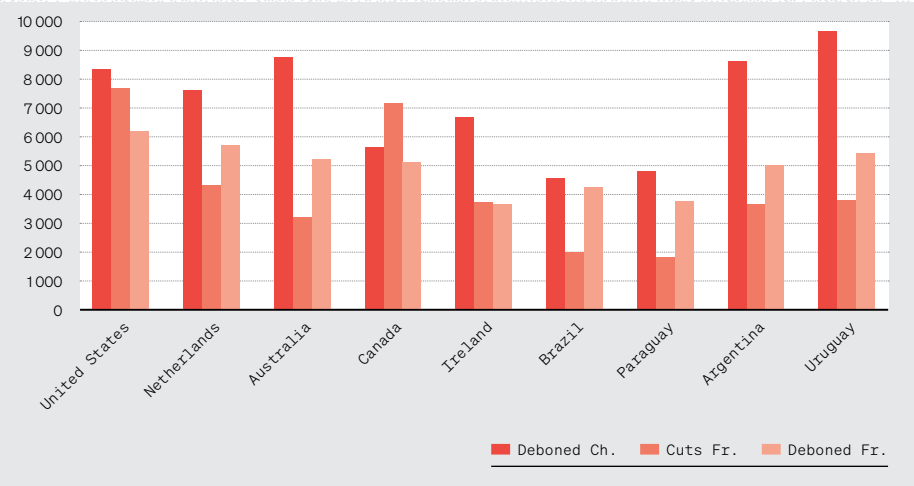

Figure 9

Export prices for different meat products (fresh/chilled/frozen, with bone/deboned) (USD/tonne)

Source: Trade Data Monitor (TDM, 2020).

The distance to its end markets and trade tariffs act to limit Uruguay's capacity to sell fresh/chilled meat (at a high price), when compared with the United States of America, Ireland or Canada.

Competitive meat processing industry but lack of incentives for increased productivity at primary level

After some variation in the previous decade Uruguay stabilized its cattle inventory at around 12 million heads in 2015, while cattle slaughter had stabilized at 2.2 million heads per year more than 10 years ago. As the exports of live calves continued to climb until 2018 (see Figure 10), the next few years will not see an increase in available heads for slaughter.

The slow growth of the sector is not rooted in lack of slaughter and processing capacity. In 2019, of 52 authorized establishments, only 36 were slaughtering cattle. According to the numbers collected by the *Instituto Nacional de Carnes* (INAC) in 2019, the theoretical installed capacity of the industry (maximum potential of the industry) amounts to 4.4 million head per year from 2016. The country's "proven capacity" (the maximum level of slaughter observed in any given year in each establishment) totals 3.25 million heads per year, more than a million above the number of heads slaughtered per year (CPA Ferrere, 2020).

Despite the overall idle capacity of processing units in Uruguay (Figure 11)**, average meat processing costs are still competitive compared with key producing countries** (see Sidebar 2). Each production phase in slaughterhouses implies a certain fixed cost (for labor as well as for capital, energy), which by definition occurs regardless of the number of animals that are slaughtered or the weight of meat produced. Although the cost per head and per kilogram of meat processed is also a function of the weight at which animals are slaughtered and the type of cuts and packaging applied, increasing the number of animals processed by each unit would to some extent reduce unit production costs (per head and per kg) and therefore render the sector more competitive (adapted from CPA Ferrere, 2020).

Hence, changes in the incentives structure of primary production would need to occur in order to take advantage of the Uruguayan industry's full potential and improve its competitiveness. Several combined factors keep Uruguay below its potential in terms of fertility rates, weight at birth and weight gain rates (see Box 1). Primary production performance can improve through a change in herding practices and pasture management. Likewise, solutions to decrease perceived risks by producers could be an incentive to build cattle inventories as discussed later in this section.

No one-size-fits-all solutions for the industry

Slaughterhouse performance is highly heterogeneous. Figure 11 shows that capacity use rates vary significantly from one unit to another, regardless of their size. Similarly, costs per head also vary significantly depending on the processing unit, its capacity use rate and its product mix – the higher the value added (precise cuts, packaging, etc.), the higher the costs. According to CPA (2020), the most efficient processing units are able to lower their labor costs to 40 percent of the overall costs (against 51 percent for the national average).

The ten largest refrigerators amassed 65 percent of the total slaughtered heads in 2019 and the 25 refrigerators authorized to export represent 95 percent of total meat production. Ownership is also rather concentrated.[15] However, different units also cater to different markets and are supplied by producers with different characteristics. Hence, it would be important to understand what variables beyond size and ownership – e.g. market outlet and suppliers – determine processing units' performance in Uruguay and how.

15 According to information from INAC (in CPA, 2020), nationally owned units processed 42 percent of the volume in 2018, units composed of Brazilian capital 40.5 percent, 8 percent of Japanese, 2 percent of Chinese and about 8 percent of mixed capital.

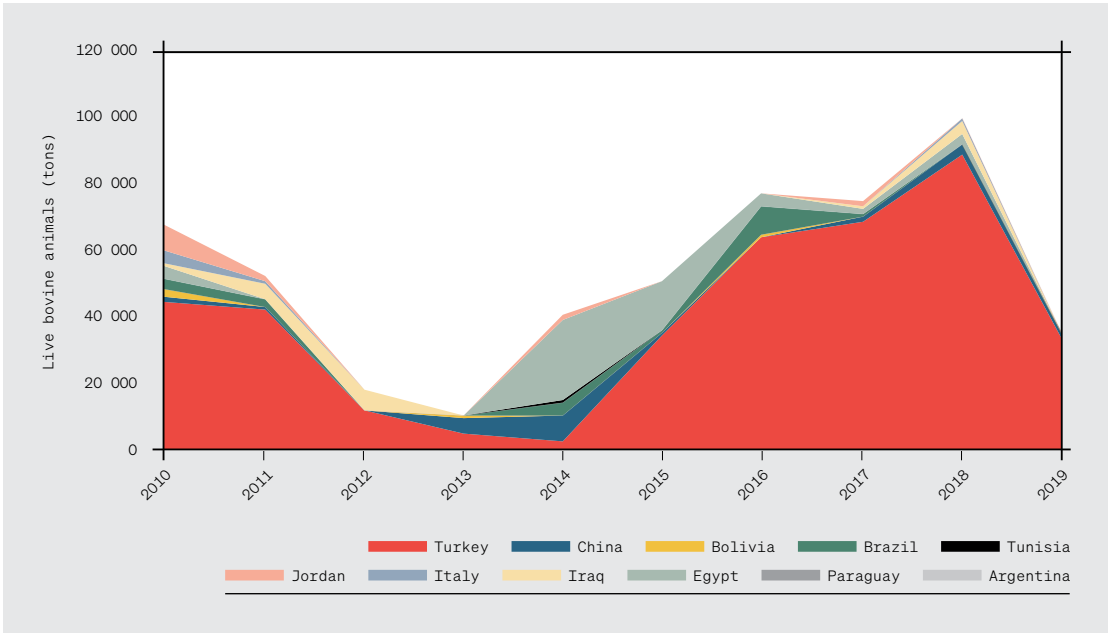

Figure 10
Exports of live bovine animals from Uruguay

Source: TDM (2020).

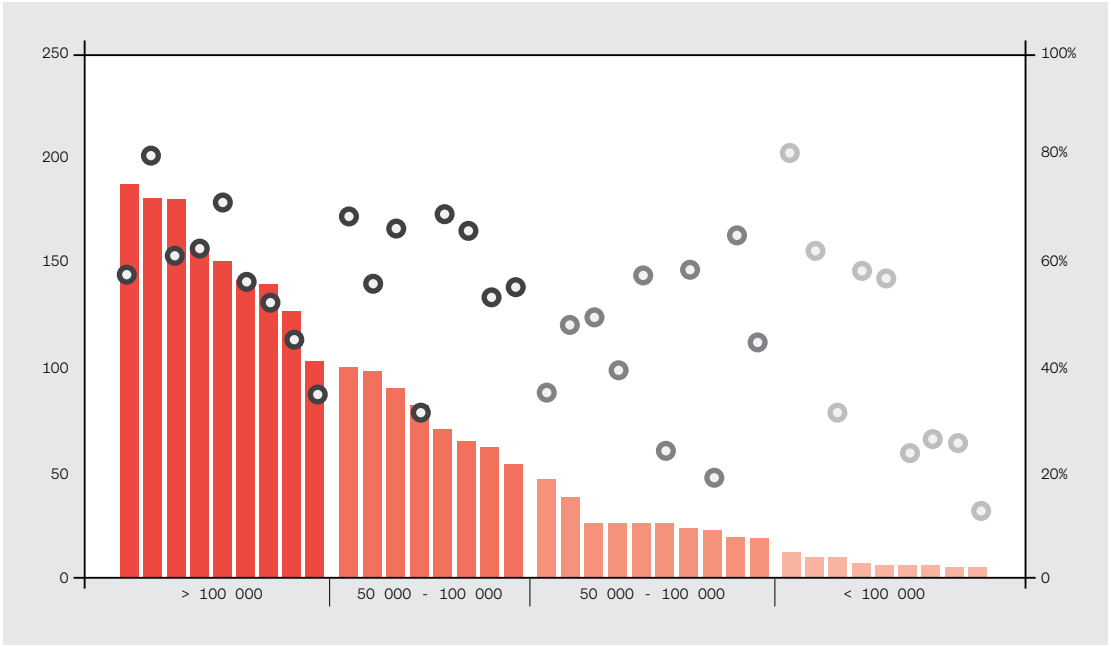

Figure 11
Number of slaughtered animals (in thousands) and share of total capacity used per processing unit

Source: CPA, 2020 based on data from INAC (2019).

Sidebar 2

Uruguay meat processing costs on a par with those of developed countries

Uruguay's labor costs are closer to those of developed economies than of its neighbors, suggesting that trends in processing technology in Uruguay are bound to follow those of countries such as Australia, New Zealand or the United States of America in the longer term.

In the United States of America – and in Australia to some extent – slaughtered animals are on average larger than those slaughtered in Uruguay, which translates into significant gains in processing efficiency.

Brazil and Argentina have significant distortions in their energy markets and in currency exchange, which means that their costs are not a true indicator of their level of efficiency.

This comparison, though illustrative of Uruguay's international competitiveness, has its limitations. For example, the cuts produced by some processing units in Uruguay are labor intensive but add value to the meat (CPA Ferrere, 2020).

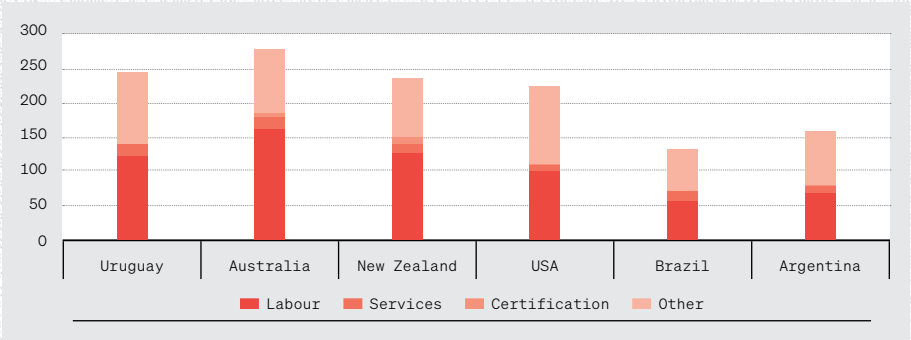

Figure 12
Processing costs USD/ head

Source: CPA 2020 from AMPC (2019) and INAC (2018).

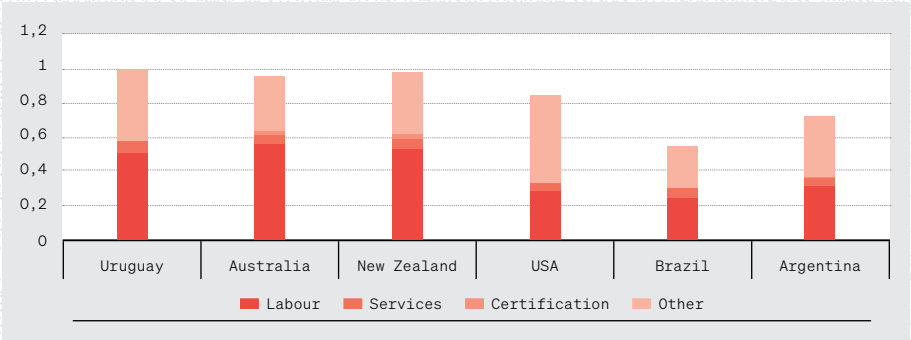

Figure 13
Processing costs USD/ kg of meat (hot standard carcass weight equivalent)

Source: CPA 2020 from AMPC (2019) and INAC (2018).

Note: (i) services comprise electricity, fuel, water, sanitation and waste treatment; (ii) certification costs for the United States of America are only for compliance with environmental regulations; (iii) "other" comprises packaging, transport of finished products, maintenance, other.

Sidebar 3

Labour is not a constraint…

The meat industry in Great Britain faces problems attracting skilled workers, missing about 25 percent of the necessary workforce (British Meat Processors Association - BMPA, 2018). In Australia, plants are working at 90 percent of their capacity or less, and to operate at maximum capacity, they would require close to 3 000 additional workers, of which 25–30 percent would have to be covered by foreigners (Meat Industry Association - MIA, 2018). New Zealand is also short of nearly 2 000 workers, with effects on the volumes produced and exported by the country. Poor motivation and growth prospects are usually the factors limiting labour supply, as well as the perception that the skills acquired are specific to it, not offering many alternatives in case of job loss or search of a career change. In Uruguay, meat industry jobs are still attractive and well remunerated for a sufficient share of the population – labour scarcity does not seem to impact production.

… and Uruguay will not be amongst the earliest adopters of industrial automation

Countries facing labour constraints have been testing the introduction of robotic technologies. In 2016, JBS acquired a controlling stake in Scott Technology, a leading New Zealand company in industrial automation and robotics for industrial processes and supply chains. However, the successful application of this technology to cattle requires further advances in imaging and automation. Scott Technology had been testing technologies for beef cutting since 2015, but to date their implementation on actual production lines has not been announced. Once mature, these technologies will have a high impact on labour productivity. However, given the current labour availability for menial tasks, the difficulty in ensuring sophisticated machinery maintenance in rural areas, and the high value of Uruguayan meat cuts, it is not clear if slaughterhouse managers will invest in automation of cutting and deboning.

Source: CPA (2020).

Another opportunity may lie in the domestic market – which consumes over 25 percent of overall production – as some of its segments may be supplied by specialized processing units. An analysis of internal meat demand could provide further pointers in terms of opportunities in the domestic market and maybe enable some of the strategies described in Box 1 below.[16]

Improved primary production, efficiency gains in packaging and logistics, and increased product differentiation

Lack of skills does not seem to be a constraint on processing capacity in the medium/long term. Some stages of the industrial process are critical in terms of work productivity (such as de-boning and packaging and logistics processes) as they are the most labour intensive. At these stages there is potential for the adoption of new technologies which would require re-adjusting the profile of

16 In February 2020, for instance, 25 percent of consumed beef in Uruguay was imported, against 10 percent in the same period in the previous year. This is both the result of the low steer stock in the country and the depreciation of the currencies in Brazil and Paraguay from where beef is imported, but also indicated that there is a growing share of the domestic market that is unserved by Uruguayan beef and could be led to pay a premium for national meat.

workers – incorporating knowledge of electronics, programming, and maintenance of robotic equipment.

While the automation of packaging and logistics processes is gradually spreading in Uruguay, current wages offered by the sector are still attractive and, in the short term, labor may not be replaced to the full potential current technologies allow (see Sidebar 3). Nevertheless, the sector should see a gradual increase in demand for workers with knowledge of mechanical and electronic engineering, which Uruguay is well equipped to provide (see next chapter), but who lack incentive to move to rural areas (CPA Ferrere, 2020).

The most relevant barrier to expansion lies in the incentives perceived by primary producers as current levels of live animal supply to the national industry are not sufficient for it to work at full capacity. Land use for cattle production has increased as the areas devoted to crops and sheep have receded in the last decades (see Chapter 1). Yet cattle stocks have remained virtually unchanged. Various factors may contribute to this: (i) a large part of cattle production still occurs in traditional pastures, despite the increase in area of improved pastureland during recent years; (ii) cattle producers are usually amongst the more aged and have little motivation to introduce changes in their production systems; (iii) feeding costs are low and the opportunity costs of land use are often poorly understood or assessed by producers; (iv) risk aversion regarding changing practices. Mechanisms that ensure producers of medium-term price stability, such as the *precio convenio* for rice, may help reduce the perceived risk of investing in improving productivity and in enlarging steer inventories. Likewise, support schemes that promote the adoption of new practices (such as those in place by DACC) together with training and advocacy can contribute to accelerating change. However, any change is unlikely to happen before producers recover from the impact of the COVID-19 crisis (see Note 1).

Note 1
How may the COVID-19 crisis affect the subsector's prospects?

The COVID-19 outbreak changed forecasts for the bovine meat trade worldwide. World bovine meat exports are now forecasted to hover around 11 million tonnes in 2020, 1 percent down from last year, in sharp contrast to the 7.3 percent growth registered in 2019. The global contraction is anticipated to be driven by lower imports by Viet Nam, the USA, the Russian Federation, Mexico, the Philippines and the Republic of Korea, which should more than outweigh the foreseen increases in purchases by China and Japan (FAO, 2020). Uruguay estimates on cattle slaughter contraction in the current financial year range from 3 percent to 14 percent. (OPYPA-MGAP, 2020). The Chinese market's recovery speed is the main factor affecting the evolution of the sector's situation in the short term. A slower recovery is expected from the European market, which also showed decreased relevance in Uruguayan exports. Three scenarios were examined by OPYPA ((OPYPA-MGAP, 2020) with the following main findings:

- For 2019/20, cattle slaughter will be almost 20 percent lower than that registered in the base year (2017/18) and exports will be down 10 percent under all scenarios.
- Under all scenarios proposed there would be a significant increase in cattle inventory in 2019/20. However, should producers decide to cull a larger number of cows in view of a depressed market, calf production may be negatively affected in the next couple of years.

Further value addition opportunities may stem from a group of small operators. Uruguay is well placed in the Chinese market (98 percent of exports of cuts with bone and 52 percent of deboned cuts), which is expected to continue to expand in the medium term – although due to the COVID-19 outbreak it may contract in the short term.

However, about 80 percent of its exports with the highest value added (chilled meat) are destined for European Union countries, the United States of America and Switzerland. These markets are expected to change considerably during the next decade. In the European Union beef production should decrease, but in both the European Union and the United States of America consumers should also shift towards healthier and more environmentally sustainable diets. Changing consumer preferences – such as the shift to processed meat and ready-to-eat meals, the rise in vegetarian or vegan lifestyles, the increasing attention of consumers to animal treatment, and attitudes to global Greenhouse Gas (GHG) emissions – are relatively new factors, and the extent to which consumers are willing and able to pay a premium for such goods remains unclear (FAO-OECD, 2019). Nevertheless, Uruguay could consider strategies to place itself in a number of high-value-added market segments, especially if it negotiates higher access quotas for grass-fed fresh beef and if it just markets it better (Ministry of Agriculture, Nature, and Food Quality of the Netherlands, 2019).[17]

If the country is to maintain a diversity of actors (there are no more than 36), it will have to enable smaller units to adopt differentiation strategies for their products, as competition with large and increasingly automated units may become ever more difficult. One possible strategy could be the promotion of meat from specific territories, produced in a more sustainable way and with certain taste characteristics (see Box 1).

Large scope for a new set of skills in the sector

The meat industry can still benefit more from the strong green economy policy that Uruguay is pursuing (see Box 1) and that is particularly visible in the dairy sector. In the meat sector the opportunities mainly lie in improving pasture productivity. In addition to the direct economic gains from increased productivity, these could add valuable selling points to Uruguayan meat: as the main emission source of GHG emissions is enteric fermentation and manure on pasture, increasing productivity – as well as optimizing the age and weight at which the animals are sold – can lower emissions per kg of meat produced.

Hence, in terms of human capital and awareness raising, the subsector will require: (i) highly trained agronomists specialized in animal production for the continuous development of production systems; (ii) individuals highly trained in livestock products lifecycle assessment; (iii) market analysts with knowledge in differentiation and marketing of livestock products; (iv) consumer awareness of unique selling points of Uruguayan products; (v) strong sector associations with cadres trained in innovative and efficient production systems equipped with adequate extension materials; (vi) producers trained and coached on new production techniques. Policies that help in rejuvenating farm management/ownership may also contribute to a faster shift in the existing capacities for livestock management.

17 Japan establishes import duties of about 38.5 percent, the United States of America, 26.4 percent after the quota of 20 000 tons is filled, and the European Union charges 20 percent in duties to the importer – 12 percent on the product price and a flat rate from 3.30 to 4 Euro/kg depending on the quota (information obtained from interview with exporter).

Box 1

Market-based mechanisms to improve productivity and value addition in cattle production systems

Uruguay has an average cattle pregnancy rate of 64 percent. The weight of weaned calves is generally below 150 kg and weight gain rates are generally low, which leads to an age of first pregnancy of around 24 months. This means that there is a clear opportunity to improve pasture use efficiency – and consequently decrease carbon intensity per kg of meat generated. Likewise, the fact that the cattle are, to a great extent, grass-fed provides opportunities for meat differentiation schemes based on production systems.

According to a 2017 report by FAO, the New Zealand Agricultural Greenhouse Gas Research Centre and the Climate and Clean Air Coalition, changes in practice can help reduce GHG emissions in Uruguay by up to 43 percent and increase production in live weight terms by up to 200 percent (FAO and New Zealand Agricultural Greenhouse Gas Research Centre, 2017).

In Ireland, it was recorded that a one-month reduction in age at the time of first calving improves yields by EURO 50 per cow and reduces the carbon footprint by around 0.3 percent; an increase in the calving rate from 80 to 85 percent improves yields per cow by around EURO 45 and reduces the carbon footprint by 4 percent; and an increase in weight gain during the average life span from 900 g to 1000 g increases the profit per head by EURO 63.

The Green Growth report (World Bank, 2018a) provides more details on market mechanisms that can be used to foster possible changes in Uruguayan beef cattle production systems. Such mechanisms are based on a remuneration of producers for their compliance with a set of norms. These norms – comprising measurable indicators and targets, the achievement of which may be subject to certification – should be established so as to promote improvements in productivity as well as in environmental sustainability of production systems in a cost-efficient manner. Producers may be remunerated for their compliance through price premia on their certified products and/or through payments for environmental services schemes. The Tropical Agriculture Research and Higher Education Center (CATIE) report on policy instruments that could be used in the agriculture sector in Uruguay describes these mechanisms in detail (Alpízar, 2017).

There is no one-size-fits-all set of norms nor a globally agreed definition of sustainable beef. Several attempts have been made at creating sustainable and economically well performing cattle production systems. For example, the largest segment in the labelled beef market is naturally raised. Grass-fed and organic grass-fed beef have been the fastest growing sectors in the first half of the last decade. Such labels – eventually combined with additional environmental certifications – can provide good opportunities both for premium cuts in niche markets and non-premium cuts that cater to the needs of large international corporations in the food industry. Alternatively, Uruguay can choose to take the route of countries such as Ireland and create its own "country image" based on specifically developed standards of sustainability for the sector (World Bank, 2018a). This would imply:

- identifying unique selling points, such as certified organic, breeds (for example Wagyu), and origination from a territory, for which it is possible to define concrete specifications;
- investigating/developing productive models that are best adapted to a region, specifications for the practices to be adopted, and training technicians and producers on compliance with such specifications;
- generating technical assistance services and other adoption incentives;
- exploiting the initiative from a marketing point of view.

These are complex endeavours that require cohesion amongst value-chain actors and sustained investment in changing practices, adapting infrastructure, agreeing on measurable standards and promoting labels/brands. Slaughterhouses and traders need to signal long-term commitment to these initiatives if they are to be successful.

Source: Prepared by the authors with data from World Bank (2018a).

2.2 DAIRY

Sustained growth perspectives in the consumption of cheese and sustainable products in international markets

An increase in the consumption of dairy products is foreseen, mainly in Asian countries; yet this is not matched by an increase in international trade. China is the main importer of milk, especially as whole-milk powder (WMP). During the last 12 years it has doubled its per capita consumption of milk from 18 kg in 2007 to 36 kg in 2018 (United States Department of Agriculture [USDA], 2019) and it features levels that are still around a third of the average global per capita consumption of 117 liters. Despite these encouraging data, China has reduced its imports of WMP over the last few years[18] and the crisis triggered by the COVID-19 pandemic has depressed demand in this country (see Note 2); in the long run China is not expected to significantly lead international trade in milk, in terms of quantity, given that the country continues to increase its domestic production.

Note 2
How may the COVID-19 crisis affect the subsector's prospects?

World exports of dairy products (in milk equivalent) are forecast to fall by 4.1 percent (3 million tons) in 2020, marking the sharpest year-on-year decline in three decades. Steep drops in dairy imports were forecast for China, Algeria, Saudi Arabia, United Arab Emirates, Viet Nam and Mexico, slightly offset by expected increases in Canada, Indonesia and the Republic of Korea. China's dairy product imports were expected to decrease by 8 percent in 2020, with the largest decline in milk powders, whereas butter and cheese purchases were expected to rise. Overall, exports of milk powders (-7 percent WMP and -8 percent skim-milk powder [SMP]) and butter (-6 percent) were forecast to decline most, while trade in cheese may slightly rise (0.5 percent). In 2020, the Russian Federation, China and the Republic of Korea were forecast to increase their purchases, generally underpinned by continued demand from affluent consumers (FAOSTAT, 2020).

In Uruguay, according to OPYPA (2020), labor shortage led to using a higher proportion of milk to produce milk powders whose processes are more automated and easier to store. This trend could represent an additional pressure on the fall of its price. Although up to June 2020 the dairy sector in Uruguay had not yet experienced a fall in its exports due to COVID-19, there will probably be temporary falls in the short run given the situation of international trade in terms of powdered milk. OPYPA has built scenarios to estimate the impact of COVID-19 on the sector which consider a reduction in dairy exports in 2019 of between 0.6 percent and 5 percent. In the most optimistic of scenarios, losses are estimated at USD 4 million, while the most pessimistic projections imply losses of USD 32.8 million (OPYPA-MGAP, 2020).

Similarly, projections estimated before the crisis caused by the pandemic suggested that world production would grow by 1.7 percent in the next decade, well above other agricultural commodities (OECD-FAO; 2019). Despite changes in the projections caused by the pandemic, India and Pakistan are still estimated to be leading actors that will contribute over half the growth in production. However, production in these countries will be mostly geared to local consumption.

The coming decade may bring a change in the type of dairy products consumed, though the COVID-19 pandemic may slow down these trends. Sidebar 4 describes the estimates prepared by OECD/FAO (2019) relative to the growing importance of cheese and butter trade in the forthcoming years. This increase is framed in a scenario where consumers in the most developed economies (which are also producers) will enjoy a much broader selection of dairy products. The United Kingdom, the Russian Federation, Japan, the European Union and China

18 Although imports of milk (liquid) have increased from the European Union and New Zealand (OECD/FAO, 2019).

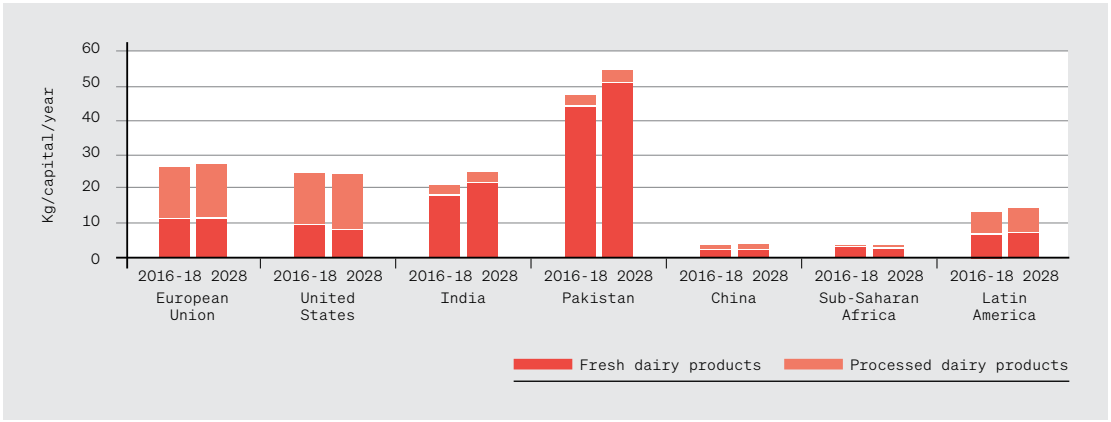

Figure 14
Per capita consumption of processed and fresh dairy products in milk solids
Forecasts made before the COVID-19 crisis

Source: OECD/FAO OECD-FAO Agricultural Outlook 2019-2028 (2019). http://dx.doi.org/10.1787/888933958904

are foreseen as the five main importers of cheese in 2028. Likewise, the consumption of biological dairy products is expected to increase in Europe.

Uruguay – a modern yet heterogeneous industry

In recent decades, Uruguay has positioned itself as a competitive player in dairy exports. It was the second most important export country for dairy products in Latin America in 2019 and globally ranked tenth as an exporter of milk and concentrated or sugar-content cream (HS 0402), which includes powdered milk (TDM, 2020). Its exports are diversified and account for 9 percent of total country exports, reaching out to over 60 markets worldwide.

Approximately two thirds of the production is exported. The basket of main export products (in litres of milk equivalent in 2018) includes whole powdered milk (68 percent) and cheese (26 percent). The main import markets are Algeria (28 percent of total exports in 2019), Brazil (20 percent), the Russian Federation (14 percent), China (8 percent), Cuba and the Philippines (both 5 percent) and Mexico (3 percent).

At the industrial level Uruguay is well equipped to increase production and produce at high levels of efficiency and quality. The industry processing capacity has been growing over the years in parallel with the increase in production, although it experienced a fall in 2017 and 2018 after the emblematic PILI plant was closed down; this plant had specialized exclusively in exporting certain products to Venezuela (Bolivarian Republic of) and could not go on after the fall of that market (*Instituto Nacional de Leche* [INALE], 2019).

The dairy industry value chain in Uruguay features high levels of efficiency and adaptability in the main units. The main operator is a cooperative of primary producers that covers 70 percent of production.[19] In addition, according to data furnished by INALE (2019), in 2018 83 percent of milk delivered to the plant was concentrated in the three main firms of the industry, however in 2018 the industrial stage of the dairy industry was integrated into

19 Although on average the industrial productivity of labor (729 000 liters per person in 2018) is below that in competitor countries like New Zealand (1 727 000 liters per person for that same year), this is mainly due to differences in scale of production, as well as to differences in the product mix. Uruguay's production is 9 percent of New Zealand's (CPA Ferrere, 2020).

48 companies (CPA Ferrere, 2020). This has helped penetration into relevant markets and adapting production to demand from such markets. From 2014 to 2018, the share of powdered milk in the total dairy exports of Uruguay shows a progressive increase from 38 to 68 percent.

Yet the milk industry is heterogeneous. While larger-size industries have access to cutting-edge machinery and technologies, leading the innovation process (see Box 2 below), smaller enterprises will show some delay in terms of matching capital and their access to spear-head technologies is considerably lower (*Ministerio de Industria, Energía y Minería* (Bertamini, *et. al*, 2012)), with their production being less export-driven and concentrating on goods such as cheese and, to a lesser extent, *dulce de leche* and mozzarella. Also, there is **artisanal production** carried out "on the farm" with cheese being the main product under this modality (CPA Ferrere, 2020).

There is room to enhance labour skills and the availability of technicians in rural areas. The dairy industry, according to data from DIEA-MGAP for 2018, employed over 4 700 workers, with almost 90 percent as permanent staff. In terms of human capital skills to serve the industry, innovation requires training and continuing adoption of technical skills in operations. Moreover, there are other challenges such as the availability of highly qualified technicians in rural areas, training of mid-management staff, re-skilling of human capital after labour automation processes, and the presence of qualified technicians in small industries. In micro and small enterprises, there are more weaknesses in terms of access to training and technical assistance. The so called "dairy technician" (frequently the company owner or a supplier for production) turns out to be the main agent for technical assistance and training which, in addition, is often not very knowledge-intensive and hardly planned (Bertamini, *et. al*, 2012).[20] Thus, when addressing the transformation of the industry, it will be crucial to guarantee the availability of higher-level technicians with skills in information technology, chemistry, mechanics, and management, etc. (CPA Ferrere, 2020).

A differentiated primary sector

Intensification and larger-scale enterprises have increased productivity in the primary sector. The vertical integration of the sector – 74 percent of milk delivered goes to producers' cooperatives (CPA Ferrere, 2020) – and recent investment throughout the whole value chain have contributed to a significant increase in productivity per cow and per hectare during the past decade.

The increased concentration of industrial activity occurred in parallel with the yearly reduction in the number of producers delivering milk and of the areas dedicated to dairy activities. In 2017/18, there were 2 662 milk farmers delivering to industry and 754 000 hectares dedicated to dairy production (17 and 11 percent less, respectively, than in 2011) and the average volume delivered per farmer has gone up to 2 120 liters per day – 35 percent over the figure for 2011 (DIEA, Estadísticas Agropecuarias, 2019); see Figures 16 and 17. In addition, the country has approximately 1 100 artisanal cheese makers.

Costs go up and prices remain stable. Regarding production costs, Uruguay is still competitive in relation to other countries, due to low feeding costs of grass-based milk production. However, margins have shrunk according to data from the International Farm Comparison Network (IFCN), submitted by the National Agricultural Technology Institute (INIA, 2019). According to them, production costs today reach levels close to 40 cents.

20 Paragraph adapted by authors based on CPA Ferrere, 2020.

Sidebar 4

Largest trade increases are for cheese

The four major exporters of dairy products in the base period are New Zealand, the European Union, the United States of America, and Australia. These four countries were expected to jointly account for around 75 percent of cheese, 78 percent of WMP, 79 percent of butter, and 81 percent of SMP exports in 2028.

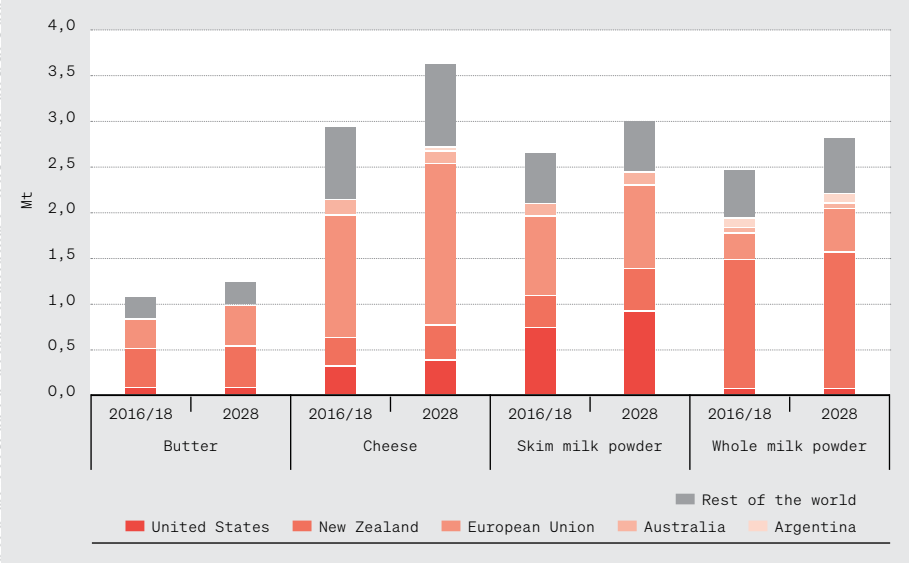

Figure 15
Exports of dairy products by region

Source: OECD/FAO (2019). http://dx.doi.org/10.1787/888933958980

In projections made before the COVID-19 crisis, the European Union would increase its exports by over 45 percent in butter, 30 percent in cheese and 53 percent in SMP. The United States of America would increase its butter and milk production replacing exports of WMP by SMP. New Zealand export increases would also be mostly in SMP (over 25 percent) and cheese (just short of 20 percent). In addition, a growing share of milk produced in the European Union is expected to be organic; more than 10 percent of dairy cows – and about 3 percent of milk – are in organic systems with relatively low yields, but a considerable price premium for milk.

Source: OECD/FAO (2019)

Although Uruguayan costs are below those of Brazil and match those of Argentina, Chile produces at lower cost and has better access to certain markets through its international trade agreements. In addition, milk production is very demanding in terms of time and labour effort and it competes with other sectors that offer better remuneration to labour employed. This may jeopardize the competitiveness of Uruguayan milk production.

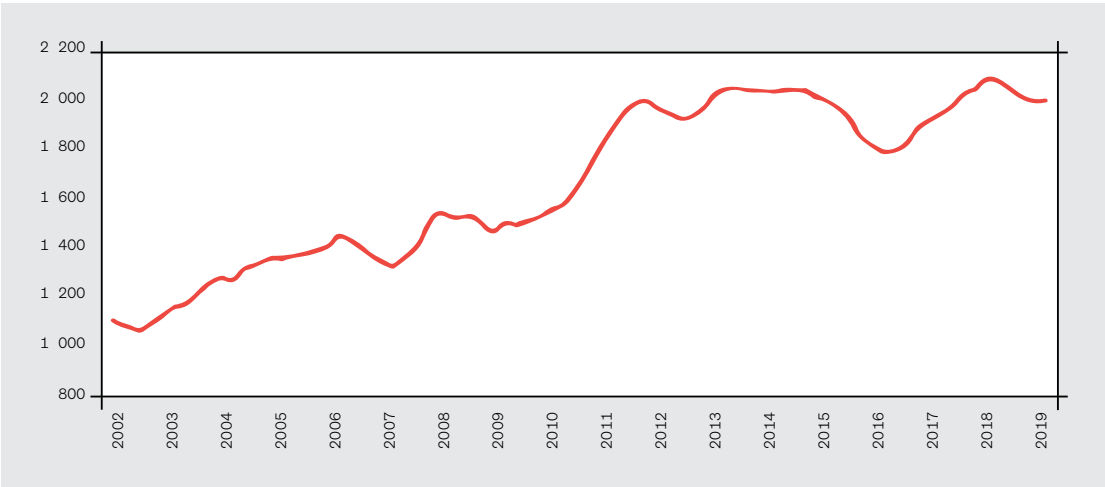

Figure 16
Milk delivery to industrial plants (millions of litres: 12 mobile months)

Source: CPA Ferrere (2020) based on INIAL (2019).

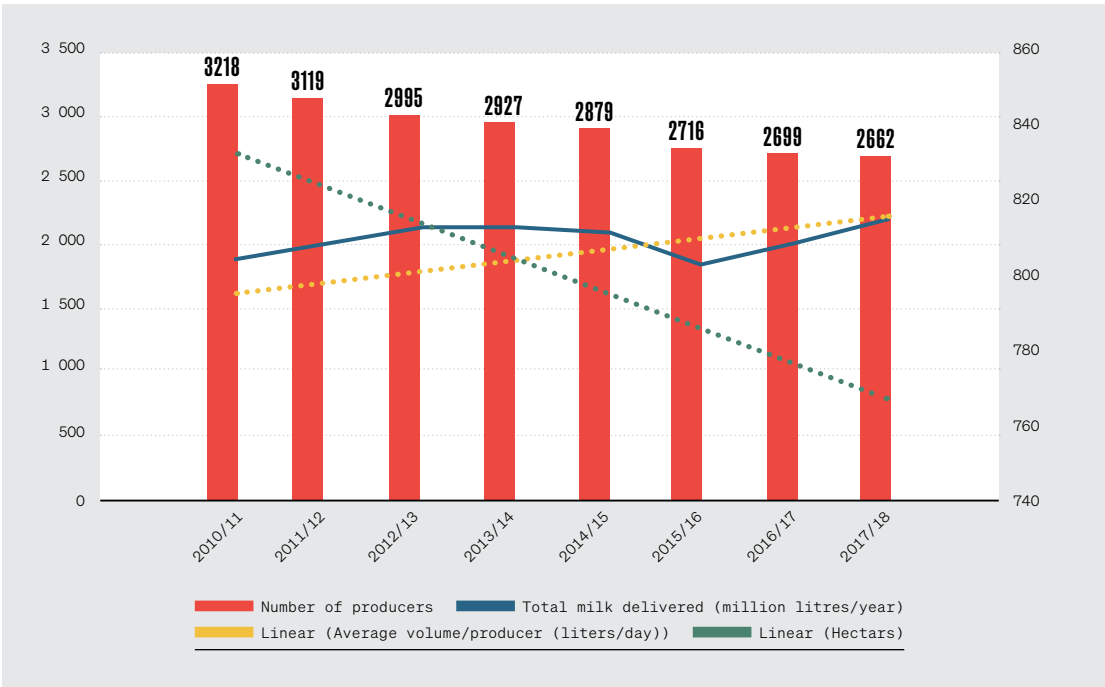

Figure 17
N° of producers delivering, total volume of milk delivered per year (million litres) and average volume per producer in litres/day (left axis), hectares involved (right axis)

Source: Authors' elaboration from DIEA, Estadísticas Agropecuarias (2019).

The future of the chain depends on productivity enhancement

Management of pastures with a comprehensive approach and controlled feeding conditions are crucial to the success of the sector. Both the tons of grass harvested per hectare for animal feed and the stocking rate per hectare are positively correlated with the returns on capital in the sector (INALE, 2019). Uruguay, despite having favorable climate and geographic conditions, ranks below its competitors (see Sidebar 5) in some productivity indicators. Although each country may have its production specificity, these indicators are important for Uruguay where feeding explains almost 50 percent of direct costs on dairy farms and 75 percent of such direct costs relate to concentrated feed. Accordingly, there are opportunities to increase the percentage of grass in the diet, reducing the rates for concentrated feed. Recent results in the increase of improved pastures (see Chapter 1) may change this situation but it is important for results of recent policies to be evaluated and to continue investing in the development of efficient production systems.

Possibility to enter some market niches but trade agreements will be decisive

Dairy products enjoy special treatment in international trade agreements and have quotas and tariffs that define priorities when accessing markets. Today, Uruguay's competitors such as Australia, Chile or New Zealand have trade agreements in force, with zero tariffs to enter China. The United States of America has recently reduced tariffs on imports from Korea. Trade agreements signed by Uruguay are mainly concluded within the framework of Mercosur and, to a lesser extent, with Mexico and the United States of America. Although commercial ties with China have been strengthened in recent years, a better positioning in this market is crucial to expand the international presence of this sector. Conversely, other agreements may have counterproductive effects for the current positioning of the country in the region, should the market open to products imported from other countries with higher levels of subsidy.

Cheese is the dairy product that is expected to propel the growth of international trade and this can generate an opportunity for Uruguay. The market also presents opportunities in terms of *ecological products*, in particular those coming from biological agriculture in European and North American markets where consumers are willing to pay for high-nutritional level products that respect the environment (World Bank, 2018a). Yet growth rates for such non-essential products will depend on how the region recovers from the current crisis.

To leverage the opportunities provided by these high-value-added markets would imply creating an alternative to the current scenario of migration to larger, more productive dairy farms. Organic dairy farms are usually smaller and produce 40 percent less milk per cow than conventional methods. For example, an average organic dairy farm in Vermont would produce around 6 000 kg of milk per year – 9–30 percent lower than conventional yields – and have 20–40 percent of the conventional stocking rates. The average farm size would be 63 cows. However, organic dairy farming offers higher margins due to a price premium on organic milk and lower feed costs once conversion is achieved. If Uruguay decides to go for production of organic milk as a strategy of diversification (for smaller farmers?), it needs to invest in research to generate organic farming systems that are as productive and efficient as possible to be competitive with the conventional systems. Additionally, processors must be on board with such strategies as they will need to be able to guarantee interesting prices in the medium–long term and to invest in specific production lines for organic products.

Sidebar 5

Production strategies depend on context

The European Union production originates from a mix of grass-based and feed-based production systems. The highest average yield per cow is expected to occur in North America as the share of grass-based production is low and feeding is focused on high yields. New Zealand production is mainly grass-based and yields are considerably lower than in North America and Europe. The efficiency of grass management and the year-round grazing, however, allows New Zealand to be competitive.

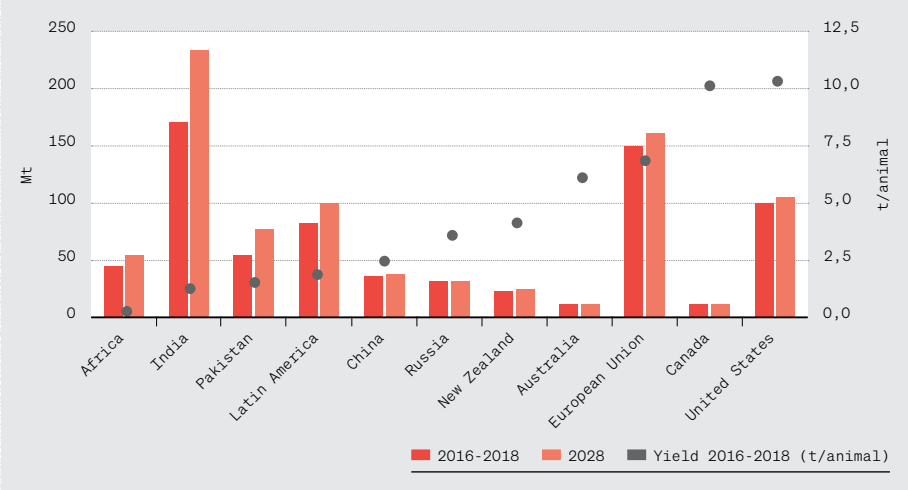

Figure 18
Milk production and yield in selected countries and regions

Source: OECD/FAO (2019). http://dx.doi.org/10.1787/888933958961

Uruguay today has a stocking rate and pasture production per hectare for animal consumption that is lower than that in other exporting countries. However, policies elaborated in recent years have led to a permanent increase of land occupied by sown pastures in dairy farms (see Chapter 1) and this scenario may change in the coming years.

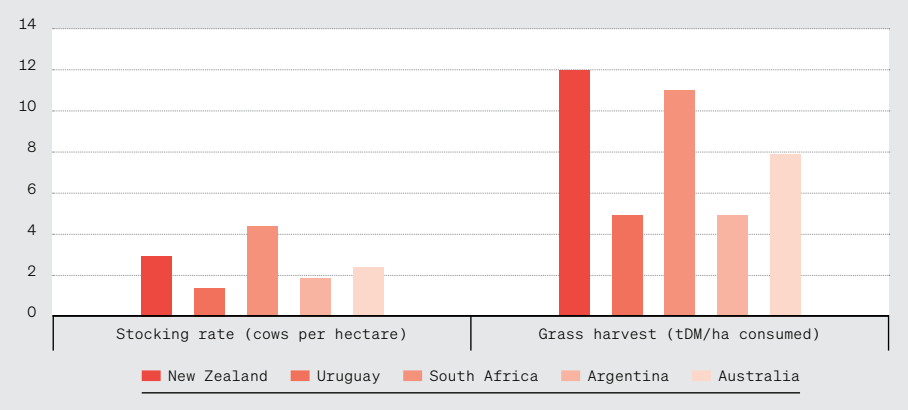

Figure 19
Stocking rate per hectare and grass harvest for consumption per hectare

Source: INALE (2020).

Combination of skills on production systems development farm automation and data analysis needed

While at the industrial level Uruguay has reached a very high level of competitiveness, at the level of primary production the sector must continue its focus on improving productivity. Conventional agricultural systems need to continue to increase their productivity per animal and per hectare if they are to attract young and well-trained workers and managers. The development of robotics and farm automation coupled with systems for data collection and analysis for the specific production systems of the country can also: (i) lighten the normally heavy nature of the work in dairy farms; and (ii) contribute to developing ever more efficient production systems. Simultaneously, there is an opportunity for the development of a niche product industry, whether it be for example differentiated cheese types targeting urban consumers or organic agriculture milk products (including WMP).

Alternative farming systems – organic, but also high-end market cheese for example – need research and development on producing systems that can deliver high value addition at the lowest possible cost per unit.

Hence, in terms of human capital and awareness raising, the subsector will require: (i) highly trained agronomists specialized in dairy production for the continuous development of production systems (including organic and specialized dairy products); (ii) information technology, electronics and robotics experts to develop digital and automation solutions that are appropriate to Uruguay; (iii) continuous incentives to producers' organizations to train their technicians well enough in innovative and efficient production systems and equip them with adequate extension materials; (iv) producers trained and coached on new production techniques; (v) mid-management skills for large industries; and (vi) qualified technicians and new managerial and marketing capacities for smaller and family-run processing units aiming to develop differentiated high-value products (large industries can train their personnel). Policies that help in rejuvenating farm management/ownership and the establishment of populations in rural areas may contribute to a faster shift in the existing capacities of dairy farms and small processing units.

Box 2

Industry's capacity to adapt and strategic market penetration

Conaprole (the largest milk processor in Uruguay) is a cooperative that invests in the development of new services for its members and incorporates new production technologies. Going beyond the automation of packing processes or at the end of the product line where the largest profits in productivity are typically achieved, Conaprole invests to improve the variety of export products and to achieve flexibility and capacity to handle raw material in order to obtain products that appeal to the market. Likewise, Conaprole invests permanently in the use of digital technologies to improve in-company efficiency, as well as to support products associated with productivity enhancement (see Chapter 4 on digital agriculture). Another example of the high levels of technological innovation at their industrial premises is the export company Alimentos Fray Bentos (second in terms of market share), whose facilities have cutting-edge technologies to produce demineralized whey used in the production of food for children and the elderly. The same may be said about the company Estancias del Lago and its export-driven milk powder plant.

Source: CPA Ferrere (2020).

Sidebar 6

Uruguayan rice fetches high average prices amongst the high-quality long-grain white rice

But Uruguay is following the international trend of increasing shares of paddy in overall rice exports.

Data seem to confirm the reports from the industry that the historical positioning of Uruguay in high-value-added rice exports seems to be eroding as exports of paddy increase in the last years. While exports of milled rice from Paraguay and Brazil increased slightly in absolute terms, their shares of milled rice in their overall rice exports also decreased.

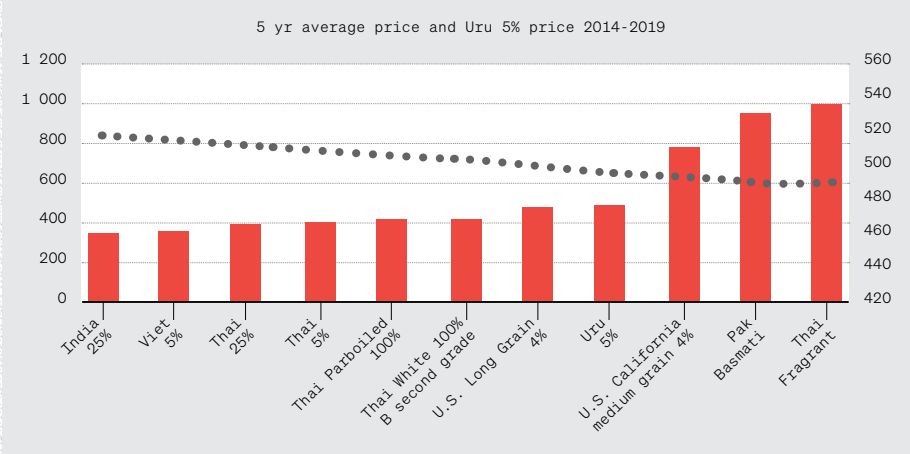

Figure 20

Five-year average export price, in USD/Mt (left axis); Uruguayan rice price trend 2014–2019, in USD/Mt (right axis)

Source: Authors' compilation from FAO Rice Market Monitor (2020).

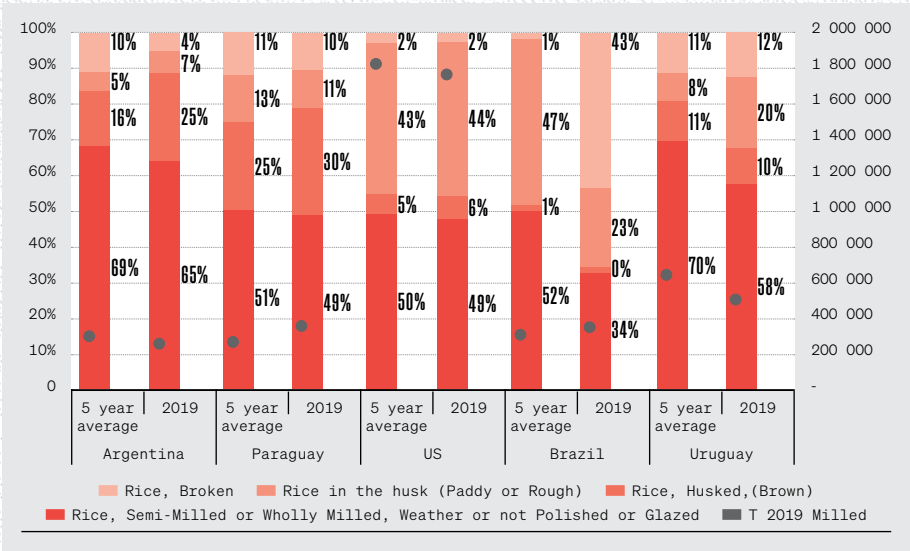

Figure 21

Share of rice exports per country (left axis); total export volumes of milled/semi-milled rice, 2019 and five-year average (right axis)

Source: Authors' compilation from Trade Data Monitor (2020).

2.3 RICE

Global market for rice produced in Uruguay not likely to grow

OECD and FAO (2019) foresee that up to 2028 world rice production will grow by 65 Mt to reach 578 Mt in 2028. Production in developed countries will have a marginal increase (+1 Mt) while in developing countries it is expected to increase rather vigorously (64 Mt). **Asia will contribute most of the additional global production (56 Mt) during the said period.**

Rice consumption worldwide must increase by 67 Mt during the same period and this is mostly attributed to an increase in the demand for food in **Asia (+35 Mt)** and **Africa (+17 Mt)**. Additionally, the growth of global trade in rice is foreseen at 2.3 percent annually during the period covered, and the volume exchanged will slightly increase by 12 Mt, mostly in Asia and Africa.

Hence, world trade will continue representing a relatively low percentage of total rice production. World trade only represented 10 percent of global production in 2018 (FAOSTAT). The OECD and FAO (2019) estimate that the real average price of rice will fall slightly within the next 10 years.

A downward trend in prices has been verified in recent years in markets served by Uruguay, though this trend may be affected in the short and medium term given the impact of COVID-19 (see Note 3).

The country plays an outstanding role as a rice exporter in Latin America and the world, standing tenth in the global ranking for total volume of exported rice in 2019, being the seventh largest global exporter of milled rice and the fifth largest global exporter of paddy in that same year (TDM, 2020). Its production mainly comprises long-grain varieties (which account for the largest share in international trade) of the highest quality, with prices just under those of high-quality aromatic rice and medium grain among the different varieties. Although this represents an important competitive advantage for Uruguay, demand is not expected to increase significantly in the main importing countries in the near future.

Note 3
How may the COVID-19 crisis affect the subsector's prospects?

In the European Union and the United Kingdom, strong demand for fragrant varieties, cuts to non-basmati husked rice tariffs, as well as scheduled reductions to safeguard duties on imports under the Everything-but-Arms Agreement, are all expected to underpin purchases. In the Americas, strong aromatic demand is likewise set to sustain record-breaking United States imports, while Bolivia (Plurinational State of), Haiti, Mexico, Peru and Venezuela (Bolivarian Republic of) are all anticipated to purchase more to compensate for production cuts or supply limitations. Although subject to much uncertainty at this stage, global trade in rice in 2021 is preliminarily pegged at 47.6 million tons, up 6.2 percent from 2020 (FAO, 2020).

Hence, no negative impact of COVID-19 is foreseen in the case of Uruguay. Indeed, rice exports increased in volume and value during the first quarter of 2020 compared to 2019. (OPYPA-MGAP, 2020).

Processing in importing countries and international competitiveness change the export profile

Uruguay's main export product is milled rice (63 percent of the total volume in 2019), the product with the highest added value and best prices, followed by paddy (15 percent), broken rice (13 percent), and brown rice (9 percent).[21]

21 Shares of paddy equivalent.

In recent years the share of exported milled rice has been reduced. This coincides with an increase in the volume of milled rice produced in competitor countries such as Paraguay and Brazil (see Sidebar 7) and with the progressive loss of relevance in two very important markets during the past years, Brazil and Iraq. In the case of Brazil, demand is mostly for products with a lower degree of processing (paddy and brown).

The increased demand for paddy rice can also be explained by the growing demand in Venezuela (Bolivarian Republic of), in addition to the strong entrance of this product in the consolidated markets of milled rice such as Mexico and Costa Rica. Conversely, Uruguay still holds a strong and consolidated share of markets such as Peru, Mexico and Costa Rica, accounting for about 40–55 percent of the total milled rice imported in the last 5 years (TDM, 2020).

In terms of brown rice, apart from Brazil, destination markets are diversified within the EU.[22] Regarding broken rice, in recent years exports have mainly gone to Sierra Leone and Senegal (where Uruguay supplied 55 and 37 percent of total imports of those markets in 2019, respectively), thus entering one of the fastest growing markets (TDM, 2020).

An efficient sector with little scope for significant improvements at the industrial level in Uruguay

The sector is clearly export-driven as 95 percent of the total production is exported (CPA Ferrere, 2020) and ranks sixth in terms of the total exported value per product in 2019 (DIEA, 2019). In addition, it carries out an intensive production in the use of supplies and high levels of revenue per hectare which generates high levels of linkages in the areas where production and industries are located.

On a global level, the country stands out due to its high yields, which reached 8.3 ton/ha on average during the 2018/2019 clip (DIEA, Estadísticas Agropecuarias, 2019), and the high quality achieved, in attributes such as uniformity of grain, food safety, and cooking quality. This is the result of production and institutional capacity building. The 350 primary rice growers are firmly integrated with industry (with instruments such as the agreed price system and the contract between growers and industry) and production, mainly concentrated in the eastern part of the country and to a lesser extent in the northern areas, employs animal and crop rotation systems to enhance soil properties. In terms of Research and Development, there is a strong collaboration between public institutions and the private sector, and the role of institutes like INIA and *Laboratorio Tecnologico del Uruguay* (LATU) in aspects such as productivity of native varieties in the primary phase and in industrial tests, respectively, must be highlighted.

The industrial sector has an adequate level of capital. Regarding the potential for technological improvements in industrial processes, there are technologies that lead to the automation of logistic processes such as packaging and storage of bags with the help of pallet systems. Innovation in such processes may bring about a significant impact in labour productivity, given that rice logistics and shipping account for a large share of labour at the mills. Some companies in Uruguay have advanced into these technologies, in particular using automatic rice-packing machines, but return on investment will be subject to the destination profile the country defines, either higher-value markets or bulk and liner-bag transactions.

Other processes such as calibration of equipment, grain sampling and laboratory analysis are likely to incorporate automation, with improvements in

22 The sector finds it difficult to enter value markets, such as the European Union, that are protected by import tariffs.

labour productivity between 6.5 and 10 percent. However, these are all technologies that the industry will adopt whenever the prospect for a return on investment is real. The installation of a cutting edge rice mill was scheduled for completion in 2020. Furthermore, rice mills have been gradually incorporating optical color-sorting machines that impact on product quality by allowing greater homogeneity of the grain in terms of color.

Maintaining and repairing a modern rice mill with a high degree of automation represents a challenge in terms of human capital training, especially in areas such as programming automation, hydraulic equipment, pneumatic systems, and other specific digital technology skills, such as robotics and artificial intelligence. Some stakeholders consider that implementing a program for development and capacity building among local suppliers could represent a useful alternative for the sector. Nevertheless, the lack of trained human capital does not seem to be a constraint in terms of incorporating capital to increase industry productivity. From the viewpoint of public policy, the challenge would be to install formal training centers to address the needs of this industry which is geographically scattered, with little connection to other industrial clusters (CPA Ferrere, 2020).

Reducing rice sown areas implies reducing industrial efficiency

The main constraint for the sector lies in the profitability margins of primary production. Despite the high yields and high quality achieved, there is a permanent trend in the number of rice growers who are abandoning this activity year after year, and this is reflected in a sustained fall of sown areas and production in recent years, reaching 135 000 hectares in the 2019/20 clip (estimated by CPA Ferrere and based on MGAP surveys), the smallest area since 1993 (see Figure 22).

Primary profitability issues stem from high production costs and investment that led to negative margins of profitability in recent years (see Sidebar 7). Although there were prospects for change after the devaluation of the Uruguayan peso in early 2020, the stability of the exchange rate in recent years and the high costs of fuel and energy have not allowed competitive profits vis-à-vis neighboring countries. Even though the main rice mills are part of the association *Gremial de Molinos Arroceros* (GMA),[23] they establish an "agreed price" (*precio convenio*)[24] guaranteed to rice growers, this arrangement has not been enough to maintain the same number of rice growers nor the sown areas (CPA Ferrere, 2020). Given the global market context, as the level of indebtedness of farmers becomes unsustainable or as the shelf-life of investments ends, it is only natural for the less efficient growers to quit the sector.

Due to a lower volume of production and lack of stability in the format used for product delivery,[25] the sector loses efficiency in the use of capital. Evidence suggests that there is significant heterogeneity both across firms and across plants belonging to the same firm. Some plants are operating under idling capacity which has led, for example, to frequently resorting to mechanisms such as unemployment insurance, eliminating one whole working shift or operating in 2.5 shifts on average. (CPA Ferrere, 2020).

23 The rice industry features a high level of concentration, with a leading company (SAMAN) that comprises between 40 and 45 percent of the exports market, and five companies that concentrate almost 90 percent of the value of exports.

24 This agreed price or precio convenio is determined through a contract that sets up a bargaining mechanism and sets the price received by farmers, taking as a reference the expected export price, from which costs of industrialization, logistics and commercialization are deducted.

25 Some transactions are in bulk while others are packed.

In the rice chain, intensity in the use of factors implies a strong economic and social impact in the regions where production takes place. It is estimated that in the primary phase alone the sector creates one job every 60 hectares, this being one of the sectors with the highest potential to generate labour opportunities (DIEA, 2019).

Given global trade trends, Uruguay must get ready to change crop systems

To boost the sector and harness acquired skills in the industrial segment of the value chain, an in-depth examination of recent changes in the crop patterns of rice-sown areas and their perspectives in the medium run, is required.

In view of international price scenarios and after considering possible scenarios for the evolution of production costs in Uruguay, the rice areas that could sustain a competitive position (and under what conditions) must be identified, thinking both globally and in relation to current production alternatives in those areas. In this way, it will be easier to understand the circumstantial and structural elements that affect competitiveness and the scope for improvement.

Likewise, the analysis on competitiveness and alternatives in those areas could be complemented with a consideration of impacts, costs and benefits expected in terms of chain interactions, employment and tax revenues. This will help understand whether the recent trend in shifting to cattle breeding is the best alternative from an economic and financial standpoint or whether to justify investments that allow farmers to change to other crops with higher added value.

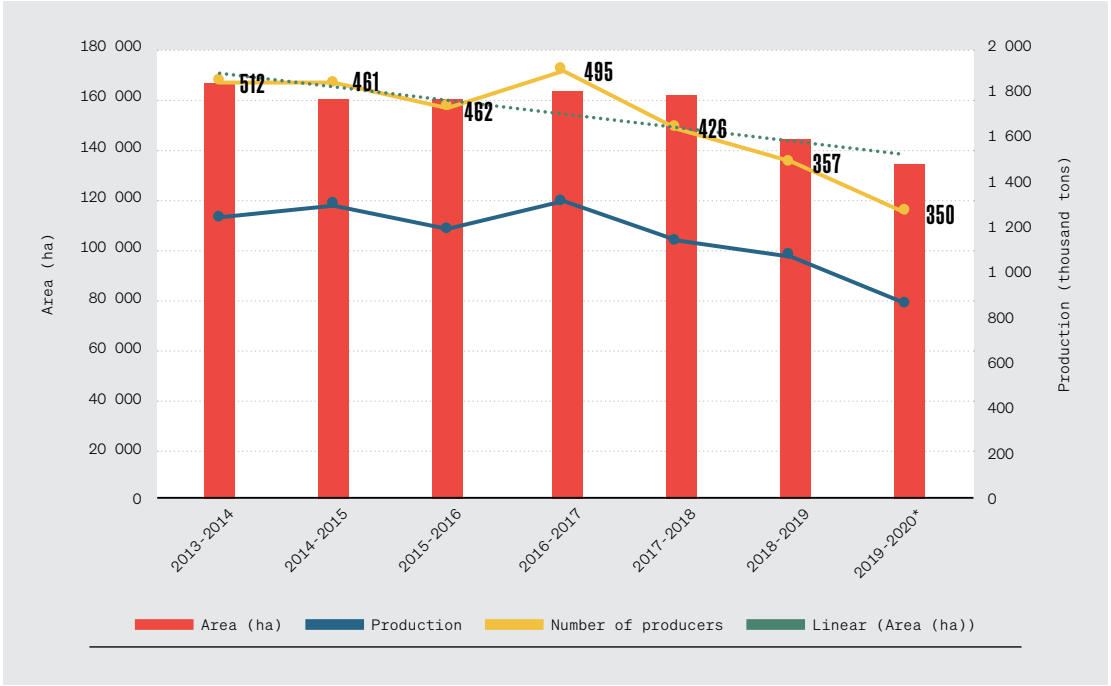

Figure 22

Rice production area, in ha (left axis); number of farmers, 2013-2020; rice production, in tonnes (right axis)

Source: Authors' elaboration from DIEA, Estadísticas Agropecuarias (2019).

Uruguay's high rice yields do not offset its high production costs

Uruguay's total production costs per hectare were on average 75 percent higher than those of Paraguay.

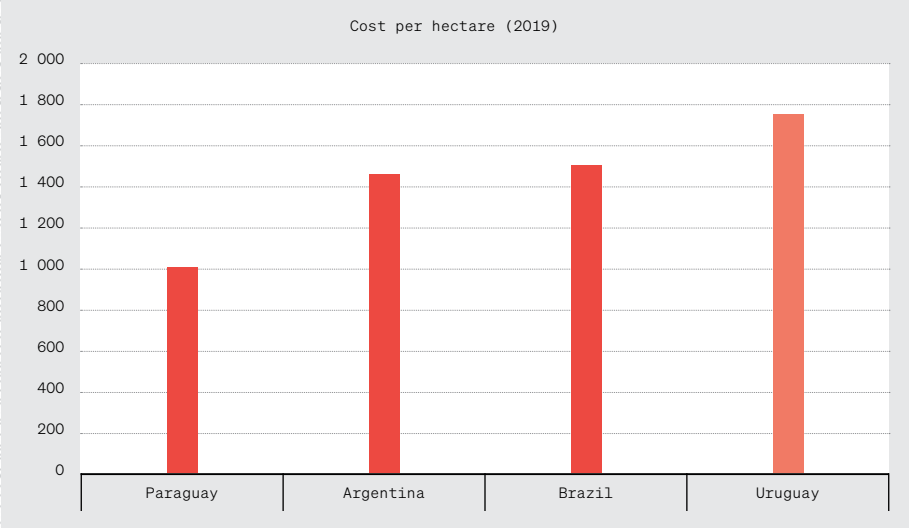

Figure 23
Cost of production (USD/ha) for 2019

Source: Authors compilation from USDA (2019), CONAB (2019) and Fundarroz (2019).

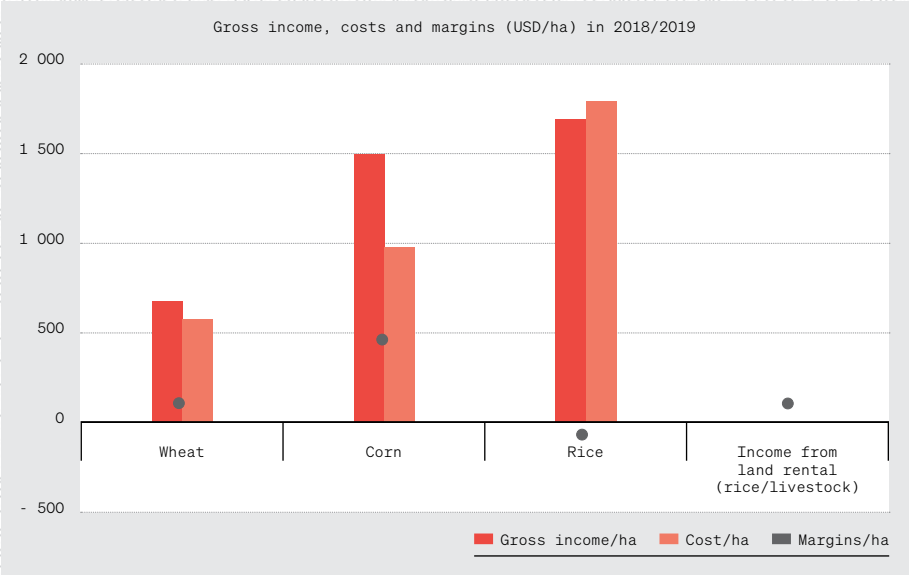

Figure 24
Average gross income, costs and margins (USD/ha) for selected crops in Uruguay in 2018/19

Source: Authors estimations based on FAOSTAT (2020), Uruguay USDA Grain and Feed Annual Report (2019; 2020) and DIEA (2019).

Box 3
Irrigation to foster development in rural areas

The new information technologies allow for frequent updating of different production scenarios in parts of the country with a potential to enhance the existing performance or install irrigation. Such scenarios were developed on the basis of open-access geographic information systems that can take into account the estimated effects of climate change and incorporate a high number of dimensions, namely:

- hydrological (hydrological availability, analysis of water supply/demand of the systems, etc.);
- agronomic (soil uses, types of soil, yields);
- productive (production models, current and potential productivity, prices and markets);
- economic (costs, economic and financial profitability, current and future responsiveness);
- environmental (water and soil quality, expected impacts);
- social (land tenure situation, analysis of users' organizations, identification of potential beneficiaries);
- institutional and legal (evaluation of critical issues in terms of irrigation water management in every province, legislation, public institutions, private agents, access to credit, organized participation of stakeholders)

Drawing from a real time analysis and with digital support, mechanisms for the right investment strategy in infrastructure, organization capacity building, institutional and legal action, funding mechanisms and strategies, and public-private participation can be proposed.

Source: Authors' elaboration.

Accordingly, Uruguay might be interested, for example, in examining the potential of introducing irrigated crops at a larger scale. The latest irrigation strategy for the country, though recent (2017) was formulated in the context of a market evolution that was different to the current one. Revisiting the irrigation strategy for the country could result in long-term benefits (see Box 3). **A recent study on the opportunities for agriculture in Uruguay commissioned by the Embassy of The Netherlands identified irrigation as one of the main opportunities for development of the sector** (Ministry of Agriculture, Nature, and Food Quality of the Netherlands, 2019).

New skills will not change the fate of the subsector

Uruguay has reached levels of efficiency throughout the value chain where improvements are not foreseen that would result in significant progress at the industrial level. Despite the fact that there are still possibilities to solve some inefficiencies at the port level – analysis of which is outside the scope of this report[26] – unless free trade agreements are reached with markets such as Peru or the European Union, the rice sector in Uruguay will tend to diminish in importance. However, as it is a sector that creates jobs and often is the only source of employment in the industrial sector of cities where it is located, it is important to find development alternatives for rice-producing regions. Skills to be developed must therefore be matched to those required in the sectors that will gradually take the place now occupied by rice.

26 See CPA Ferrere (2020).

2.4 WOOL

A industry reinventing itself worldwide

In the last thirty years, the wool industry has gone through a process of decline at the international level. The dissolution of the Union of Soviet Socialist Republics (USSR), as well as increased competition in the textile sector with the growth of the use of cotton and synthetic products for textile manufacturing, led to a crisis in the wool sector in 1990-91. Chapter 1 captures how this change affected Uruguay in terms of land use change and size of the sheep herd.

The process of systematic decline that started in the early 1990s seems to have come to a halt in the last decade. A report (Persistence Market Research, 2019) predicts that the wool market will expand at a compound annual growth rate of about 3.5 percent during the period 2019–2029, but that manufacturers will need to innovate in the production process to reduce its overall cost and to expand the customer base. The report advises wool **producers to strengthen their partnership with companies operating in the fashion industry to stay ahead of the pack**, considering the demand for fine wool for apparel and footwear.

Uruguay is well placed to surf the new wave, but it is not guaranteed that it will

Uruguay is well placed internationally in terms of wool production. In 2019 it ranked 17 in wool production (FAOSTAT, 2020). In the same year, it was the twelfth largest exporter of greasy wool, the sixth largest exporter of degreased not carded or combed wool and the third largest exporter of wool tops (TDM, 2020). Uruguay has also managed to differentiate its woollen products by incorporating ecological and environmental certifications that are demanded by the market, which enabled its exporters to compete with those that do not yet meet these requirements. For example, the Uruguayan industry has managed to position itself as a global example in the area of water collection and treatment (CPA Ferrere, 2020). This is a strength that Uruguay should continue to use in the short/medium-term to secure a diversified clientele, particularly in Europe.

However, in recent years, **most large wool producing countries have invested in integrating production from greasy wool to consumer goods**, something Uruguay has not done. Additionally, traditional sellers of woollen finished products, such as Italy, have increasingly outsourced manufacture to wool producing countries (see Sidebar 8), further concentrating production in a handful of countries. This trend of vertical integration of the value chain means that net importers will mostly import greasy wool, whilst wool producers will sell greasy wool surpluses that they do not process into consumer goods.

Although Uruguay adds value to the wool it imports, the price of wool tops exported by the country are on average lower than those obtained by Australia for greasy wool [27] or than the average import price of greasy wool into China. As the international market is made mostly of greasy wool and consumer goods, demand (and therefore prices) for intermediate products tends to be low.[28] In the next few years, the share of greasy wool exported by Uruguay vis-à-vis wool tops, may increase. Additionally, as the national heard is predominantly made up of Corriedale sheep, Uruguayan wool may not fetch the prices offered for finer wools.

27 The authors used a conversion factor for wool weight of 0.65 from greasy to degreased wool.

28 Furthermore, Uruguay does not have trade agreements with China (or the European Union), which makes it lose competitiveness in these markets.

Sidebar 8

Strong trend for integrated industries

Uruguay, Argentina and New Zealand are amongst the few large wool producers without an integrated wool industry.

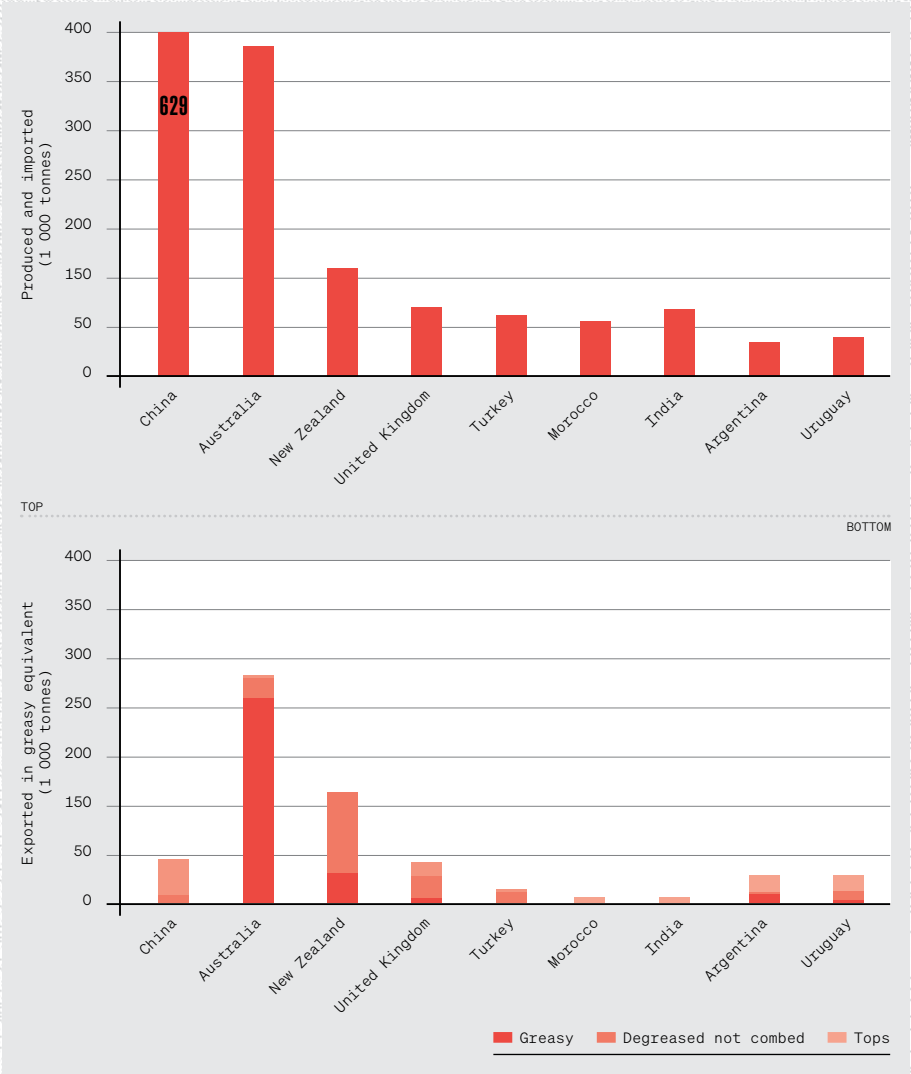

Figure 25

Greasy wool production plus imports (top); export breakdown per country (bottom) for 2019

Source: Authors' estimations from TDM and FAOSTAT (2020) data.

A quick overview of international trade reveals that: (i) Australia transforms a sizeable share of its production into wool consumer goods; (ii) China is by far the largest producer and importer of unprocessed wool, while exporting less than 10 percent of the raw material it uses as degreased wool or wool tops; (iii) large wool producers with low labor costs process the wool they produce into final products (Turkey, Morocco, India); (iv) the UK is an important trader of wool products from all value chain tiers; (v) a number of other European countries (Italy, Germany, and Czech Republic) have developed advanced wool products manufactures.

Sidebar 9

Little value addition in intermediate products

The four major exporters of dairy products in the base period are New Zealand, the European Union, the United States of America, and Australia. These four countries were expected to jointly account for around 75 percent of cheese, 78 percent of WMP, 79 percent of butter, and 81 percent of SMP exports in 2028.

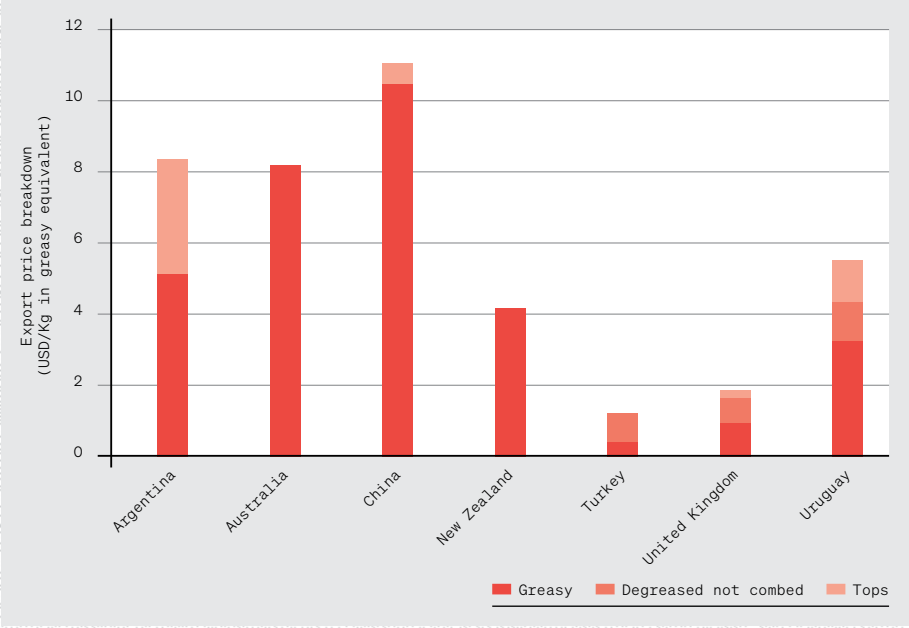

Figure 26
Value addition along the production chain for 2019

Source: Authors compilation from TDM (2020).

The fact that Uruguay trades on World Trade Organization (WTO) rules places it at a disadvantage with countries such as Australia that have trade agreements with China.

This fact may be impacting farmers in terms of incentives for keeping their sheep inventory. As seen in the previous chapter the land surface dedicated to ovine livestock has decreased substantially from the early 2000s. Although increases in land productivity have partially made up for it, resulting in a much smaller decrease in wool production, it is not completely clear whether or not sheep breeding for wool production will continue its downward trend. In 2018, Uruguay produced over 25 000 tonnes and imported approximately 17 000 tonnes of greasy wool (DIEA, Estadísticas Agropecuarias, 2019), meaning that in order not to keep its factories idle, the country imports wool – mostly from Brazil, Peru and Argentina.[29]

29 See Note 4 on how the current pandemic may be impacting short to medium prospects for the sector.

Uruguay could target markets for fine greasy wool as stock of wool breeds increases

Persistence Market Research (2019) reports that **manufacturers worldwide are targeting opportunities in high-end niche wool markets such as luxury clothing and athleisure**, rather than interior wool textile, as a response to the instability of demand for woollen products resulting from the increasing adoption of synthetic and relatively cheap fibers for interior textiles. This means that consumers will increasingly value wool properties such as comfort, elasticity, durability, and breathability giving a preference to Merino wool, which is emerging as a key fabric for sportswear and even shoes. Despite the entry of other natural fibers such as cotton and silk into *performance and sustainability sectors*, the anti-odour benefits of Merino wool will continue to give it a head start in a number of applications. Persistence Market Research (2019) also remarks that higher innovation and investments are directed towards this specific source of wool.

While Uruguay sells its wool products to important niche markets, such as makers of upholstery for luxury cars, **the country could also explore possibilities in terms of increasing its share of sales to makers of fine clothing items**. Positioning Uruguay as a country with a competitive vertically integrated wool industry may be a difficult endeavour. Countries with highly developed and integrated wool manufacturing industries either benefit from a large domestic/neighbouring countries' consumer base – the case of Europe and China – or from efficient logistics, relatively cheap labour force and proximity to end markets (e.g. Turkey and Morocco). Uruguay, with its small population and being a region with a generally mild climate, may find it difficult to find the market traction to develop an industry of high-end woollen consumer goods. Furthermore, developing an industry around cheap labour is not an appealing prospect for a country that has made progress in generating a stable middle class. Nevertheless, Uruguay could position itself better in the segment of high-quality greasy wool and compete for the better-paying markets segments for the product, even in the short/medium term, as demand for luxury/non-essential products may fall due to the economic impact of the COVID-19 pandemic (see Note 4).

Note 4
How may the COVID-19 crisis affect the subsector's prospects?

The wool sector has been badly beaten by the pandemic with restrictions on both the demand and supply side. Due to the COVID-19 outbreak, the wool prices index (Australia) reached a ten-year minimum (since 2010) in March 2020. All producer countries reported a massive drop in exports in April 2020: New Zealand (-82 percent), Argentina (-80 percent), Australia (-16 percent) and Uruguay (-75 percent). Exports to China dropped by 30 percent in April 2020, and by 67 percent to Germany, by 70 percent to Italy, by 89 percent to Czech Republic and by 79 percent to other European countries. China´s demand recovery will be crucial in restabilising strong demand for wool.

However, the ovine meat trade is also expected to decline in the short/medium term. The ovine meat trade has registered the sharpest fall in global demand in the meat sector in the wake of the COVID-19 crisis (-23.5 percent from January to May 2020) as stocks remain high due to unsold meat in the previous months – especially in China – and demand decreased significantly.

Depending on how long each subsector (ovine meat and wool) takes to recover, the short/medium term incentives to producers may be either towards keeping mixed-purpose breeds or to continuing to transition into fine wool specialized breeds.

For many years Uruguay invested in breeding Corriedale sheep for mixed purpose (meat and wool). The continuous genetic selection of this breed left it very well adapted to the rich grasslands of most of the country and made it

Box 4

Centro Tecnológico Ovino: an R&D mechanism

Central Lanera, with the support of public programs, has invested in the creation of the Centro Tecnológico Ovino (Sheep Technology Center) with the objective of promoting innovation and technology transfer in the sheep production sector. The purpose of this center is to improve competitiveness and it provides training, technical assistance, products and services to its members. Central Lanera acknowledges that there is a considerable technology gap between Uruguay and its competitors in terms of the primary phase of wool and meat production chains, and that to a large extent it can be reduced with the application of processing technologies. In this way, Central Lanera offers sheep farmers in the cooperative the best practices in sheep management and handling, through the application of processing technologies. The Center does not develop its own experimenting units but rather centralizes information and works towards designing this experimentation through networks and gets support from sheep farms owned by members of the cooperative that comprise the initial pilot group; in addition, through agreements, they also work with institutions in charge of technology generation, research and transfer (SUL, INIA and Academia).

the preferred breed of many sheep farmers in the country. However, the more recent concentration of sheep rearing in the country's poorer soils means that other breeds are starting to gain prominence. For example, Merino Dohne sheep were introduced in Uruguay in the 2000s and the share of Australian Merino has increased relative to Corriedale in the last years. These breeds are mostly suited for arid climates and do not produce wool of the same quality as in Australia or South Africa when in Uruguay. Continuous investments in breeding for adaptation to humid climates can produce interesting results in the long term. There can be no doubt that, before embarking on such a large shift in terms of production, Uruguay would need to invest in studying its competitiveness under different primary production and trade scenarios.

Capacities in sheep breeding and production system adaptation will continue to be in demand

In terms of human capital and awareness raising, the subsector will continue to demand skill sets catering to flock breed, health and nutrition improvement, as well as for wool quality analysis.[30] In terms of support policies, Central Lanera and its partners (producers, SUL, INIA and universities) are equipped with mechanisms to introduce the changes demanded by the market by supporting its members in breeding for better wool and in continuously improving the efficiency of their farming systems (see box above) that can benefit from blended (private and public) funding.

30 The wool tops production process has been mechanized for many years, being a sector of mature technologies that, in general, have been adopted by the industry. Although new combers with higher processing speeds and better quality could be installed in Uruguay, the potential to increase physical productivity at this level is marginal (CPA Ferrere, 2020). Additionally, the four factories in the country employ a limited number of people (around 500) to whom they supply the necessary training. More advanced skills such as mechanical engineering are currently well provided by the Universidad Tecnológica del Uruguay (UTEC).

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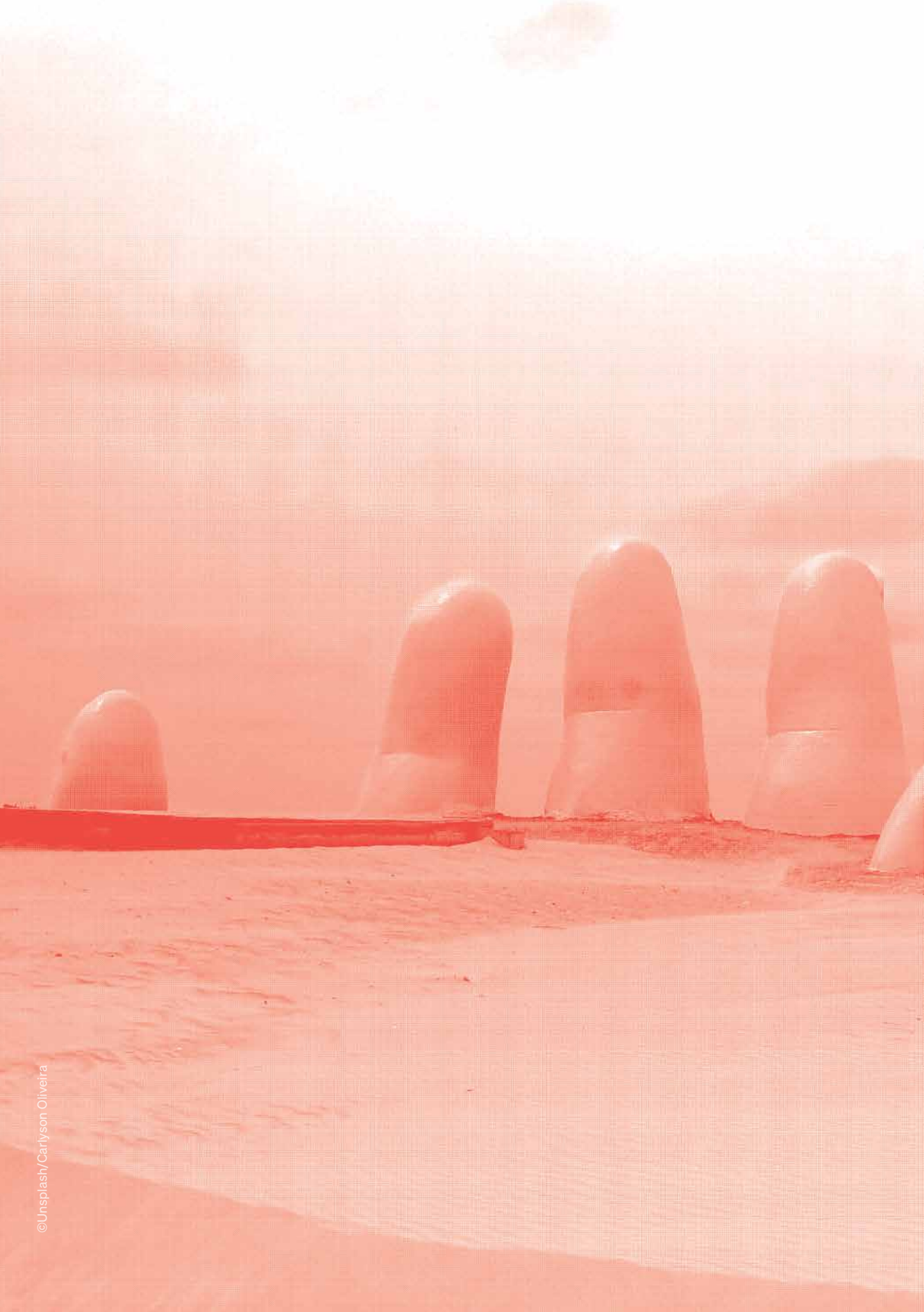

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Chapter 3
Human capital development priorities

The skills set required by a sector is a direct function from the opportunities that it is expected to face. Chapter 2 provided an overview of the four subsectors under analysis and forecast the main challenges and opportunities they should face during the coming decade. The most promising opportunities were found in livestock production, which can continue its path towards greater productivity through a constant improvement in pastures and herding practices. Greater value addition can still be attained in some value chains, such as wool, organic and/or specialized dairy products, and sustainable meat and specialized meat cuts. Digital technologies can help assess production systems and accelerate the development of efficient practices for the different production systems of the country (cf. next chapter).

This section will summarize the main findings in terms of subsector trends and needed skills per value-chain tier, while providing suggestions for mechanisms to re-skill or develop the capacities of the work force to address the forecast opportunities. It will then assess the country offer in terms of formal education and other forms of training, and identify main gaps. Finally, it will depict the current skills of those employed in the sector and summarize the key priorities in terms of increasing human capital in the sector.

3.1 KEY FORESEEN HUMAN CAPITAL NEEDS FOR THE NEAR FUTURE

Beef

Uruguay still has potential to improve the productivity and efficiency of its cattle production systems. Additionally, there is an opportunity to explore the market for sustainable beef and even the "Uruguay" brand,[31] despite the country's already good positioning in the international market for beef. As seen in Chapter 2, several routes can be taken to market more Uruguayan beef and at an even better premium than that fetched today.

All options imply more productive and efficient primary production systems, which in turn require knowledge and skills concerning the whole value chain as well as human capital delivery mechanisms as follows (see Table 1 for a summary):

i. **At primary production level:** there must be a capacity to develop and implement more productive and efficient systems, and preferably ones that can also reap environmental benefits. The development of such systems requires knowledge in cattle breeding and pasture management, as well as carbon and other inputs or pollutants lifecycle assessment. Likewise, there is a need to develop a good understanding

31 As mentioned in Chapter 2, seizing opportunities relating to the change in demand profile for beef in large and sophisticated markets, such as the European Union or the United States of America, is to a large extent conditioned by trade agreements. Options regarding such strategies should be assessed taking this into consideration.

of such systems amongst agronomists, subsector technicians (service providers) and producers. Finally, the better the monitor and evaluation system that is in place, the better the production system will be with continuous improvement measures leading to greater efficiencies overall., which makes it crucial to develop tools for sector performance M&E. This will also enable the production of relevant updated information for stakeholders. A cohort of professionals with the capacities on beef production systems described above (as well as in digital technologies) could enhance producers' organizations and public sector information systems so as to enable faster continuous improvement of production efficiency and value.

The development of new production systems requires professionals with research profiles, as well as professionals with deep knowledge of the *raisons d'être* of the current production systems in Uruguay.[32] Research organizations with strong linkages to reference international research and development (R&D) centers and to national producers are usually the best equipped to keep abreast of the latest developments in the sector, and to deliver professionals with the necessary qualifications.

On the other hand, training and coaching farmers is usually best delivered by service providers (e.g. producers' organizations) with economic incentives from the adoption of the new systems – e.g. industry or producers' organizations that will guarantee more stable inputs of a standardized quality. In turn, service providers may benefit from the development of guidelines, curricula and accredited trainer of trainers' courses on specific production systems. These may be developed and implemented, for example through public–private partnerships (e.g. public sector and producers' organizations).

ii. **At processing level:** the country is generally well equipped in terms of capacities for meat processing and packaging. However, as the level of automation in slaughterhouses increases, more professionals with knowledge on automation will be needed. Some producers' organizations and slaughterhouses can also continue to invest in the certification of their meat. As such, the sector will also need: (i) capacities to adapt the existing cattle traceability system to collect and treat information that is needed for certification and improved information to consumers/buyers – i.e. digital technology professionals; and (ii) the capacity to provide technical assistance services to producers for the adoption of certified production systems.

Regarding the development of capacities for processing and packaging activities, slaughterhouses are the best positioned actors to train their own staff. Skilled workers, such as managers, meat experts, and automation and digital technology technicians require university training and preferably professional exposure to the sector. Equipment maintenance personnel would benefit from specialized vocational training, but demand from the sector may not be sufficient to justify regular vocational training courses.

iv. **Market positioning:** should the country move towards larger use of meat certification, multidisciplinary teams need to work with producers' groups and slaughterhouses to agree on the set of standards and labels that best fits target markets and Uruguay's production systems. Depending on the nature of the labels, these will consist of nutritionists,

32 Hence, professions with the capacity to relate to producers and understand what factors may influence the adoption of new practices/technologies.

food scientists, experts on feeding and pasture management, soil scientists, ecologists, economists, communication marketing experts.[33]

As seen in Chapter 2, market positioning requires a long-term effort and strong sector organization. Producer/industry organizations with a long-term vision and investment capacity are usually the best positioned players to select and coordinate teams of highly prepared and specialized professionals. Such professionals are usually selected from amongst those with strong academic background as well as professional experience/exposure to similar initiatives.

Table 1
Trends for the beef subsector, skills needed and possible training mechanisms

	Human capital needs and possible vehicles for capacity development (CD)	
Key trends	**Professionals' education and skills**	**Delivery of CD activities**
Consumers Potential for high-value niches: increasing preference for healthy, "green"/organic products, regional specificities, etc.	◆ Development of capacities to run campaigns for consumer awareness of unique selling points of Uruguayan products.	◆ Partnerships between PO/processors and public entities to deliver key messages to consumer (nationally) or/ and importers internationally.
Processing Continuous improved efficiency, including automation of processing plants: ◆ packaging and logistics (ongoing); ◆ cuts (long term). Value addition through promotion of unique selling points (sustainable/green, grass-fed, breed, regions, etc.): ◆ enhanced traceability systems; ◆ marketing.	◆ Higher education in industrial engineering, or management (middle management skills). ◆ Higher education and experience in marketing and related fields. ◆ Higher education on electronics, mechanics, automation. ◆ Vocational training apprenticeships/ on-the job training for maintenance technicians.	◆ Higher education institutions and research centers. ◆ Vocational training, internships and apprenticeships (public, by processors or through PPP).
Primary production Higher productivity per head and per hectare: ◆ continuous pasture improvement; ◆ continuous breed improvement; ◆ continuous herding practices improvement; ◆ environmental stewardship; ◆ cyclical monitoring, evaluation and improvement of the above.	◆ Higher education/research in agronomy and livestock production. ◆ Higher education/research on animal products lifecycle assessment. ◆ Higher education + vocational training for field technicians on specific herding/ pasture management practices. ◆ Vocational training/apprenticeships/ on-the job training and coaching for producers on herding/pasture management practices. ◆ Higher education on GIS/ emote sensing/information technologies. ◆ Higher education in hydrology, statistics and geographic modeling, as well as terrestrial and aquatic ecology.	◆ Higher education institutions and research centers (herding practices). ◆ Strong POs are usually good at delivering training/coaching for technicians and producers; larger ones can also absorb some R&D activities. ◆ PO in partnership with processors for lifecycle assessments and brand/ sustainable labels development.

Source: Authors' elaboration.

33 This would be a somewhat similar arrangement to that which Uruguay implemented while discussing the possibility of having a "*cuenta agropecuaria ambiental*".

Dairy

In general, many of the opportunities for the dairy sector match those for beef, although the sector is already on a clear path towards greater primary production efficiency and productivity. The relatively low margins affecting dairy farmers in the past few years and the policies that Uruguay has put in place (e.g. *Planes de lechería sostenibles*) have already driven the sector towards the consolidation of production in larger farms, increased productivity (per head and hectare) and input efficiency.

Nevertheless, this work can still continue and the country may also explore opportunities in organic powder milk production. Hence, again, the main options revolve around more productive and efficient primary production systems and exploring new high-value-added markets. Required knowledge and skills as well as human capital delivery mechanisms are described below (see Table 2 for a summary):

i. **At primary production level:** most of what has been described for beef cattle in terms of human capital requirements also applies in general terms to milk primary production. An extra opportunity that is specific to this sector is cost-efficient automation of the milking process, which may be key to attracting younger generations to the farm.[34] However, to make it feasible, the country would need to see enough adoption to generate economies of scale in terms of investment and maintenance services.

The milk value chain is more organized and vertically integrated. As such, cooperatives such as Conaprole have taken up already many of the functions described above for beef. Nevertheless, there is still scope for continuous public support for production systems development in partnership with producers' organizations. In fact, AMS development can be undertaken by research institutions already working on the subject, such as INIA, together with producer organizations whose technicians can provide extra support to early adopters and promote further adoption as the technology becomes more mature. Research institutions and producers' organizations can also be responsible for the vocational training of AMS maintenance technicians.

ii. **At processing level:** the country already has very advanced dairy plants and is able to export high-quality differentiated products when demanded. Should organic dairy products (e.g. powdered milk and cheese) enter the dairy plant's product mix, these industries will need to invest in specialized lines of production for such products and equip themselves with staff qualified in organic certified processes ("from farm to package"). They will also need to build on the existing capacities to adapt the national cattle traceability system to collect and process information that is needed for certification.

Dairy processing plant staff will continue to be mostly trained by their employers. Managers, food engineers and scientists, experts and technicians on automation and digital technology technicians require university training and preferably professional exposure to the sector. Accredited courses on certification schemes may be needed to complement the academic background of plant technicians and of services providers (e.g. certification companies).

34 This is particularly true for family farms which are expected to run mostly with family labor.

iii. **Market positioning:** dairy products are perishable commodities with high water content (and thus expensive to transport products). They cannot be easily differentiated and/or sold if demand for them is far from the production site. As such, a new market positioning for high-value Uruguayan dairy products is more likely to happen to some extent for organic powdered milk and specialized cheese. On the other hand, unlike what happens with meat, there are well established labels or labeling systems which Uruguay can leverage, namely organic certification and geographical indications.

In this context, the producer/industry organizations – either with their own dairy plant or, for example, an association of cheese producers – would mostly need professionals with knowledge and experience in labeling and certification schemes, dairy product processing, management, and communication and marketing.

Table 2
Key trends for the dairy subsector, skills needed and possible training mechanisms

	Human capital needs and possible vehicles for capacity development (CD)	
Key trends	**Professionals' education and skills**	**Delivery of CD activities**
Consumers Very developed and mature market, but still some potential for high-value niches: organic dairy products, well differentiated cheese with high value addition, etc.	◆ Development of capacities to run campaigns for consumer awareness of unique selling points of Uruguayan products.	◆ At industrial dairy product level, business-to-business (importer). For artisanal cheese, national or regional promotions of specific labels by POs (potentially with public funding support).
Processing and vertically integrated farms Continuous improved efficiency (already very competitive). Value addition through promotion of unique selling points (sustainable/green, grass-fed, breed, regions, etc.): ◆ improved traceability; ◆ marketing.	◆ Higher education in industrial engineering, or management (middle management skills). ◆ Higher education and experience in marketing and related fields. ◆ Higher education on electronics, mechanics, automation. ◆ Vocational training for maintenance technicians.	◆ Higher education institutions and research centers. ◆ Vocational training (by processors).
Primary production Higher productivity per head and per hectare: ◆ continuous pasture improvement; ◆ continuous breed improvement; ◆ continuous herding practices improvement; ◆ AMS and data analysis; ◆ cyclical monitoring, evaluation and improvement of the above.	◆ Higher education/research in agronomy and livestock production. ◆ Higher education/research on animal products lifecycle assessment (LCA). ◆ Higher education on electronics, mechanics, automation. ◆ Higher education + vocational training for field technicians on specific herding/pasture management practices. ◆ Vocational training / apprenticeships/ on-the job training and coaching for producers on herding/pasture management practices. ◆ Higher education on GIS/ remote sensing/ information technologies.	◆ Higher education institutions and research centers. ◆ Strong POs can: (i) deliver training/ coaching for technicians and producers; (ii) employ and develop capacities of technicians in AMS, remote sensing, data analysis; (iii) manage information systems with producers' data and develop capacities at farm and PO level.

Source: Authors' elaboration.

Wool

Uruguay is well advanced in terms of its wool industry. Institutions such as Central Lanera or Secretariado Uruguayo de la Lana (SUL) can deliver high quality services to the value chain, from market intelligence to advisory services on production technology, as well as advanced wool analysis.

Demand for wool is expected to progressively focus on finer wool used for garments, possibly with some niche markets for "sustainable wool" gaining more significant size. Additionally, land use changes in Uruguay have been concentrating sheep production in the regions with poorer pastureland. These trends indicate an opportunity to shift from predominantly mixed purpose breeds, such as Corriedale, to fine wool specialized breeds such as Merino. However, these breeds usually suited to arid climates, need to adapt to the humid conditions of Uruguay. Related required knowledge and skills as well as human capital delivery mechanisms are described below (see Table 3 for a summary):

i. **At primary production level:** there must be a capacity to assist producers in changing their production systems to meet changing market demands. This means that the country needs to have available knowledge in sheep breeding and pasture management for efficient high-quality wool production. Capacity for adoption of Responsible Wool Standards[35] or similar certifications may further increase the value and competitiveness of Uruguay wool. This requires the training of agronomists for grasslands, geneticists, subsector technicians such as veterinarians or livestock nutrition specialists, and producers who are capable of developing and implementing such production systems. As in any other subsector, professionals with the capacities on digital technologies can contribute to enhance existing information systems and accelerate change.

The mechanisms to ensure that these capacities are generated/maintained and used effectively are not very different from what has been described for the beef and dairy subsectors, with producers' organizations and research centers, in addition to education institutions, playing a central role in any possible strategy.

ii. **At processing level:** there are only four firms currently producing wool tops in Uruguay and there is an international trend of vertical integration of the value chain in countries producing consumer goods. This means that the top industry in Uruguay has little room for growth. Additionally, the technology for wool tops is mature – it produces high-quality tops with environmental certifications – and specific knowledge on wool selection, and mix is developed by each firm. Hence, it is expected that the existing wool processing units will continue to train their own staff.

iii. **Market positioning:** Uruguay is not a producer of woolen consumer goods and therefore its value-chain actors do not have agency on demand. It is important that value-chain actors, such as processors and national institutions, continue to be alert concerning new market trends and transmit these to wool producers in time for them to adapt their production systems. The wool cooperatives network, Central Lanera, as well as the labouratory of the Secretariado Uruguayo de la Lana need to keep their capacities in terms of market analysis as well as wool technology and wool production in order to keep driving the necessary changes in the primary production.

35 https://textileexchange.org/responsible-wool/.

Table 3
Key trends for the wool subsector, skills needed and possible training mechanisms

Key trends	Human capital needs and possible vehicles for capacity development (CD)	
	Professionals' education and skills	**Delivery of CD activities**
Market Trend towards purchasing more greasy fine wool in detriment of the wool tops produced today. Sustainable wool?	◆ Training on wool market assessment.	◆ POs and exporters next to importers (business to business).
Processing Mature (imported) technology and trend to decrease the level of processing.	◆ On the job training for maintenance technicians and plant staff.	◆ Vocational training (by processors).
Primary production Continuous wool quality (and wool vs. meat production) adaptation to evolving market demands: ◆ continuous breed, herding practices and pasture management adaptation; ◆ animal ID and collection and analysis of performance data.	◆ Higher education/research in agronomy and livestock production. ◆ Higher education/research on animal products. ◆ Higher education + vocational training for field technicians on breeding. ◆ Vocational training / apprenticeships/ on-the job training and coaching for producers on sheep breeding. ◆ Higher education on information technologies.	◆ Higher education institutions and research centers. ◆ Strong POs can: (i) deliver vocational training/coaching for technicians and producers, (ii) promote and manage information systems and develop capacities at farm and PO level.

Source: Authors' elaboration.

Rice

Uruguay shows rice productivity levels that place it on a par with the most advanced rice producers worldwide. Likewise, Uruguay is equipped with sophisticated technology in terms of milling and is currently investing in a "last generation" rice mill, despite being somehow constrained by the lack of availability of maintenance services in remote rural areas. Absenteeism of production line workers as well as inefficiencies in terms of transport infrastructure and logistics/fees at the port, are pointed out by industry representatives as the largest constraints to increased competitiveness.

As global competition increases, rice areas recede, making way for other crops and cattle, and become concentrated in the most productive areas. Additionally, international demand and trade regulations are shifting processing of rice (and value addition) to importing countries. Hence, efforts must be made to (i) keep efficiency and competitiveness of the value chain; and (ii) provide efficient alternatives for land use change for less-competitive areas. Related required knowledge and skills as well as human capital delivery mechanisms are described below (see Table 4 for a summary):

i. **At primary production level:** despite the impressive development in terms of varieties and associated production systems, research can still be continued for instance in terms of decreasing the production cycle duration – and consequently irrigation costs. Rice research capacities at INIA should therefore be maintained. Rice production areas have potential for high productivity, due to water availability. In the wake of decreasing surfaces sown with rice, the use of these irrigated areas should be assessed and incentives (e.g. support for

improved irrigation infrastructure) provided for the transition to high value generation per hectare and per drop of water. Such studies and investment strategies require multidisciplinary teams comprising agronomists, economists, water/irrigation engineers, water management and governance experts.

Research institutions, such as INIA together with producers' organizations are well placed to keep delivering positive change in terms of knowledge and capacity in rice producing regions, as they have done so far.

ii. **At processing level:** there is a limited number of rice mills in the country and the industry is showing a tendency for further concentration (economies of scale). Apart from sophisticated equipment maintenance and plant management capacities, which need to be generated through formal education and experience in the sector, workers at processing level will continue to be trained by mills on the job.

iii. **Market positioning:** rice demand for specific varieties and quality is normally established through well ingrained cultural preferences and difficult to change. Where Uruguay may seek advantages in terms of market positioning is through strategic trade agreements that reduce barriers to key importing countries and regions such as Peru or the EU. Likewise, Uruguay's competitiveness may change if a number of logistic costs and inefficiencies are solved.

Knowledge of agricultural sector needs by port managers and law makers will be important to drive changes that will benefit the sector. See CPA Ferrere (2020) for more detail on Uruguay's agriculture competitiveness cross-cutting issues.

Table 4

Key trends for the rice subsector, skills needed and possible training mechanisms

	Human capital needs and possible vehicles for capacity development (CD)	
Key trends	**Professionals' education and skills**	**Delivery of CD activities**
Market Trend towards demand for less processed rice. Mature market for Uruguay.	◆ Train trade negotiators on agricultural affairs. ◆ Train of port managers (law makers) on state-of-the-art port management and logistics (can be done through exchanges with peers etc.).	◆ International organizations and some specialized high education institutions. ◆ Exchanges with peers in other countries.
Processing Mature technology and trend to decrease the level of processing.	◆ On the job training for plant staff. ◆ Training on for maintenance technicians. ◆ High education on management.	◆ Higher education institutions. ◆ On the job / vocational training (by processors or sector associations).
Primary production Yields already stabilized at the level of the best global performers: ◆ less productive areas changing to alternative land uses; ◆ marginal improvements through variety development.	◆ Higher education/research in agronomy and irrigation. ◆ Higher education in agricultural economics. ◆ Technical advice to farmers.	◆ Higher education institutions, research centers and POs.

Source: Authors' elaboration.

Most of the knowledge and skills needs identified above for the four subsectors are already offered in Uruguay through different mechanisms. The next section of this chapter analyses the existing offer in Uruguay *vis-à-vis* the identified needs. The last section will discuss to what extent this offer is in fact placing the needed skills in each tier of the analyzed value-chains.

3.2 LARGE OFFER ON CAPACITIES DEVELOPMENT FROM HIGHER-EDUCATION AND RESEARCH, PRODUCER ORGANIZATIONS AND THE PRIVATE SECTOR IN GENERAL

This report has highlighted that the agriculture sector is likely to suffer numerous changes in the next decade and that being ready for changes entails adequate and motivated human capital. This section looks at how the current formal educationsystem – and, where data is available, vocational training options – addresses the human capital needs that are seen as key for the strategic development and positioning of the Uruguayan agriculture sector in the next decade. The analysis is based on the work conducted by OPYPA in 2017 (Ackermann and Cortelezzi, 2017) and updated in early 2020 (Ackermann, Cortelezzi and Voss, 2020). This work analyzed the formal and non-formal education and training offer in the country related to the agriculture sector. It also analyzed the offer of education not directly linked to agriculture, but which could see demand from the sector (e.g. engineering).

Academic remuneration improves and university offer increases

Over the last ten years financial contributions to education in general have increased, according to the Presidency of the Republic (2018), going from 3.2 percent of GDP in 2005 to 5.14 percent in 2018, the year in which it reached 18.4 percent of the country's social public spending.

As regards public education, the value geared to education increased within the overall total of public spending, and more teachers were hired to extend education service delivery, creating more education centers nationwide, in particular at the level of UDELAR (University of the Republic of Uruguay). Likewise, this allowed for gradual increases in teachers' salaries. In this way, salaries at UDELAR increased by 89 percent between 2004 and March 2019.

As public spending increased a slight increase in enrolment was also observed, and according to the Ministry of Education and Culture, the number of students at UDELAR rose from 98 532 in 2010 to 107 623 in 2018. As regards UDELAR there was a slight increase in active students between 2010 and 2018, from 81 774 to 85 905, respectively. In terms of private universities including UDE, ORT, UM and UCU, there were increases in recent years, with the exception of 2018.

Nevertheless, **the Uruguayan education system grew at a rather slow rate between 2005 and 2015 (11.7 percent)** when compared to other countries in the region. According to a report from *Sistema de Información de Tendencias Educativas de América Latina* (Information System on Latin American Education Trends) updated in May 2019, only 2 out of every 100 youth between 18 and 24 years of age were enrolled in tertiary education in the country.

The trend to decentralize university education is not yet firm

UDELAR has diversified its education offer by creating new careers delivered in cities outside the capital of the country. There are several cities outside Montevideo that are significant centers of important activity in tertiary and university education, both public and private.

In 2019, of the 77 courses (both graduate and postgraduate) that were 100 percent related to the agricultural sector, 64 were taught in Montevideo. The NW region hosts five of the university courses delivered in the provinces.

Since the 1980s the provinces of Tacuarembó and Rivera have UDELAR University Centers that deliver technical courses such as Meat Technician and Forestry Engineer.

In the eastern region of the country, in 2007, UDELAR established the Centro Universitario Regional Este (Eastern Region University Center or CURE in Spanish) with facilities in Maldonado, Rocha and Treinta y Tres, but only in the province of Maldonado does it offer a course that somehow relates to the agricultural sector (though not to the subsectors under analysis): a B.A. in Landscape Design. During the last ten years university education in this region have grown around courses such as IT Technician, Administration Technician and B.A. in Environmental Management. It must be pointed out that private universities were also established, as is the case of Universidad de la Empresa that offers a career as Technician in Agriculture. In addition, the Cluster Punta del Este Ciudad Universitaria (a private university) was created, generating more development in terms of education.

Needs in terms of formal education are broadly covered

Today, there are more than 120 nationwide tertiary education careers, graduate and postgraduate courses, both in public and private institutions that relate to the agricultural sector (see Annex 5), according to opportunities featured in the websites of UDELAR (School of Agronomy, School of Veterinary Medicine, School of Engineering, School of Sciences), Universidad Tecnológica del Uruguay (UTEC), Universidad ORT, Universidad Católica del Uruguay (UCU), Universidad de la Empresa (UDE), Universidad de Montevideo (UM) and Universidad del Trabajo Uruguay (UTU).

In addition, other careers offered were analyzed in the fields of Economics and Business Administration, as well as Technology, Industrial and ICT Engineers, as professionals with these backgrounds will be able to contribute to the development and innovation of the agricultural sector.

In terms of careers that are 100 percent related to the sector, such courses are found in public institutions like UDELAR and UTEC as well as in

Table 5
Number of graduate and postgraduate programmes and courses related to the agricultural sector in 2019

Province	Number of Courses
Montevideo	64
Colonia	3
Durazno	1
Florida	1
Maldonado	1
Paysandú	1
Rivera	1
Salto	3
Tacuarembó	2

Source: Ackermann and Cortelezzi (2017).

private centers like UCU and UDE. In Annex 5, Tables 11 and 12 feature a list of careers designed by each institution. The University Schools of Agronomy, Engineering and Veterinary Medicine together offer 21 courses that are 100 percent related to the sector.

In November 2013 the Universidad Tecnológica del Uruguay was founded with a mission to provide comprehensive training to high-level professionals in order to boost innovation and technological, economic and social development of Uruguay. This generated strong support to the dairy sector as the following courses were designed: B.A. in Dairy Sciences and Technology; Technician in the Management of Milk Production Systems and Irrigation; Drainage and Effluent Management Engineering (the first two are delivered in the province of Colonia and the last one in Durazno) (see Table 13).

New trends in terms of subject matter have been incorporated into the courses, particularly those related to climate change and/or sustainable environments. Also, within each course in the different career tracks related to the sector, both private and public universities emphasize the importance of the use and management of agrochemicals, sustainable management of natural resources and animal welfare.

Other examples of careers that are relevant to the development of this sector (outside the School of Agronomy) are the B.A. in Food Analysis (UTEC), Production Engineering (UDELAR), Biological Engineering (UDELAR), as well as Master's Degrees in Nutritional Sciences and Food Sciences and Technology (UDELAR) or the postgraduate course on Technology and Management of the Food Industry (UTU) – see Table 15 in Annex 5 for a broader overview of the courses offered in the country.

Yet in terms of careers that are not 100 percent related to the sector it is important to point out that typically there are no references to the agricultural sector. For example, despite the importance of engineering knowledge in the agricultural sector (IT, mechanics), engineering careers do not offer specialization in agriculture. This is particularly important in a context where technology applied to agricultural activities is crucial to maintain the competitiveness of production systems.

Uruguay has developed a vocational training offer in the sector

UTU-UDELAR and the Consejo de Educación Técnico Profesional (Vocational Training Bureau) of the Universidad del Trabajo del Uruguay (CETP-UTU), under the Administración Nacional de Educación Pública (National Public Education Bureau or ANEP in Spanish) oversee technical and technological education in secondary and tertiary non-university levels, as well as professional training (basic and higher) throughout the whole of Uruguay.

Lately, greater importance has been granted to technical education through technical courses. These courses are short and take fewer hours compared to university courses, which is appealing to students with fewer possibilities to study. In addition, in some cases it is possible to replace pre-university education provided by high schools for similar technical courses (geared to a specific profession), the so called 'tecnicaturas' (being certified as Technician), that make them more attractive. Unlike university education, mostly centered in Montevideo, technical careers are distributed all around the country. Most of them are offered by UDELAR, UTU and UDE.

UTU, in particular, has played a key role in formal non-university training. In Table 17, Annex 5, 22 careers that are or could be related to the agricultural sector are listed.

Table 6
Number of training activities offered during 2016 and 2017, by institution

Institution	Activities 2016/17	% of total
IPA	298	56%
MGAP	91	17%
INIA	80	15%
INC	41	8%
INASE	14	3%
INAC	3	1%
INALE	1	0%
Total	**528**	**100%**

Source: Ackermann and Cortelezzi (2017).

The Ministry of Livestock, Agriculture and Fisheries, as well as the Institucionalidad Agropecuaria Ampliada (IAA) also provide training on specific subjects addressing different aspects of the sector. According to data collected by Ackermann and Cortelezzi in 2017, there is a high number of training activities nationwide, including workshops, courses, field day activities, etc., organized in 2016 and 2017 in two modalities (face-to-face and remote) – see Table 6. It is important to highlight that courses offered by Instituto de Profesores Artigas (Teacher Training Institute or IPA in Spanish) are specific to teacher training.

Finally, producers' organizations and specialized research institutions also provide professional training to technicians and producers from the subsectors they are part of. Some examples of this type of activity are: (i) the already mentioned technical support to dairy farms by Conaprole and to wool growers by Central Lanera that help in capacity building of their technicians; or (ii) training offered by the Secretariado Uruguayo de la Lana in collabouration with the National Institute for Employment and Professional Training (INEFOP).

To a large extent, the vocational training and non-university training offer depends on the degree of organization of the subsector. Subsectors that are more vertically integrated through producers' organizations, as in the case of dairy products and wool, offer more specific training on production systems developed according to the needs of their chain. In particular, the dairy subsector offers specific training and technical assistance so that producers are aligned with public policy and meet the regulations in force (for example, support for the formulation and implementation of plans in sustainable dairy activity).

In other sectors, where the value chain is not integrated in the same way, as is the case in the beef sector, there is a smaller vocational training offer and it is less geared to specific production systems. Table 7 provides a summary of the analysis included in this section.

3.3 LEVELS OF EDUCATION AND VOCATIONAL TRAINING IN AGRICULTURE DO NOT YET MATCH THE CURRENT OFFER OR THE LEVELS ATTAINED BY OTHER SECTORS

The sector needs to become more attractive to educated and young professionals, particularly to women.

The previous section analyzed the training and education offer in the country in relation to the needs of the subsectors under analysis. This section aims at

Table 7

Summary of the human capital needs and type of offer in Uruguay

Human capital development offer by type	Maturity level	Observations on maturity level
Beef and dairy trends: (i) automated packaging and logistics (ongoing) and cuts (long term); (ii) value addition through enhanced traceability system and marketing; (iii) pasture, breed, herd management practices improvement; (iv) cyclical monitoring, evaluation and improvement.		
Higher education:		Most of the knowledge and skills needed for efficient livestock production are produced in the country – some highly productive farming and industrial systems attest it. Most courses are taught in Montevideo. Some important skills such as full lifecycle assessment, or management and marketing are mostly taught in institutions not directly related to agriculture. Vocational/on-the job training for producers/ industry workers exists particularly for dairy, but only in some cases is (i) tailored to the development of specific production systems; or (ii) coupled with incentive mechanisms/ regulation.
◆ industrial engineering, or management;	***	
◆ marketing and related fields;	***	
◆ electronics, mechanics, automation;	***	
◆ agronomy and livestock production;	****	
◆ food science and technology;	***	
◆ animal products lifecycle assessment;	**	
◆ GIS/ remote sensing/ information technologies.	***	
Vocational training (from education institutions):		
◆ Livestock management practices (pastures, feed, breeds, etc.).	**	
Vocational training (from processors and/or service providers):		
◆ processing equipment maintenance – for technicians;	****	
◆ herding/pasture management practices and AMS (for dairy only) – for technicians.	**	
On the job training, capacity development and career growth (at start-ups, POs, research institutions, agencies for innovation and technological parks):		
◆ Research and development on practices improvement for better cattle performance (skills on pastures, breeds, remote sensing, data analysis, product development and marketing).	**** (dairy) *** (beef)	
Consumer awareness of unique selling points of Uruguayan products (public sector and service providers):		
◆ agricultural marketing;	**	
◆ certification and Life Cycle Assessment skills.	**	
Wool trends: (i) breed adaptation to wool/meat demands and pastureland, animal ID and collection and analysis of performance data		
Higher education:		Knowledge and skills that are needed for efficient high-quality wool production are generated in the country, mostly in Montevideo, though. Important skills such as full lifecycle assessment are taught in institutions not directly related to agriculture. Vocational/on-the job training for producers/ industry workers exists but it is not coupled with incentive mechanisms.
◆ agronomy and livestock production;	****	
◆ sheep breeding;	***	
◆ animal products life cycle assessment;	**	
◆ information technologies.	***	
Vocational training / technical assistance:		
◆ sheep breeding;	***	
◆ livestock management practices (pasture, health, high quality wool production).	**	
On the job training, capacity development and career growth (at start-ups, POs, research institutions, agencies for innovation and technological parks):		
◆ Research and development on practices improvement for better quality wool (skills on pastures, breeds, remote sensing, data analysis, traceability).	***	

Continues on next page >>

Human capital development offer by type	Maturity level	Observations on maturity level
Rice trends: sector contraction to highest yielding areas and producers; assessment of best options for land use change		
They are mature but there are problems with absenteeism and difficulty in having technicians to maintain processing equipment.		Not so much a matter of raising human capital as of establishing incentives to work/live in rural areas - see CPA Ferrere (2020) for more details.
Higher education:		
◆ water resources management engineer;	**	The country is well provided with knowledge on rice production as the sector performance attests.
◆ agronomists;	****	
◆ agricultural economists.	****	More knowledge/skills could be generated on options for alternative land use, as well and port management and agricultural trade negotiations.
Vocational training (from education institutions):		
◆ specific training in water resources planning and management;	****	Water resources management is a discipline that normally is not taught in institutions related to agriculture.
◆ training on specific varieties and production systems.	**** (for rice, not necessarily for alternative land uses)	

Legend: **** Mature, potential to develop *** Developed, but not limited ** Not linked to agriculture * Non existent

Source: Authors' elaboration.

assessing how this offer translates in terms of actual human capital in the sector and how this human capital is distributed throughout different segments of the sector workforce, based on the results of the latest Uruguayan household surveys.

As in many countries, in Uruguay the population working in the agriculture sector (primary and secondary production) is predominantly male.[36] Women represent only 28 percent of the entire labour force in the sector. It is also an aging population where most workers can be found in the age group between of 25 and 54 and where those aged above 54 already represent a larger share than those with ages below 25 (see Figure 27). While the sector's age distribution is more or less aligned with that of the overall country, the gap in women participation is notable.

The sector is also not all homogenous and there are marked differences between primary and secondary production. The participation of women is 22 percent for primary agriculture and livestock, while it is 39 percent for food processing and textile activities. The age composition also shows important differences between the two subsamples: if the average age is 43 years for primary agriculture, it is 39.5 years for agroindustry. Although already a little dated, the data from the last Census (2011) also suggests that beef cattle and sheep-related value chains have workforces that are considerably older than the rest (see Table 8). The dairy value chain, which has been the target of major reforms and has recently seen significant gains in productivity, is amongst the ones with the youngest workforce.

36 Uruguayan household surveys (ECH) are representative at the national and department level for dimensions such as age group, gender, income classification, and general labor market outcomes, but are not representative at the sector or subsector level. As such, the results of this analysis are indicative, but not definitive.

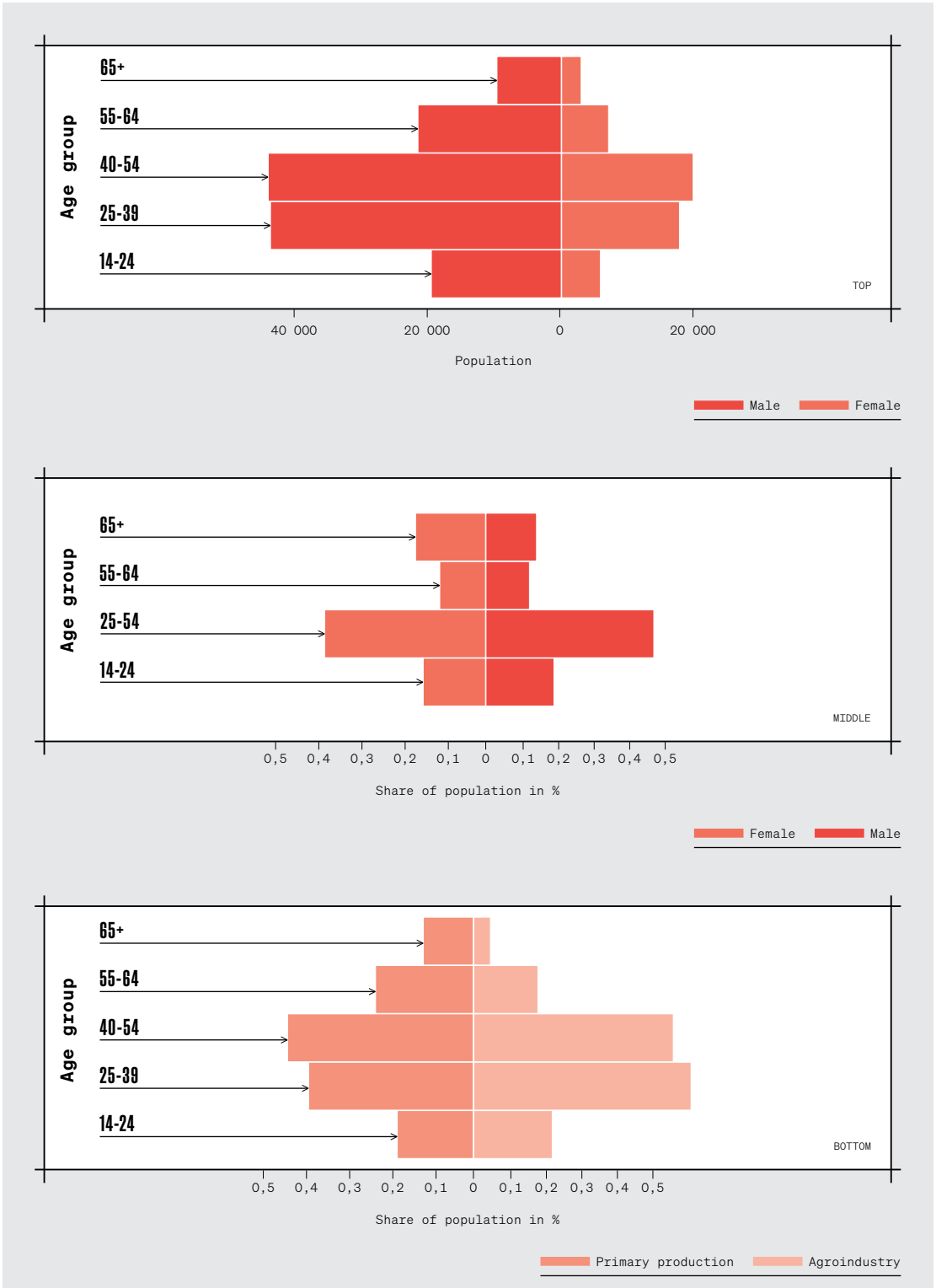

Figure 27

Agriculture sector age pyramid (top); countrywide (middle); disaggregated (primary/ secondary production) (bottom)

Source: Authors' elaboration from INE (2019) data.

Secondary production concentrates a higher share of skilled jobs, but generally most jobs in the sector require low educational levels and consist of routine occupations (see Figure 28). Almost two-thirds of workers throughout the sector are engaged in specialized agricultural or elementary occupations with a low skill content. However, the share of workers performing elementary occupations is twice as high in primary as in processing establishments (34.5 vs. 17 percent), while both mid-range and highly skilled service workers are two to three times more represented in processing than in primary establishments (7 vs. 21 and 3 vs. 6 percent, respectively).

Slightly more than a quarter (26 percent) of workers in the sector perform industrial occupations, a category which includes operators and craftsmen of mechanical arts and plant and machine operators and assemblers. **Service workers performing activities such as commercialization or administrative support make up around 12 percent of the total**, whereas **highly skilled service personnel such as directors and managers, scientific and intellectual professionals make up only 4 percent of the workforce.** Overall, a higher share of women is employed in service occupations, and a lower one on industrial or elementary occupations.

As may be expected, despite the existing education offer in the country, education levels in the sector are low. The overwhelming majority of workers in the sector (more than three quarters) have primary education as their highest level of completed education. Similarly, only 3 percent of workers completed university or an equivalent tertiary education degree, and about 0.3 percent have a postgraduate degree. There remain, however, differences between the two sub-sectors.

Workers in primary agriculture are over three times more likely to have not completed any level of formal education, compared to workers in agroindustry (10.6 vs. 3.3 percent). Conversely, workers in agroindustry are 1.6 times more likely to have completed secondary education, compared to those in primary agriculture.

Regardless of the specific educational level attained, the most prevalent fields of study are business administration, agriculture, veterinary medicine, and engineering and industrial production. Compared to the total average, women's advanced education is less focused on subjects directly related to the sector, such as agriculture or veterinary medicine, and is instead disproportionately concentrated in business administration.

Table 8
Age distribution of permanent workers per subsector (primary and secondary production)

Subsector	Below 34 years	Above 64 years
Cereals and oilseeds (excluding rice)	35%	5%
Rice	34%	3%
Poultry	33%	5%
Dairy cattle	32%	6%
Forestry	29%	6%
Agricultural services	29%	7%
Fruits and vegetables	24–20%	6–11%
Meat cattle	22%	13%
Sheep	20%	17%
Total/% over total permanent workers	**25%**	**11%**

Source: INE (2019).

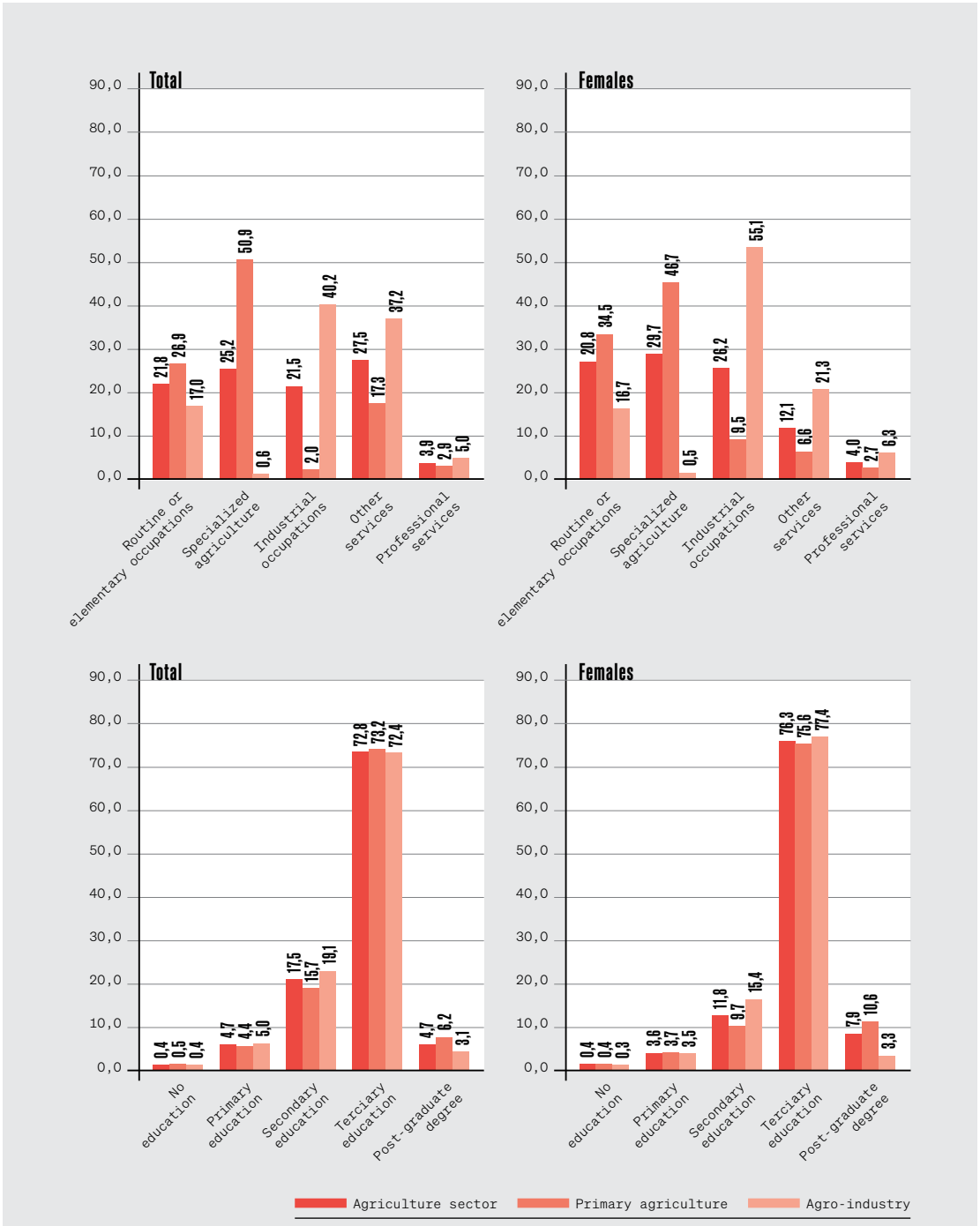

Figure 28

Occupational composition of jobs (occupational categories are listed in decreasing order of cognitive-task intensity) by subsector (left) and highest level of completed formal education by subsector (right)

Source: Authors' elaboration from INE (2019) data.

Beside formal education, around 10 percent of workers in the full sample also received some form of technical training, which represents an important tool for complementing, updating, and supplying technical knowledge and training on practical labour aspects. Notably, this percentage is almost twice as high for agroindustry (14.3 percent) as for primary agriculture and livestock (7.7 percent).

The agriculture sector workforce has a much lower average level of education than other industries in the country. Figure 29 compares the educational attainment of the agricultural production labour force with that of workers in manufacturing (excluding food processing and textiles). The differences are quite impressive: where almost 85 percent of workers in agricultural production have at most completed primary education, around 78 percent of workers employed in other manufacturing activities have at least completed secondary schooling, and the share of university graduates is five times higher in the latter group than in the former. These differences are also reflected in a lower level of technology adoption. Sixty percent of workers in other manufacturing industries used laptops in the 3 months prior to the survey, against 30 percent in agriculture (INE, 2019).

However, the country shows potential to acquire new lines of economic activities in the service sector that attract more skilled labour. The country ranks first in the region for computer access at home by people between 15 and 24 years (almost 65 percent in rural areas and 70 percent in urban areas). Access to the Internet is the highest for all quintiles of incomes compared to other countries. As agriculture moves away from commodities into more differentiated products and the domestic and regional markets offer new opportunities, the sector may start to attract professionals with skills in product development, and marketing. Together with the strength of the country's cooperative sector, which provides value chains with the scale and the risk-sharing mechanism that is necessary to enter new ventures, this provides an opportunity to develop new lines of services in the country.

A window of opportunity for attracting a new and skilled workforce to the sector

The analysis in this chapter has shown that the agricultural sector still has a large share of its workforce with relatively low levels of education and training, despite the current educational and training offer. Nevertheless, the rapid intensification around field crops since the early 2000s has left pockets of highly skilled technicians and managers with experience in agriculture and service companies who need to reinvent themselves now that cropland is being increasingly used in favor of pastures for cattle and forestry. Additionally, the need to increase efficiency and to comply with stricter environmental regulations has also forced increased capacities in some subsectors, such as dairy, particularly at processing and producer organization levels. However, this does not change the fact that the sector still has a much lower share of workers with secondary and tertiary education than the other industries in the country, particularly at farm level.

Young people and particularly women who work in agriculture tend to take on more cognitively intense jobs, often service related, which is in line with the expectations of a generation which has an average level of education higher than the previous ones.

Secondary and tertiary sectors jobs normally requiring more skills have attracted younger workers and women. Additionally, the high connectivity of Uruguay provides a fertile ground for the application of digital technologies (big data, precision agriculture, remote sensing and control) and other potential areas for development, such as e-commerce or a renewed services sector catering for agriculture. However this requires an innovative and skilled workforce.

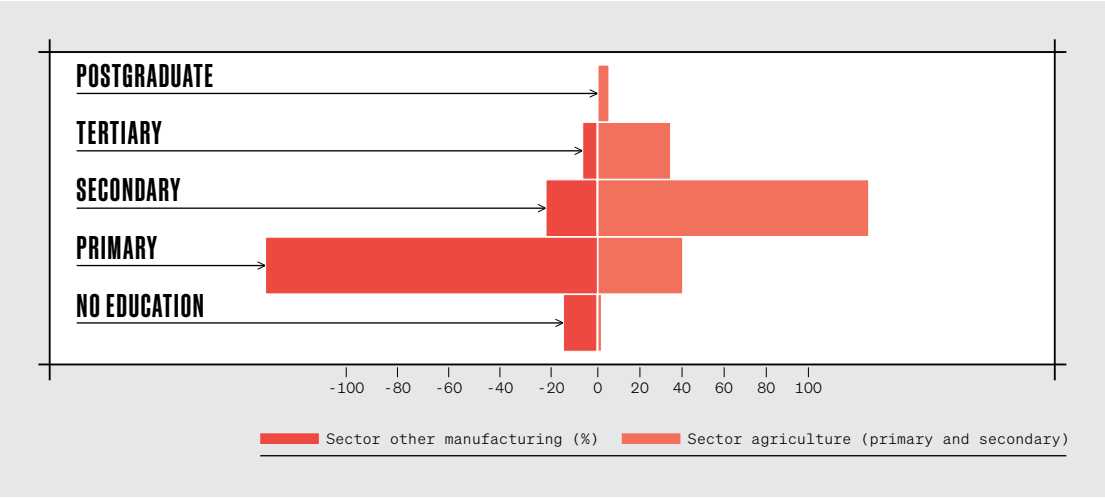

Figure 29
Highest educational attainment (%)

Source: Authors' elaboration INE (2019) data.

In a moment where agriculture in Uruguay is changing, there is an opportunity to enact policies that enable the further integration of agricultural production and develop the service industry so as to attract skilled youth, particularly women, to the sector and to reskill the technicians who were working in the waning crop industry. Whilst the subsectors under study provide little opportunity for vertical integration (with the exception of some small and specialized dairy industries), other agricultural subsectors, such as fruits and vegetables, may provide better opportunities for this.

Additionally, dealing with uncertain demand in the next decade requires addressing competitive challenges with strategic public policy and skill development efforts, which would expand high-productivity standards and to be prepared for market opportunities.

The argument made so far in this report suggests that human capital in agriculture is as much dependent on the offer of capacity development in the country as it is on the policies in place and therefore on the opportunities offered by the sector. Uruguay has a robust academic system and, compared to other countries, an interesting vocational training model. Yet the education and training levels of the workforce in agriculture are low. This means that the education and training systems need to be more inclusive of producers, and also that rural areas and jobs need to become more attractive to young and skilled professionals.

Building on the findings of the analysis so far, the next and last chapter will suggest some policy and investment areas that could contribute to up-skilling the existing workforce, as well as providing enhanced incentives to attract to the subsectors under analysis a new skilled, young and gender-diverse workforce.

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Chapter 4
What role for digital technologies in up-skilling key value-chains?

This report has highlighted opportunities for human capital improvement in key value chains of Uruguay's agriculture and agribusiness sector. Alongside specific recommendations outlined in Chapters 2 and 3, digital technologies are an important tool that could be leveraged to enhance human capital efficiency as well as to contribute to human capital formation.

Digital solutions worldwide are increasingly fueling the development of agricultural ecosystems that are unprecedentedly more productive, efficient and transparent. By bridging gaps in communication and distance and improving transparency all along the supply chain, these technologies are also ushering in new opportunities to attend to environmental and social priorities while increasing productivity and profitability, for example: (i) the optimization of the use of natural resources; (ii) a reduced cost of remoteness that can help bridge the urban–rural divide and promote inclusion of traditionally underserved communities; and (iii) an increased appeal for more tech-savvy younger generations, which holds promise to re-engage youth in agri-food production.

This chapter aims to identify: (i) where digital solutions can contribute to human capital efficiency to increase the competitiveness of Uruguay's agriculture and agribusiness sector, in particular in the four value chains analyzed in Chapter 2, and the skills required to seize those opportunities; and (ii) how digital technologies themselves can be a driver of human capital improvement.

4.1 DIGITAL TECHNOLOGIES AND HUMAN CAPITAL EFFICIENCY

Digital technologies are tools that collect, store, analyze, and share information digitally, including mobile phones and the Internet. Applied to the agriculture and livestock system, they offer significant potential to improve efficiency and address many of the market failures that pervade the agri-food system, from the existence of middlemen to product waste throughout the supply chain, to imperfect information, helping producers make more precise decisions on resource management. The tools that encompass digital agriculture are multiple and varied, each one requiring different skill sets, levels of investment, and degrees of mobile and internet connectivity. They can be as simple as an off-line advisory service provided to farmers through Short Message Service (SMS) or involve more advanced and complex technologies such as distributed ledger technology for value-chain traceability and use of big data on the observation of optimal climate conditions. For example, precision technologies have the potential to improve the quantity and quality of agricultural output while reducing input and resource use, based on data collected from global positioning systems, satellite and aerial imagery, and sensors. Their adoption also allows farming

practices to be performed remotely, usually by mobile phone, which can increase the attractiveness of rural work to the youth.

Table 9 offers a simplified conceptual framework for the main uses of digital technologies by key actor type (producers, service providers, public sector). Producers can benefit greatly from the adoption of technologies that assist both in data collection and the use of data. Through the collection, storage, analysis and dissemination of information in the rural domain, digital tools have contributed to a shift in management of agricultural production systems towards a highly optimized, individualized and data-driven management model.

Larger agribusinesses may be able to afford solutions that treat and analyze data. However, smaller producers mostly rely on service providers for data storage, analysis and formulation of recommendations. Uruguay has witnessed the development of several service providers that offer, *inter alia*, services based on data collection and analysis such as precision agriculture firms. *Sima*, for instance, is software developed in Argentina that allows farmers to monitor their lots, geolocate data, analyze the collected information, and even generate service orders for its management. The information reports are customized by lot, and beyond receiving actionable recommendations and early warnings for plagues and adverse climate events, users can monitor the frequency of visits made by consultants and service providers. As regards livestock rearing, *Chipsafer* is a widely used platform that allows tracking of cattle and the detection of anomalies in cattle behavior at any time and from any place. Through the platform, the producer automatically receives warnings of anomalies and actionable recommendations based on information collected through an external smart device worn by each animal. Likewise, producers' organizations such as Conaprole have developed digital solutions that help them provide better technical assistance services to their members.

The public sector, in turn, serves an important function as public-good provider through investments in the collection, analysis and dissemination of key information for agriculture stakeholders. This role is particularly well played in Uruguay, where public databases such as National Livestock Information System (SNIG) and National Agricultural Information System (SNIA) are a valuable repository of detailed information on livestock, soil mapping, land administration database, or weather.

Beyond the generic framework sketched in Table 9, each agricultural value chain faces, to an important extent, a unique combination of challenges and opportunities, which makes the concrete development and adoption of digital technologies for enhanced competitiveness very dependent on the specificities of each subsector. Table 10 provides some examples of how each of the four prioritized value chains could leverage digital technologies, considering their specific trends and human capital needs described in the previous chapters, highlighting the roles that different actors could play in the development of the value chain and of the skill sets needed to perform such roles.

The rice sector is perhaps the one that shows the highest levels of maturity in terms of digital technologies incorporation. For instance, the country's cropped areas incorporate a large number of technologies, fruit of the strategy that has been pursued of large areas, high yields and high cost-efficiency. This together with the fact that the value chain is not expected to grow or develop significantly in the next few years also means that there may not be much room left for improvement in terms of ICT use. Nevertheless, no sector is ever static. For example, recent advances in the availability and interpretation of satellite imagery or in the use of drones may enable the development of increasingly more cost-effective tools to measure evapotranspiration and be ever more precise in

Table 9

Digital technology and data use by key actors of the digital agriculture innovation systems

Data and technology use per user	Possible data and technology applications per group of users
Farm/industry level : Data production, collection and analysis for own use. Technology uses.	**Who:** Farmers/manufacturers (who will need to have incentives for adoption). **What:** i. Collect and analyze information from its farming system to support decision making (e.g. sensors, chips, drones, digital record keeping). ii. Automation and artificial intelligence to perform tasks based on collected information (e.g. automated precision planting, irrigation, fertilization and spraying; automated cattle feeding; pasture management; grain grading; milk analysis and automated use of feed and antibiotics, automation of meat cuts). iii. Improved sales: use collected information to inform buyers (e.g. traceability systems), e-platforms to sell produce, distributed ledger technologies for smart contracts and traceability.
Service providers (may include POs and agribusinesses): Data collection and storage. Data analysis. Information systems for partners.	**Who:** Agribusiness and other value-chain actors (e.g. retail chains) including financial institutions. **What:** i. Data collection: use of sensors, drones, satellite imagery, etc. to collect data from suppliers/members/clients or collect data from their databases. ii. Data storage and handling: private servers, clouds or distributed ledger technologies. iii. Data use: traceability systems, geographic indications/animal breed management systems, crop/pastures programming, internal control systems, risk assessment and management of financial products and services, marketing and increased consumer awareness about production practices (product differentiation/traceability), price differentiation to producers based on product quality.
Public sector: Data collection (from the above actors as well as big data). Data analysis. Generation of information. Technology and data use.	**Who:** Research institutions and think-tanks (public or private), public institutions (ministries, universities, research and extension bodies). **What:** i. Collection of information pertaining the attribution of farm subsidies and other administrative systems such as animal ID systems, soil management, water, land use, etc. as well as relevant big data. ii. Artificial intelligence services: provide analysis on soil, weather, cropping systems, phytosanitary information etc. to provide ad-hoc recommendations to farmers; price and food availability forecasts; policy effects scenarios; market forecasts. iii. Enable more efficient processes and services: for example, through risk analyses and indexes for new financial products and services, well-tailored and timely agricultural services, ad hoc technical assistance services. iv. Promote and monitor the development of the remaining actors.

Source: Authors' elaboration.

water provision to the crop. This is particularly important as energy costs related to irrigation are an important share of the total rice crop budget.

All livestock-based value chains show potential to build on the work that has been started regarding pasture management. Dairy sector players, such as Conaprole, already give advice to their members and suppliers based on the interpretation of satellite imagery from their pastures. Sheep and meat cattle producers' associations and/or research institutions working with them could develop similar systems adapted to their production objectives.

The animal individual ID system that Uruguay has introduced since the early 2000s for cattle and that can be extended for sheep also provides a wide range of opportunities. Traceability systems can incorporate large amounts of data linked to each animal identification code. Performance in terms of response to nutrition, milking, shearing, health and animal welfare practices can be recorded and analyzed if not at farm level (too complex for a small-scale endeavor and limited sample of animals) then at producers' association or even national levels, through the use of artificial intelligence. Tools that can rapidly improve knowledge and capacity to act on drivers of productivity and value creation can accelerate the changes in livestock production discussed in the previous chapter.

Box 5

Automatic milking systems increase efficiency but require adaptation to production systems

Automatic milking systems (AMS) monitor the health and wellbeing of dairy cows in near real-time. They identify ailments and diseases proactively, such as mastitis, and help maintain both productivity and herd health while reducing inputs such as feed and antibiotics (Rotz *et al.,* 2019). These systems have the potential to increase milk production by up to 12 percent, decrease labor by as much as 18 percent, and simultaneously improve dairy cow welfare by allowing cows to choose when to be milked (Jacobs and Siegford, 2012).

The type and size of production system are key determinants on how efficient the adoption of automated systems may be. For instance, the average herd size in Ontario is around 70 cows which is roughly what a robot can handle, whereas the average herd size in the United States of America is 223 (Statistics Canada, 2016; USDA, 2016) making it more complex to automatize. Herd sizes vary significantly across Europe (from an average of 15 in Poland and Austria to 160 in the Czech Republic), but generally, the uptake of robotic milkers on European dairy farms developed much earlier than in the United States of America or Canada (Rotz *et al.,* 2019).

AMS also need to be different for the mostly grass-based systems, such as those in Uruguay, and the more intensive systems in Europe or Canada. Hence, such AMS are only partially exportable and a considerable share of the investment needs to be made in adapting them to each context (see for instance INIA's work on the subject in Uruguay[37]. The statement of Richard Yarwood, a dairy farmer in the United Kingdom, summarizes how important systems adaptation is: "As long as the herdsperson is bright enough to use the software and adapt the equipment to suit the system it opens up all sorts of avenues" (James, 2016).

Source: Authors' elaboration.

37 See INIA in Uruguay https://www.youtube.com/watch?v=i9PMOjpsKRA and https://www.youtube.com/watch?v=sAVDl7tQPr8.

Table 10

Examples of digital solutions in the four value chains, by level of penetration/maturity

	Farm/industry level	Aggregate level (private)	Aggregate level / institutional
Beef	*Data collection on:* * Animal performance (chips for ID), digital scales, info on pasture use and feed, info on meat quality. *Technology use:* * Automatic drafting based on individual info. *Data analysis and use:* * Larger farms can develop their own applications to evaluate response to pasture management and adapt practices).	*Collection and analysis of suppliers' data for:* * Breed improvement, practices improvement, enhanced traceability and certification systems for improved marketing. *Technology for processors:* * Robotics for precision cuts. * Automated packaging (when financially efficient). * Traceability systems with improved features for better marketing.	*Data collection pertaining to:* * Animal ID, soil management, land use, water, the attribution of farm subsidies, weather, big data – e.g. SNIA, SNIG, statistics, hydrology, pest control. * *Publication of information in institutional websites* (see Annex 2). *Artificial intelligence services:* * Collection of soil, whether, cropping systems, phytosanitary, crop and animal performance information in order to provide ad-hoc recommendations to farmers; price and food availability forecasts; policy effects scenarios; market forecasts (e.g. Simagri http://simagri.snia.gub.uy/webapp). *Provision of information to enable more efficient processes and the development of new services:* * Risk analyses and indexes for new financial products and services; * Well-tailored and timely agricultural services; * Ad-hoc technical assistance services.
Dairy	Same as for beef adapted for dairy cattle *Data collection and analysis:* * During milking to adjust feeding and other practices. *Technology:* * Use of robotics in milking according to collected data and set criteria (still costly, but being developed by INIA). * Use of robotics for some menial tasks (stable cleaning, feeding). * E-commerce/marketing of consumer goods and associated services (e.g. traceability, certifications and detailed info on cheese production for small processors).	*Data collection and analysis of suppliers' data:* * Cows performance, pasture performance, process efficiency in order to improve productivity at farm level by giving specific advice to each member (Conaprole has started already). * E-commerce/marketing of consumer goods and associated services (e.g. traceability, certifications and detailed information for improved marketing). *Technology:* * Automated packaging, and logistics, automated production lines for different products.	
Wool	*Data collection, data and technology use:* * Same as for beef but adapted for sheep and wool. *Technology:* * Robotic shearing (Uruguay still exports shearers).	*Collection and analysis of suppliers' data for:* * Similar as for beef or dairy, but related to factors affecting wool quality and breeding choices - e.g. breeding for each agro-climatic zone and type of wool.	

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	Farm/industry level	Aggregate level (private)	Aggregate level / institutional
Rice	*Data collection, data and technology use:* * Precision agriculture used to its near full potential and responsible for high yields in the country.	*Data collection and analysis:* * Software to manage internal systems and suppliers. *Technology:* * Color sorters and automated packaging/logistics.	*Data collection and analysis:* * INIA has for long worked with producers to map soil, climate, and practices and uses information to develop the most adapted production technologies.

Legend: * Mature * Being applied with potential for development * Early stages of development but can be pursued * Still unfeasible
Data flows ↔

Note: (1) The classification of technologies/data use in terms of maturity does not pretend to be objective following with clear-set criteria. They were chosen by the authors to facilitate the narrative, and the choices can be argued; (2) Technology and data use cannot be separated – again the classification is indicative and aims to simplify the narrative. (3) In addition to these examples, digital cross-cutting solutions (as any digital solution in transport and logistics, markets, food loss and waste) can also be developed by different value-chain partners

Source: Authors' elaboration.

The introduction of robotics in dairy farms, started by INIA in 2017, can also bring opportunities in terms of productivity increases, in addition to the clear benefits in terms of reduction of work hardship in dairy farms. As detailed in Box 5, automatic milking systems (AMS) can measure in real time a high number of animal-level parameters. Likewise, the use of automatic readers and sensors in sheep or meat cattle drafting mechanisms, coupled with good knowledge of pasture conditions can collect data that inform the famers about the overall health and performance of their livestock. The analysis of data from these systems enables faster improvement of practices and breeds for the intended production objectives. More profitable farms with lighter menial tasks can attract younger generations to the subsector.

Once data on performance is collected, not only is it faster for improving productivity but it is also easier to identify selling points to be used for marketing purposes and to obtain certifications. If Uruguay continues its trend of greening the agriculture sector, digital solutions can provide many of the means to do it (by quickly assessing results of different practices),[38] but also to register all data that may be used to differentiate each product and to obtain certifications (e.g. organic status). Producers or producers' organizations can compare their performance against averages in the country or internationally and identify where their competitive advantage and unique selling point reside. Information on unique selling points can be made public and managed through distributed ledger technologies to reassure clients/consumers of the legitimacy of the claims.

4.2 DIGITAL TECHNOLOGIES FOR HUMAN CAPITAL FORMATION AND MATCHING

Other than by complementing labour through productivity-enhancing services, digital technologies can prove to be a critical ally in the development of a better trained, informed, and adequately skilled labour force.

Importantly, digital technologies can be used to increase access to information and facilitate collaboration, learning and partnerships. As such, they have a role to play in modernizing agriculture extension and advisory services, expanding their reach and impact in promoting behavior change.

38 Digital applications such as the Global Livestock Environmental Assessment Model (GLEAM) and its web-based GLEAM-I, and the Ex-Ante Carbon-balance Tool (EX-ACT) developed by FAO (see: http://www.fao.org/in-action/epic/ex-act-tool/overview/en/ and http://www.fao.org/gleam/resources/en/).

Table 11
E-extension technology and tools

Extension Function	Radio	TV & Video	Cell phones	Feature & Smart Devices	Computer & Internet
Identifying farmers' problems and opportunities – What do they need and want?					
Diagnose problems	Some potential if dealing with general problems, or if capacity for interaction and expertise available.	Visuals are very helpful as "seeing is believing." Even better if combined with ways to receive feedback.	Some potential if farmers can call or text in and sufficient expertise is available.	Additional potential to a simple cell phone as it enables web or App access to special diagnostic tools.	Good comprehensive diagnostic tools are available.
Collect information	Some potential if capacity for interaction.		Can use for data collection.	Good for data collection with GPS.	Some potential if internet available.
Promoting behavior change – What is practical and relevant to meet the needs?					
Raise awareness of general opportunities or needs; convince farmers to try something new	Very good especially with persuasive programming.	Visuals are usually very helpful as "seeing is believing".	Is an option if users are registered to receive such messages (SMS).	Is an option if users are registered to receive such messages (SMS, email).	Is an option if users are registered to receive such messages (email).
Provide specific information needed for change. What is involved? What are the benefits/ Demonstrate or train?	Some potential – but limited information delivered. Can be enhanced with call in.	Good option as "seeing is believing.	Potential if farmers can call or text in and sufficient expertise is available.	Additional potential to a simple cell phone as it enables web access and plays videos.	Good option for intermediaries to seek information and videos.
Facilitate access to credit and inputs	Can be used to inform of available services, but one-way communication.	Can be used to inform of available services, but one-way communication.	Mobile banking and negotiate directly with the suppliers.	Mobile banking and negotiate directly with the suppliers.	Mobile banking and negotiate directly with the suppliers.
Link farmers to markets	Good for providing general price reports.		Access to price information (call in, subscription).	Can bring potential buyers and producers together; access price information.	Can bring potential buyers and producers together; price info.
Collect feedback – How can each step be improved?					
Collect and respond to farmer feedback	Good if producers can call or text and sufficient expertise is available.	Good if producers can call or text and sufficient expertise is available.	Some potential if farmers can call or text in and sufficient expertise is available.	Good option for intermediaries to seek information (if optimized for smart devices).	Good option for intermediaries to seek information.
Assist with business planning	Some potential.	Some potential.		Simple farm management "Apps"; record keeping.	Farm management tools; record keeping.

Source: Bell, Payne and Bohn (2011).

Commonly applied technologies in e-extension include radio and television, videos, computer and mobile phones both online and offline. The most interactive solutions allow for the customized identification of individual farmers' problems and opportunities, frequent exchanges between farmer and extensionist through voice, text or photos, and feedback collection (cf. Table 11).

An example of digital extension platform developed in Argentina and now operating at a global scale is the platform *Tambero*, which uses artificial intelligence and cognitive services to provide customized advisories based on the situation of each cattle head. Farmers and producers can communicate through a chat, and through the app they also receive alerts and actionable recommendations to improve cattle productivity. The platform offers differentiated services according to the size of the livestock production, and it exists in a free version, popularly used by smallholder producers.

Another way of improving human capital of the agricultural and agribusiness labour force is to ensure that workers with the right skills are hired for the right jobs. Digital matching platforms, which can facilitate producers' access to needed resources or services (such as farm machinery), are now also being used to facilitate job placement and labour matching. This is the principle behind the Uruguayan platform *Zafrales*, developed to connect temporary and seasonal workers to farms and companies with open labour demand. Originally developed to ease obstacles in hiring temporary workers, high rates of work absenteeism, and a general downfall in prices, the platform has now grown exponentially, and matches labour in agribusiness (especially in citrus farms, deciduous leaves, vineyards, olive groves, and in wheat and soybean farms), hospitality, gastronomy, and other industries with high demand for operating personnel and manual tasks, such as packing jobs in logistics centers. All workers are interviewed and certified, classified according to their experience and rated by the companies that hire them. For workers, the app is helping to reduce the weight of intermediary agencies and is a source of better work continuity, while companies can quickly connect to workers with desired sets of skills during peak times. Interestingly, companies are also allowed to offer permanent positions to workers after the end of a season, contributing to improving formality and job quality.

4.3 A TECH-RESPONSIVE ENABLING ENVIRONMENT

Despite their promise to transform the nature of work in the agri-food system, digital technologies cannot be adopted in a vacuum, and need a conducive environment and a set of minimum conditions to deploy their full potential. Technology use cannot be considered in the abstract, separate from basic conditions such as availability, connectivity, affordability, use of Information Technology and Communication (ICT) in education, and supportive policies and programs (e-government) for digital strategies – which in turn translate into digital literacy and skills and in improved use of internet, mobile phones and social media. On a more specific level, targeted support for agro-entrepreneurial and innovation culture can further facilitate the adoption of technologies in agri-food value chains, like talent development, sprint programs including hackathons, incubators and accelerator programs.

Uruguay, on many fronts, shows numbers ahead of the curve in comparison to the Latin American region or other developing countries. The country presents a set of favorable conditions for the development and adoption of digital technologies that result from various public policies adopted over the last decades. Despite ample margins for improvement in remote rural areas, Uruguay is for instance a top performer in Latin America in terms of network coverage, with numbers on mobile connectivity similar to many high-income countries (GSMA, 2019). In addition to communication infrastructure and coverage, Uruguay has also implemented policies and programs to improve computer literacy and access to ICT. The country features an overarching strategy on digital development (*Agenda Digital*), as well as an agency responsible for its development, the National Agency for e-Government and Information and Knowledge Society (*Agencia de Gobierno Electrónico y Sociedad de la Información y del Conocimiento*, AGESIC), and several other public policies and institutions that promote innovation and the adoption of technologies. A popular example is the adherence, in the year 2007, to the One Laptop per Child (OLPC) program,[39]

39 One Laptop per Child (OLPC) is a non-profit initiative established with the goal of transforming education for children in low-income countries through the creation and distribution of low-cost, low-power, connected laptops as well as educational software and content for those devices.

nationally known as *Plan Ceibal*. Currently, government policies have to various degrees sponsored ownership of digital devices other than cell phones by 20 percent of Uruguayan households, a figure that rises to 48 percent among households in the lowest income quintile, and 25 percent among households in the interior of the country (INE and AGESIC, 2020).[40] In comparison to other countries in the region, Uruguay also shows a more symmetric proportion of internet use by different social groups: the difference between male and female individual use of the internet is only 0.7 percent, and the internet penetration rate is increasing among groups over 65 years of age (GSMA, 2019).

In addition to structural aspects, Uruguay has a strong culture of research and innovation, supported by initiatives from a multiplicity of actors from government, academia, and the private sector. When it comes to agri-food systems, however, existing initiatives are still sparse, leaving ample opportunities for the development of a coordinated digital agriculture ecosystem in the country. For the corporate sector, one example of a challenge calling for solutions is the limited access by digital agriculture entrepreneurs in Uruguay to venture capital funds, accelerators, and incubators – although there are a few venture capital funds active in Uruguay, there is still a limited presence of AgroTech startups in their portfolio.

As regards the labour force, it is critical to promote the development of skills that enable workers of all levels to take advantage of technological opportunities. Beyond basic literacy and numeracy, digital functional literacy will become increasingly essential, as will cognitive skills, socio-behavioral skills, and skill combinations associated with greater adaptability. To ensure that technological dividends do not reinforce existing patterns of exclusion and vulnerability, particular efforts should be made to increase these skills among poor farmers, rural women, and other vulnerable populations. Furthermore, since digital agriculture solutions often come from a multidisciplinary approach, efforts to promote opportunities for interaction between IT software and the agri-food sector will have high payoffs. As such, education and training curricula will benefit from a higher emphasis on a wider range of skills that will encompass, alongside agronomy, livestock production, and business administration, also electronics, database management, and information technologies. To some extent, a movement towards more tech-intense content is already taking place in Uruguay, as reflected in the vista of educational offers for the agri-food sector in the country presented in Chapter 3. Uruguayan agricultural universities and training institutes should consider riding this wave, incorporating more entrepreneurial and digital technology content in their curricula.

At the same time, it is also important to establish numerous pull factors for tech jobs in agriculture and agroindustry, to make the sector appealing for dynamic entrepreneurs and skilled workers, in particular women: currently, as the digital technologies development industry usually offers well paid and secure jobs in urban centers with good infrastructure, skilled workers in the field tend, in fact, not to engage with the sector. For instance, rice mills and dairy plants with high levels of technology adoption in rural areas report they have difficulty in ensuring timely maintenance services (CPA Ferrere, 2020). Therefore, in addition to innovation programs, the sector may need to generate competitive and secure jobs in digital R&D – as well as in digital technologies maintenance and operation services – in enterprises with the scale and level of innovation that can attract well prepared and motivated professionals. Initiatives such as co-funding subsector start-up ecosystems with long-term R&D positions in partnership with producers' organizations could contribute to achieving this objective.

40 The use of these technologies is also promoted through various policies such as the use of laptops and internet research in the education system or incentives for the use of electronic payment methods.

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Chapter 5
Key policy and investment areas

5.1 IMPROVED HUMAN CAPITAL REQUIRES IMPROVED JOBS

As suggested by the analysis in the previous chapters, increasing human capital in agriculture goes beyond providing learning opportunities that match the needs of the sector. In fact, despite the large and encompassing offer of learning opportunities related to agriculture as well as other fields that may be useful to some of the sector activities, the educational and training levels of the sector workers are considerably below those of other sectors.

Hence, agriculture needs to be competitive with other sectors in attracting strong human capital. The capacity to attract young and educated professionals depends to a large extent on the generation of jobs/functions/roles that are interesting to these professionals in each subsector. Some key characteristics of jobs that render them attractive to young professionals are that they: (i) provide intellectual stimulus; (ii) allow being innovative; (iii) remunerate well; (iv) provide stable jobs and a possibility of career growth; (v) have acceptable levels of physical workload. Likewise, the regions in which these jobs are created need to be appealing to the intended professionals and to their families.

Classical farm work does not tick many of these boxes: livestock, particularly dairy, involves physical hardship; farm work may seem to offer too little option for change and innovation; and in case of family farms, remuneration will depend on farm size and family arrangements. Work at the secondary production level is often more attractive, but, with rather concentrated industries, the sector's job offer is limited in terms of quantity.

The question, then, is what changes in the four subsectors under analysis could create new jobs for young educated workers – particularly women – and opportunities to upskill the existing workforce. As discussed in the previous sections, all subsectors provide opportunities to generate knowledge-intensive jobs that could bring each subsector's competitiveness up to the next level. In the livestock sector these revolve mostly around the generation of more efficient and value-adding production systems. Regarding rice, some efforts can be made in terms of optimizing the use of the land that is no longer used by the crop. All subsectors may benefit from investment in making rural areas better equipped with services, more non-agricultural jobs and infrastructure to attract new citizens and/or minimize out-migration.

5.2 OPTIONS FOR A NEW GENERATION OF SKILLED AGRICULTURAL ENTREPRENEURS AND WORKERS

Policies and investment in the agriculture sector need to provide the incentives for the changes that have been discussed so far in this report and that can potentially help create job opportunities for a younger and more educated generation. The document prepared by CATIE with OPYPA (Alpízar, 2017) provides a complete account and discussion of the policy instruments that are

normally used in agriculture and that can be applied in Uruguay. Mechanisms to provide incentives are divided into four main groups: (i) taxes and subsidies; (ii) property rights (e.g. cap and trade); (iii) regulation; and (iv) voluntary schemes (e.g. payment for environmental services, labels, certification and corporate social responsibility).

It is not the aim of this document to discuss in detail the advantages and disadvantages of each type of instrument under each circumstance. Nevertheless, some of these instruments have been proven to provide some opportunities for coupling capacity development interventions with incentives for change. The paragraphs below present some options in terms of policies that can be used with this dual purpose, based on the work by (Alpízar, 2017) and the authors' experience.

Taxes or tax breaks can be imposed on/offered to those who comply or do not comply with certain prerequisites.[41] These are options often used to change incentives in terms of environmental conservation. For instance, Norway and Denmark use these tools to incentivize the adoption of fertilizer and pesticide use plans. Specific vocational training curricula and courses could be developed – both for (advisory/farm machinery) service providers and producers, including smallholders – that would equip professionals with the right knowledge and skills to manage their production systems so as to benefit as much as possible from tax breaks. However, experience has proven that it is difficult to design tax and tax break systems that allow all types of farmers to introduce the desired positive change in their systems or provide a clear enough incentive for farmers to re-skill. Additionally, once in place, such systems are politically difficult to remove.

Regulation (and its enforcement) is often the simplest way to introduce change. Uruguay, with its advanced environmental regulation, is experienced in this field. The mandatory *Planes de Lechería Sostenible* (PLS), require the formulation and adoption of pasture management plans according to established prerequisites. These have contributed to improving the quality of the country's water resources while increasing dairy farm productivity. These plans have also served as a nudge for producer associations to equip themselves with the technical capacities to assist their members in formulating and complying with such plans. Nowadays, Conaprole provides services on pasture management (see Chapter 3).[42] As regulations apply to all producers/industries, they can be particularly effective in promoting a renovation of skills within the existing workforce, including, crucially, smallholders and elderly producers. This beneficial effect is particularly likely to occur in more integrated value chains, such as dairy, where most producers can receive technical assistance and coaching from their producer organizations and/or buyers. In less integrated value chains, however, regulations requiring significant change may act as an obstacle for those producers who are more marginalised or who have fewer opportunities to acquire new skills, such as elderly or poorer producers, unless concrete mechanisms for acquiring those skills are also introduced. The establishment of regulations is on the other hand likely to be neutral in terms of attracting more workers and entrepreneurs into the sector.

Support for the development of quality and environmental voluntary schemes can produce multi-faceted benefits. Support for (and when needed regulation of) the creation and adoption of labels, brands, certifications or geographical indications in products such as cheese or meat can generate clusters

41 Although as a principle, it is important to start by removing any distortions that may incentivize undesired practices (e.g. tax exemption for chemical fertilizers).

42 The use of property rights over the results of certain practices (e.g. cap and trade of carbon emissions) can be a substitute for other forms of regulation, when direct regulatory measures are politically difficult to implement, see Alpízar (2017)).

of excellence where new production systems are developed, tested, evaluated, and deployed, and where skills such as marketing and communication or information systems management are further mainstreamed into the sector. Establishing these clusters in turn can stimulate the creation or reinforcement of producers' organizations around the common objectives associated with the label,[43] which would also produce additional benefits in the form of increased bargaining power for the associated producers. Moreover, new labelling and certification systems represent opportunities for boosting research and development, as well as for disseminating new knowledge and practices among the existing producers' base and workforce through strengthened extension services, specialized training, and skills development opportunities. By making the sector more innovative and dynamic, these transformations again have potential to attract a new generation of younger, well trained workers and entrepreneurs into the sector.

Payments for ecosystem services could be a way to promote efficiency-enhancing practices among existing producers. As many practices promoting environmental stewardship have also been proven to stimulate production efficiency (e.g. improved grassland management), payments conditional on the adoption of such practices can achieve the parallel goals of preserving the environment and giving producers an incentive to acquire an enriched skill set that would in turn spur the productivity of the value chain. Clearly, these considerations hold as long as adequate training and technical assistance opportunities exist to support the learning needs of producers willing to adopt these practices. In certain cases, therefore, the payments for ecosystem services could be more efficiently channelled through producers' or professional associations capable of providing the necessary coaching to their members.

Table 12 provides examples of the options discussed in this section for the key value chains analysed in this report.

Regardless of the mechanisms that are used to directly incentivize change and therefore new capacities in agricultural subsectors, it is fundamental that the country keeps supporting its innovation systems with long-term sustained financing. In addition to the existing public–private partnerships (e.g. technological centers and INIA work with producers and POs), new jobs/programmes can be financed to introduce desired change in the subsectors (e.g. research on breeding of Merino sheep for humid climates or on specific production systems for cattle). Such arrangements can also be used to develop curricula for training of trainers and of producers on the productions systems that are to be incentivized.[44]

Similarly, incentive schemes for the installation of young farmers have proven to help the rejuvenation of the sector in some regions of the world (e.g. the European Union countries have provided support for the installation of young farmers and retirement of older generations throughout several European Union framework programs). Such programs may assist younger and better trained entrepreneurs in accessing productive land, therefore constituting a *sine qua* non for access to the remaining policies by a share of their potential beneficiaries.

43 Normally, organization in the meat subsector occurs around specific breeds and production systems that can add value to the final product if correctly marketed. Other opportunities may be developed around payment of environmental services, where normally POs are responsible for training beneficiaries and for assisting them with compliance.

44 Training courses on systems with clear specifications which adoption can be certified (and compensated) are likely to be more effective in terms of promoting adoption of new practices and technologies. If well supported in their development, POs are usually good vehicles for training and also good creators of jobs for young graduates.

A necessary condition for these interventions to work is establishing an adequately attractive pension scheme for older farmers.

Finally, investment in infrastructure, such as the modernization of irrigation may also enable some farmers to adopt more advanced and more knowledge-intensive systems. If coupled with adequate incentive systems and technical assistance, especially for vulnerable groups (such as small producers, women, the elderly) who may otherwise be excluded from skill-biased innovations, these investments can represent crucial opportunities for improving the productivity and skills of rural producers and workers. As was seen during the agricultural commodities boom in Uruguay, more capital-intensive production systems can also generate new job opportunities for skilled workers, not only at farm level but also in service providers (precision agriculture and machinery companies, irrigation equipment and service providers). **These options can be drivers of transformation of the human capital in the agricultural and agroindustrial sector in Uruguay.** By helping to attract younger and more highly skilled workers and entrepreneurs into the sector, as well as promoting the up-skilling and continuous training of existing workers and producers, the combination of the interventions proposed in this section can lead to improved productivity and efficiency in Uruguay's agro-industry. However, this list is not comprehensive, and a number of parallel structural issues may need addressing in order to promote a more effective change. For instance, some of the challenges faced by youth in rural areas include insufficient infrastructure in rural areas, lack of services, and tenancy of farms by an aged population. While it is not the aim of this report to discuss these issues, they may be key in determining the success or failure of any future strategies for integrating youth in the agricultural sector. As such, interventions promoting investment in infrastructure and services in rural areas, tax benefits for people living in rural areas or benefits for early retirement of farmers may be crucial complements to human-capital-focused strategies.

Table 12

Examples of enabling policies for human capital development in Uruguay

Beef and dairy trends: (i) automated packaging and logistics (ongoing) and cuts (long term); (ii) value addition through enhanced production systems; traceability, and marketing; (iii) pasture, breed, herd management practices improvement; (iv) cyclical monitoring, evaluation and improvement.
Possible enablers: ◆ long term support for innovation hubs in strategic areas; ◆ public co-financing and partnership with POs (or some private sector entities) to develop alternative production systems and related curricula for training courses; (that can be delivered by young graduates/re-skilled older technicians) on strategic improvements in production systems; ◆ vocational courses on specific production systems for producers with secondary or tertiary level education (preferably linked to financial incentives for adoption such as payments for environmental services, certifications or labels); ◆ programs that support generational shifts in farming and investment in modern production systems and that attract young graduates; ◆ continuity of support for innovation programs with special windows for financing of product and certifications development; ◆ consumer awareness campaigns on "buy Uruguay" and/or on specific certifications.
Wool trends: (i) breed adaptation to wool/meat demands and pastureland, animal ID and collection and analysis of performance data
Possible enablers: ◆ long-term support for innovation hubs in strategic areas; ◆ public co-financing and partnership with POs (or some private sector entities) to develop alternative production systems and related curricula for training courses (that can be delivered by young graduates/re-skilled older technicians) on strategic improvements in production systems; ◆ vocational courses on specific production systems for producers with tertiary or secondary level education (preferably linked to financial incentives for adoption); ◆ programs that support generational shifts in farming and investment in modern production systems and that attract young graduates.
Rice trends: sector contraction to highest yielding areas and producers; assessment of best options for land use change
For rice the key issue is not so much a matter of raising human capital as of establishing incentives to work/live in rural areas – (CPA Ferrere, 2020) for more details. However, the country can benefit from solid capacities on modern port administration and agricultural international trade at port management, law-makers and trade negotiators level. In terms of alternative land uses, enablers for human capital development could be: ◆ collaboration programs with institutions abroad and international organizations on best practices in water resource planning; ◆ programs to attract and enable the establishment of fruit and vegetable farms run by young farmers; ◆ curricula and training courses for young farmers on advanced techniques for irrigated crops (e.g. maize or fruit and vegetables).

Source: Authors' elaboration.


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Annex 1
Examples of current policies and projects

ENVIRONMENTAL STEWARDSHIP

Uruguay is well known for its advanced environmental legal framework and policies. In agriculture among the best- known policies with an impact on land use choices by farmers are the soil use and management plans. Additionally, the Sustainable Management of Natural Resources and Climate Change Project co-financed through a World Bank Loan is promoting farmer adoption of climate-smart agricultural and livestock practices, and improved natural resource management practices. In addition to providing some information on these key initiatives, this Annex also provides short descriptions of other projects that illustrate government efforts to change the paradigm of agricultural commodities production in the country. These examples do not pretend by any means to be exhaustive of all the government efforts in this area.

Soil use and management plans

The framework of Law Nº 15.239 and its regulations, mandated MGAP to require farmers to present a Plan on the Responsible Use and Management of Soils (henceforward Use Plans), that takes into account the type of soil on their farm, management practices, crop sequence and acceptable level of erosion. In April 2013, the compulsory phase of this requirement was started, and a gradual phase-out in terms of surface and production systems was established. The MGAP will continue this gradual process by incorporating farms with smaller surfaces dedicated to agriculture and other production systems. Special attention is being paid to the protection of water quality along the Santa Lucía River basin; this features 11 measures, among them being Measure 3, which among other things requires the obligation for all farms located along this basin to control the application of nutrients, through the presentation of their Plans in the Use, Management and Preservation of Soils (Decree 405/2008 of the MGAP), and requires that the application of fertilizers be based on an analysis of the soil to prevent the concentration of phosphorus from exceeding 31ppm (Bray1). (Source: https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/politicas-y-gestion/planes-uso-manejo-suelos . More information can be found in (World Bank, 2018a)).

Sustainable Management of Natural Resource and Climate Change Project

The Project, which had USD 42 million of extra financing in 2017, is divided into three components: (i) developing the Agricultural Information and Decision Support System (SNIA); (ii) territorial interventions and On Farm Investments for Climate Smart Agriculture and Livestock Management; and (iii) developing the capacities of the DGRN (Dirección General de Recursos Naturales) and will also add new support to the USCC (Unidad de Sostenibilidad y Cambios Climáticos) within the OPYPA (Oficina de Programación y Política Agropecuaria).

Component 1 adds to an ongoing effort to generate open data to support decision, both at policy and farm level. This effort is complementary to other initiatives, such as the FAO project *National Land Monitoring and Information System for a transparent Nationally Determined Contribution (NDC)* reporting from which Uruguay is one of the beneficiary countries and that will strengthen the country's reporting capacity under the United Nations Framework Convention on Climate Change (UNFCCC) by (i) developing in-country capacities; (ii) developing a cloud-based monitoring and mapping application built upon Google Earth Engine and Google Earth technology to enable assessment and evaluation for results-based mechanisms, e.g. REDD+, Nationally Appropriate Mitigation Actions; and (iii) assist countries in setting up Geographic Information System (GIS) labs (FAO, 2018b).

Component 2 will finance investment, technical assistance and training for farmers and farmers' organizations, to generate a greater capacity for mitigation of and/or adaptation to climate change and climate variability and other co-benefits. It applies non-reimbursable support mechanisms of up to 80 percent of the amount of investment for family farmers, and 50 percent for medium-sized farmers, with a threshold of USD 16 000. Farmers' organizations that demonstrate competence in the transparent and efficient use of resources may be contracted by the Sustainable Management of Natural Resources and Climate Change Project (DACC) on behalf of the farmers, to provide services, be responsible for procurement (in case of the productive water subprojects), manage payments and be accountable to the project.

This component is complemented by a USD 16.3 million Global Environment Facility (GEF) co-funded project that aims to mitigate climate change and to restore degraded lands through the promotion of climate-smart practices in the livestock sector, with a focus on family farming. Under this project 60 farm-level Climate Smart Livestock Management (CSLM) strategies will be implemented using a co-innovation approach. Capacities of 120 farmers will be strengthened. Through a cooperation arrangement with the DACC, about 700 farms will be targeted indirectly. An on-farm monitoring system will be set up to keep track of the greenhouse gas emissions, vegetation and soil quality on the 60 pilot farms (FAO/GEF, 2018).

Component 3 provides support for the implementation of the DGRN's Strategic Plan for the Use, Management and Conservation of Natural Resources, with an emphasis on soils, waters and natural pastures, to support the implementation and execution of medium- and long-term environmental and climate-smart public policies. Thus the DGRN aims at (i) generating information for the improvement of the regulatory framework; (ii) expanding the capacity to effectively monitor Land Use and Management Plans, completing the new mapping at a scale of 1:40 000 of the country's agricultural areas under SISU (Sistema de Información de Suelos en Uruguay) and expanding and upgrading the Soil Laboratory; (iii) improving the quantity and quality of water available for production by improving the training of personnel and including the Soil Management Plan of irrigated agriculture in the monitoring system for the management of all the plans; and (iv) promoting more productive management of grazing areas with a view to increasing productivity and conservation in the medium and long term.

The above-mentioned GEF project will also contribute to develop a national Climate Smart Livestock Management strategy, as well as a replace with Nationally Appropriate Mitigation Action (NAMA) framework and corresponding monitoring, reporting and verification system for the beef sector.

Source: World Bank (2017).

AGRICULTURAL AWARENESS

As part of the project aiming to improve the country's agricultural awareness, FAO and the Government of Uruguay have designed the National Agricultural Awareness Promotion Program with a budget of USD 850 000. The objective is to develop a program that will enhance mutual trust of rural and urban populations and foster new undertakings on the basis of a broader knowledge of the agricultural sector and its importance for the Uruguayan economy, environment and society. Actions within this program must build on the capacity and human resources needed to increase opportunities for employment, research, innovation and entrepreneurship in the agricultural sector (with an emphasis on the participation of rural women and youth) and promote decent job opportunities in this sector. In particular, the project will provide support to: (i) enhanced education curricula (education system) with information and activities that allow learning about the agrifood system and the production and elabouration of food; (ii) priority Uruguayan population groups become aware of the contribution of farms to national development and better understand the work of agricultural systems and the farm options in terms of lifestyles and production; and (iii) public and private institutions, companies and organizations from the agricultural sector strengthen their capacity to communicate with the national population and priority target groups in the framework of a CpD strategy.

Source: FAO (2019).

Annex 2
Information systems developed by the public sector and producers' organizations

Annex 2 is replicated from the publication Diagnóstico y propuesta de escalamiento de las TICs en la agricultura familiar en Uruguay (FAO, 2018a).

Different public sector institutions in the country have developed a series of specialized tools that provide farmers with specialized information and solutions when making decisions in different production scenarios. The majority of these tools are available free of charge on the web. The following platforms stand out as references in decision making for the overall agricultural sector.

Statistical information system – Instituto Nacional de Estadística – INE (National Statistics Institute) –http://www.ine.gub.uy). This IT platform compiles a large amount of information on demographic, social and economic indicators, census and specialized survey databases and publications from different national production sectors, including agriculture. All this information, including the census and survey databases, is available to all users at no cost.

Ministry of Livestock, Agriculture and Fisheries (MGAP) Systems. The MGAP has several specialized IT platforms that facilitate institutional work of the ministry and its different administrative and technical bureaus. Among the main systems the following stand out:

Platform	Characteristics
Sistema Nacional de Información Agropecuaria (SNIA) National Agricultural Information System http://www.snia.gub.uy/template/PORTAL%20SNIA?,,mnu-e-55-1-mnu-	This platform integrates information systems and contains data on natural resources, production and climate coming from different sources of information. Access is free.
Sistema Nacional de Información Ganadera (SNIG) National Livestock Information System https://www.snig.gub.uy/	This is an information system whose main objective is to ensure bovine cattle traceability from farm of origin to slaughterhouse, both individually and by batch of animals, according to MGAP provisions and regulations. The system can be accessed through a user's name and password.
Sistema de Monitoreo Avícola (SMA) Poultry Monitoring System https://www.snig.gub.uy/principal/sma-sistema-de-monitoreo-avicola-registro?es	This is a platform whose objective is to improve management and control the stakeholders' registry and their activities in the poultry sector.

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Platform	Characteristics
Sistema de estadísticas agropecuarias Agricultural Statistics System https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/datos-y-estadisticas/estadisticas	An IT platform that provides statistical information. Census and survey data, and specialized publications related to the agricultural sector. It can be accessed free of charge at the MGAP website.
Sistema de gestión del conocimiento y la información Knowledge and Information Management System https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/tramites-y-servicios/servicios/sistema-nacional-informacion-agropecuaria	A knowledge management platform that provides users with specialized audiovisual material relative to the cattle breeding sector in the country.
Plataforma informática de educación a distancia Remote Learning IT Platform http://capacitacion.mgap.gub.uy/	This is a specialized web platform that delivers remote learning courses to users on topics relative to the agricultural sector.

Information Systems – Instituto Nacional de Investigación Agropecuaria – INIA (National Agricultural Research Institute). INIA, through its Agro-climate and Information Systems Unit, is responsible for the development and deployment of specialized IT platforms that help decision making processes in the agricultural sector. The institution has developed and/or connected a series of free-access web-format tools for all types of users. The main platforms and their respective characteristics are described as follows:

Platform	Characteristics
Sistema de información de balance hídrico Water Balance Information System http://www.inia.uy/gras/Monitoreo-Ambiental/Balance-H%C3%ADdrico	A specialized platform to estimate water balance according to basins, areas, crops and soils.
Sistema de Monitoreo del estado de la vegetación Vegetation Condition Monitoring System http://www.inia.uy/gras/Monitoreo-Ambiental/Monitoreo-de-la-vegetaci%C3%B3n	An information system to estimate and monitor the development of vegetation on the basis of remote sensor measurements of the intensity of radiation of certain bands in the electromagnetic spectrum that are emitted or reflected.
Sistema de pronóstico de heladas Frost Forecasting System http://www.inia.uy/gras/Alertas-y-herramientas/Previsi%C3%B3n-heladas	An information system to forecast frosts with a nationwide coverage developed on the basis of data from the National Space Research Institute.
Sistema de mapas de precipitación acumulada Accumulated Rainfall Mapping System http://www.inia.uy/gras/Clima/Precipitaci%C3%B3n-nacional/Mapas-de-precipitaci%C3%B3n-acumulada	A nationwide information system to estimate rainfalls. The system was developed on the basis of information from INIA's and the Uruguayan Meteorology Institute's meteorological stations.

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Platform	Characteristics
Sistema de monitoreo de la radiación fotosintéticamente absorbida por la vegetación (APAR) Monitoring System for Photosynthetically Absorbed Radiation by Vegetation http://www.inia.uy/gras/Monitoreo-Ambiental/monitoreo-apar	This system was developed to monitor vegetation growth of annual or permanent crops in order to make management decisions.
Sistema de datos agroclimáticos Agro-climate Data System http://www.inia.uy/gras/Clima/Banco-datos-agroclimatico	The system provides information from INIA's meteorological stations through a set of climate indicators.
Sistema de pronóstico meteorológico Meteorological Forecast System http://www.inia.uy/gras/Clima/Pronostico-meteorologico	This is a weather forecast system that provides nationwide information on specific indicators.
Sistema de perspectivas climáticas Climate Prospects System http://www.inia.uy/GRAS/Clima/Perspectivas-clim%C3%A1ticas	An information system that analyzes the probability of climate phenomena such as El Niño or La Niña.
Sistema de información geográfica (SIGRAS) Geographic Information System http://sig.inia.org.uy/sigras/	A geographic information system that provides users with information on a series of cartographic indicators, soils, climate, water balance, vegetation, satellite maps. It can be used in web environments and as app in smart phones.
Sistema de Información Satelital para el AGRO (ISAGRO) Agricultural Satellite Information System http://www.isagro.org.ar/	A satellite system for decision-making in the agricultural sector. The platform was developed together with Argentina, Chile, Paraguay and Uruguay. It was funded by the IADB through its Regional Public Goods Program. It provides satellite information on different soil, meteorological, water balance, vegetation, draught, frost, fire, forestry indicators.
Sistema de previsión de condiciones ambientales para corderos recién nacidos Forecast System on Environmental Conditions for Newborn Lambs http://www.inia.uy/gras/Alertas-y-herramientas/Prevision%20Corderos	The system provides information to forecast environmental conditions to prevent the death of newborn lambs.
Sistema de pronostico DON trigo Wheat Forecast System http://www.inia.uy/gras/Alertas-y-herramientas/Pron%C3%B3stico-DON-para-trigo-	A system that announces the presence of and infestation by fusarium fungus in wheat crops, through meteorological data.
Sistema de Alerta a Roya Asiática de la Soya (SARA) Asian Soybean Rust Early Warning System http://inia.uy/estaciones-experimentales/direcciones-regionales/inia-la-estanzuela/saras-sistema-de-alerta-a-roya-asi%C3%A1tica	The system integrates all information available in relation to Asian Rust. It predicts disease outbreaks and the risk levels in terms of infestation.

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Platform	Characteristics
Sistema personalizado de estimación de agua en el suelo a nivel predial Personalized System for the Estimation of Ground Water on the Farm http://www.inia.uy/gras/Alertas-y-herramientas/cuantagua	A web platform system to estimate the amount of groundwater on a farm. It maps the water capacity of the soil as well as the capacity to store water according to the type of soil.
Sistema de predicción de estados fenológicos de soya y otros cultivos de verano System to forecast the phenological condition of soybeans and other summer crops http://www.inia.uy/gras/Alertas-y-herramientas/Utilidades	The system forecasts the phenological conditions of soybeans, sunflower, maize, sorghum for human consumption and animal feed, according to some agro-climate variables.
Sistema de información y monitoreo para la evaluación de riesgos climáticos en la producción agrícola Information and Monitoring System to Assess Climate-related Risks in Agricultural Production http://www.inia.uy/gras/Alertas-y-herramientas/SIMERPA	An information system jointly developed by INIA, Universidad Católica del Uruguay and FONTAGRO, to monitor and assess climate-related risks in agricultural production by taking into account a series of agro-climate variables and indicators.
Sistema de simulación de cultivos Crops Simulation System http://simagri.snia.gub.uy/webapp/	A system that helps producers make decisions when planning production. It takes into account different variables and scenarios. It can be accessed in web environments and as smart phone app.
Sistema de gestión del conocimiento y la información Knowledge and Information Management System http://www.inia.uy/#	A module within the INIA web that compiles publications and audiovisual material in general.

Information Systems - Plan Agropecuario (Farming Plan) INIA, through its Agro-climate and Information Systems Unit, is responsible for the development and deployment of specialized IT platforms that help decision making processes in the agricultural sector. The institution has developed and/or connected a series of free-access web-format tools for all types of users. The main platforms and their respective characteristics are described as follows:

Platform	Characteristics
Sistema para el cálculo de carga animal Stocking Rate Calculation System https://www.planagropecuario.org.uy/web/calculadora-de-carga.html	A web app for calculating the stocking rate in a given pasture, according to the cattle herd of the grower.
Sistema de indicadores prediales Farm Indicators System https://www.planagropecuario.org.uy/web/analisis-de-resultados.html	An app that allows for the evaluation of economic results from cattle raising.

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Platform	Characteristics
Sistema de modelo explotación ganadera (MEgane) Cattle Breeding Model System http://megane.planagropecuario.org.uy/	The system simulates the evolution of a grazing paddock and takes into account the composition of the grower's herd.
Sistema de gestión del conocimiento e información Knowledge and Information Management System https://www.planagropecuario.org.uy/web/	An online module to generate and disseminate specialized information relative to agricultural activity.
Plataforma informática para cursos a distancia Remote Learning IT Platform https://www.planagropecuario.org.uy/web/iniciar-sesi%C3%B3n.html?type=EAD&courseId=170	A platform to develop remote learning courses geared to farmers and agricultural extensionists. This system is accessed through registration of user and allocation of a user's password.

Information Systems – Dirección General de Recursos Naturales – DGRN (General Natural Resources Directorate) DGRN is a specialized technical bureau of the MGAP whose main objective is to foster the rational use and management of natural resources. To this end, it has developed different IT tools to inform decision making in the agricultural sector.

Platform	Characteristics
Sistema de consulta CONEAT CONEAT Enquiry System https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/tramites-y-servicios/servicios/consulta-coneat	This is a web app to enquire about information on types of soils and productivity indices according to the characteristics of this natural resource. It can be accessed by computers or mobile apps.
Sistema de consulta a fotos aéreas Aerial Photograph Enquiry System https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/tramites-y-servicios/servicios/consulta-fotos-aereas	An online service that allows access to information relative to aerial photographs of agricultural areas and with specific scale.
Sistema de imágenes satelitales Satellite Images System https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/tematica/imagenes-satelitales	An information system that allows consulting images from different satellites with different resolution, like Sentinel2 and Lansat 8.
Sistema de consulta de plan de manejo y uso de suelos y aguas Soil and Water Use and Management Plan Consultation System https://www.gub.uy/ministerio-ganaderia-agricultura-pesca/tramites-y-servicios/servicios/consulta-sobre-existencia-plan-presentado-padron	An IT platform to find out whether certain regions have plans relative to soil and water use and management, according to a registry of users.

Information Systems – Dirección General de Desarrollo Rural – DGDR (General Rural Development Directorate). DGDR has developed IT tools on a web platform to facilitate internal administrative processes and conduct technical assistance activities geared to family farmers and producers' organizations. These platforms are used by the staff and technicians of this Directorate, as well as by private extensionists and farmers depending on their roles and responsibilities within the institutional structure of this bureau.

Platform	Characteristics
Sistema de certificación de agricultores familiares Family Farmers' Certification System http://www.mgap.gub.uy/certificadoProdFamiliar/solicitudcertifprodfamiliar.aspx	An IT platform for online certification for family farmers.
Sistema de registro de extensionistas privados Private Extensionists Registry System http://www.mgap.gub.uy/dgdr/login.aspx	An IT platform in the web environment where private extensionists register with a user's name and access password.
Sistema para la gestión del Programa de Desarrollo Rural Productivo (PDRP) Productive Rural Development Program Management System	An online IT platform that was developed to receive and evaluate proposals in response to invitations by PDRP.
Sistema de mensaje por correo electrónico a técnicos, extensionistas privados, organizaciones de productores y agricultores E-mail Messaging System for technicians, private extensionists, producers' organizations and farmers	DGDR often uses its institutional mail to get in touch with its specialists, private extensionists, producers' organizations and farmers.
Sistema de mensajería por celulares dirigido a extensionistas privados y agricultores Mobile phone messaging system geared to private extensionists and farmers	DGDR sends text messages via mobile phones to family farmers for administrative purposes or to communicate invitations. Messages are transmitted through a mechanism established within the agreement MGAP concluded with ANTEL.
Sistema de mensaje a través del WhatsApp para comunicación directa entre extensionistas de la DGDR, extensionistas privados y agricultores Messaging system through WhatsApp for a direct communication between DGDR extensionists, private extensionists and farmers	Coordination of extension activities and technical assistance are increasingly carried out through IT apps such as WhatsApp.

Information systems at the level of producers' organizations
Producers' organizations have their own information systems to contact and render services to their members.

Information systems – Federación Uruguaya de los Centros Regionales de Experimentación Agrícola – FUCREA (Uruguayan Federation of Regional Agricultural Experimentation Centers)

Platform	Characteristics
Sistema de información y gestión del conocimiento Information and Knowledge Management System http://fucrea.org/seccion/publicaciones	IT platform that provides technical information and audiovisual material to farmers and extensionists.
Sistema para la comercialización de ganado (CarneCREAconecta) Cattle Commercialization System (CarneCREAconecta) http://fucrea.org/seccion/carne-crea	This is a specialized platform to commercialize beef that takes into account the different stakeholders in the commercialization chain. Access to the system is possible through a user's name and password.
Sistema de información para la gestión de empresas agropecuarias Information System for Agri-business Management http://fucrea.org/seccion/herramientas-crea	This system integrates online apps for different purposes oriented to improving the management of agribusinesses. Each of the apps can be accessed through a user's name and password.
Sistema de mensaje por correo electrónico a extensionistas privados, organizaciones de productores y agricultores E-mail messaging system geared to private extensions, producers' organizations and farmers	Resorting to e-mail is very frequent in the case of extensionists and farmers in the CREA groups, to coordinate and exchange specialized information.
Sistema de mensaje a través del WhatsApp para comunicación directa entre extensionistas privados y asociados WhatsApp messaging system for direct communications between private extensions and members	As in many other groups of stakeholders, text and voice messages via WhatsApp have become the most popular means of communication to coordinate, transmit, receive and exchange specialized information.

Annex 3
Examples of producers' organizations in Uruguay

URUGUAY'S LONG TRADITION OF COLLECTIVE ACTION MAY CONTINUE TO PROVIDE OPPORTUNITIES FOR THE SECTOR

The importance of cooperatives in the country's rural sector should be seen as an opportunity for the implementation of policies in an efficient manner. Cooperatives stepped into agriculture in the first decades of the 20th century (the first being "Cajas de Crédito Rural" and "Sociedades de Fomento Rural") and the network is currently well consolidated and organized with around 124 cooperatives registered in December 2019. They increased 51 percent since 2008, after the general cooperative law was issued.

There is one Federation (Cooperativas Agrarias Federadas – CAF) integrating 25 member entities (first- and second-grade cooperatives and "Sociedades de Fomento") with 13 000 farmers participating (32 percent) of total and 4 000 employed workers. Most CAF members are located in the south, west coast and center regions. They provide members with varied services such as technical assistance and capacity building, access to inputs, access to finance, storage and commercialization of products. Some of them are also integrated "up-stream" and participate in processing and value-added process.

Cooperatives in the country are particularly important in the wool and dairy sectors and mainly (but not only) serve family farming (around 21 657 famers in 2018). The largest cooperative in the country is CONAPROLE ("Cooperativa Nacional de Productores de Leche") which was created in 1935 and is the largest national exporter of goods (7 percent of total exports in 2018 for USD 500 million) concentrating 70 percent of exports and dairy processing in the country. In addition, cooperatives are responsible for more than 15 percent of exported wool. Central Lanera is a confederation of wool producers' cooperatives throughout the country. The cooperatives associated with Central Lanera smoothen inter-year variations in wool price, making savings when prices are high (not distributing all the surplus to the members) and holding stocks and ensuring positive net income to producers when prices are low. Central Lanera is equipped with wool analysis labs and manages a wool technological center to promote innovation and adoption of best practices. Wool is paid on the basis of clearly established criteria, which provides an incentive for long-term investment to adapt production to market demand. Cooperatives are also important in the oilseeds and cereals subsector as they represent 15 percent of soybean plantations, 25 percent of farmers and 50 percent of grain storage capacity.

Examples of important national-level producers' organizations are given below:

Comisión Nacional de Fomento Rural (CNFR). The National Rural Development Commission is a cooperative organization that brings together 98 important entities known as Rural Development Associations (*Sociedades de Fomento Rural* (SFR), with agrarian cooperatives and other base organizations. In total, this organization comprises around 15 000 family farmers all around the

country who are dedicated to different production activities. In this way, it is the largest organization representing family farmers.

Cooperativas Agrarias Federadas (CAF). The Federation of Agrarian Cooperatives is a guild organization that brings together 25 agricultural cooperative enterprises from throughout the country that represent different production sectors that together represent approximately 13 000 large, medium and/or family producers.

Asociación Rural del Uruguay (ARU). Uruguay's Rural Association is a guild institution that brings together 53 producers' associations from different production sectors. Its mission is to promote the development of agricultural production and related and ancillary industries.

Cooperativa Nacional de Productores de Leche (CONAPROLE). The National Dairy Farmers' Cooperative is a CAF member cooperative whose mission is to collect, process and commercialize all milk produced by its 2 000 members.

Federación Uruguaya de los Centros Regionales de Experimentación Agrícola (FUCREA). Uruguayan Federation of Regional Agricultural Experimentation Centers is the organization that reunites CREA groups and producers, totaling approximately 600 members. The main purpose of the CREA Groups is to help farmers improve the production and economic results of their agribusinesses by leveraging the resources available on their farms.

Asociación Nacional de Productores Lecheros (ANPL). National Dairy Farmers' Association is a guild and services association integrated by around 1 417 members distributed in 18 provinces of the country.

Other associations with specific activities - Uruguay has a series of producers' organizations in rural areas that represent different production sectors.

Annex 4
Summary of key institutions and programs that support innovation in Uruguay

Institution	Description
High-level bodies	
Ministerial Cabinet for Innovation	Composed of the Ministry of Education and Culture (which presides over it); Ministry of Livestock, Agriculture and Fisheries; Ministry of Industry, Energy and Mining; Ministry of Health; and the Ministry of Economy and Finance. It coordinates and articulates all government actions related to innovation, science and technology activities for the development of the country.
Consejo Nacional de Innovación, Ciencia y Tecnología (CONICYT)	Advisory body made up of representatives from the public and private sectors, academia, workers and civil society. Its purpose is to propose plans, general policy guidelines and priorities related to science, technology and innovation to the Ministerial Cabinet for Innovation, the Executive Branch and the Legislative Branch.
Agencia de Gobierno Electrónico y Sociedad de la Información y del Conocimiento (AGESIC)	Dependent on the Presidency of the Republic and responsible for the development of the state's digital policy and the Uruguay Digital Agenda with the objectives to: (i) promote open government; (ii) digitally integrate society; (iii) strengthen the cybersecurity ecosystem; (iv) simplify procedures, improving services; (v) generate capacities; (vi) contribute to digital literacy; and (vii) provide innovative computer solutions to improve services.
Strategic plans and agendas and monitoring tools	
Agenda digital	Multi-stakeholder agreement between representatives of government, academia, the private sector and civil society organizations through a National Council for the Information Society. In its third edition, the current Agenda Digital Uruguay follows progress on the goals to be achieved by 2020, which include the promotion of digital skills in Uruguay's human capital, investments in ICT infrastructure, and initiatives to promote digitalization of public services. Agri-food systems appear in goals related to competitiveness and the environment, as well as in a specific goal to expand the development of an agricultural information society through the interoperability of different services that collect information from farmers and producers.
Plan Estratégico Nacional de Ciencia, Tecnología e Innovación (PENCTI)	As the main instrument of public policy, it establishes the vision, mission and strategic objectives to promote science, technology and innovation aiming at the medium- and long-term development of the country. Its operational arm is the National Agency for Research and Innovation (ANII).
National agencies and programs	
National Development Agency (ANDE)	Designs and implements programs, projects and instruments aimed at improving the business and territorial competitiveness of micro, small and medium-sized companies (MYPES). It finances innovative MYPES initiatives.

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Institution	Description
National Agency for Research and Innovation (ANII)	Works to boost adoption of knowledge in national production systems through research and entrepreneurship funds, coordination programs, and open-knowledge platforms. ANII has also supported the creation of technology centers developed to bring together science, industry, knowledge producers and end-users. The Pando Science and Technology Park, for instance, aims to serve as incubator for new ideas and enterprises and offer highly specialized technical assistance in food processing.
Transforma Uruguay	Created in 2016 and composed of various public ministries, research institutions, academia and the private sector, with members including ANII, LATU, INIA, ANDE and the Investment, Export and Country Brand Promotion Agency (Uruguay XXI). Among its projects, the current 2017–2021 national plan establishes the development of a national Agri-environmental platform, the creation of a public–private venture capital fund, a circular economy program, and incentives to promote an entrepreneurial culture among youth.
Institutions dedicated to technology	
Technological Labouratory of Uruguay (LATU)	Non-state public law organization created in the 1960s to provide services to national production chains. It is responsible for quality certification services provided to the agri-food industry, funds research and innovation programs, and its technology park has created an ecosystem of companies and organizations linked to ICTs.
The Uruguayan Association of Information and Communication Technology Companies (CUTI)	Association of information and communication technology companies made up of over 241 members that offer products and services to more than 50 markets around the world. Its mission is to promote the development of the ICT industry. CUTI supports, *inter alia*, the development of agri-tech through workshops, events, and hackathons.
Agriculture sector specific	
The National Institute of Agricultural Research (INIA)	INIA conducts long-term research projects that can lead to the development of marketable knowledge and technologies to be exported to other countries. The rice sector owes part of its achievements in terms of development of high value varieties and high yields to the work of INIA.
Private sector	The Uruguayan agricultural sector has a long tradition of cooperation. For instance, the dairy and wool sectors have large cooperative enterprises – Conaprole and Central Lanera respectively – that invest in innovation. Conaprole monitors members' pastures monthly through the interpretation of satellite images and provides advice through a portal for technicians and producers.

Annex 5
Formal education offer in Uruguay

Formal education proposals that are directly related to the agricultural sector

Table 13
Public tertiary and university courses related to the agricultural sector, by institution (2018)

Public universities: graduate and post graduate courses 2018	
University	**Province**
UNIVERSIDAD TECNOLOGICA- UTEC	
B.A. in Dairy Sciences and Technology	Colonia
Dairy Production Systems Management Technician	Colonia
Irrigation, Drainage and Effluent Management Systems Engineering	Durazno
UDELAR (University of the Republic of Uruguay)	
School of Agronomy	
B.A. in Landscape Design	Montevideo/ Maldonado
Meat Technician (CETP-UTU)	Tacuarembó
Wood Technician	Rivera
Agronomist	Montevideo/Salto
Forest Engineer	Montevideo/Tacuarembó
Agronomy Specialization Diploma	Montevideo
Sustainable Rural Development Diploma	Montevideo
PhD in Agrarian Sciences	Montevideo
Master in Agronomy	Montevideo
Master in Agrarian Sciences	Montevideo
Master in Sustainable Rural Development	Montevideo
School of Engineering	
Surveyor	Montevideo
School of Veterinary Medicine	
Doctor in Medicine and Veterinary Technology	Montevideo
Doctor in Veterinary Sciences	Montevideo/Paysandú/Salto
Master in Ruminants' Nutrition	Montevideo
Master in Animal Production	Montevideo
Master in Animal Reproduction	Montevideo
Master in Animal Health	Montevideo

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Public universities: graduate and post graduate courses 2018	
University	**Province**
Specialization in Safety of Food of Animal Origin	Montevideo
PhD in Animal Production	Montevideo
PhD in Animal Health	Montevideo

Note: Includes both face-to-face and online technical courses, graduate and postgraduate careers, Master's and PhD degrees.

Source: OPYPA and Voss (2020). These courses are 100 percent related to the agricultural sector.

Table 14

Private tertiary and university courses related to the agricultural sector, by institution (2018)

Private universities: graduate and post graduate courses 2018	
University	**Province**
UCUDAL	
School of Business Sciences	
B.A. in Agriculture and Livestock Management	Montevideo/ Salto
UNIVERSIDAD DE LA EMPRESA	
School of Agrarian Sciences	
Agricultural and Livestock Technician	Montevideo/ Colonia/ Florida
Veterinary Sciences Technician	Montevideo
Horse Management Technician	Montevideo
Forestry Management Technician	Montevideo
Veterinary Technician	Montevideo
Veterinary Assistant Technician	Montevideo
Therapeutic Horse-Riding Instructor	Montevideo
Agronomist	Montevideo
B.A. in Agricultural Sector Management	Montevideo
Livestock Business Diploma	Montevideo
Agribusiness Administration Diploma	Montevideo
Grain Management and Commercialization Diploma	Montevideo
Animal Production Diploma	Montevideo

Note: University careers 100 percent related to the agricultural sector.

Source: OPYPA and VOSS (2020).

Relevant formal training proposals in institutions not directly related to the agricultural sector

Table 15

Public university courses in schools not specializing in agrarian sciences or agronomy

Public universities: graduate and post graduate courses 2018	
University	**Province**
UNIVERSIDAD TECNOLOGICA- UTEC	
Industrial Mechatronics Technologist	Rivera
Logistics Engineering	Río Negro
B.A. in Information Technology	Durazno
Renewable Energies Engineering	Durazno
Irrigation, Drainage and Effluent Management Systems Engineering	Durazno
B.A. in Food Analysis	Paysandú
UDELAR (University of the Republic)	
School of Engineering	
Production Engineer	Montevideo
Mechanical and Industrial Engineer	Montevideo
Mechanical Technologist	Montevideo/Paysandú
IT Technologist	Montevideo/Mald./Pay./San José
B.A. in Biological Engineering	Montevideo/ Salto
B.A. in Water Resources and Irrigation	Salto
Master in Innovation Management	Montevideo
Master in Environmental Engineering	Montevideo
Master in Pulp and Paper Engineering	Montevideo
Master in Applied Fluid Mechanics Engineering	Montevideo
Master in Information Systems and Data Management	Montevideo
PhD in Environmental Engineering	Montevideo
PhD in Applied Fluid Mechanics Engineering	Montevideo
Information Systems Specialization and Data Management Diploma	Montevideo
School of Economics and Business Administration	
B.A. in Business Administration	Montevideo
Business Administration Technician	Montevideo/Colonia/ Maldonado
Administration Specialization Postgraduate Course	Montevideo
School of Sciences	
B.A. in Biochemistry	Montevideo/Salto
B.A. in Geology	Montevideo
B.A. in Environmental Management	Maldonado/ Rocha
B.A. in Natural Resources	Rivera
Natural Resources Management Technician	Rivera
Master in Biotechnology	Montevideo
Master in Environmental Sciences	Montevideo
Specialization in Environmental Sciences	Montevideo

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Public universities: graduate and post graduate courses 2018	
University	**Province**
PhD in Biotechnology	Montevideo
PhD in Environmental Sciences	Montevideo
Master in Nutritional Sciences	Montevideo
Master in Food Sciences and Technology	Montevideo
UNIVERSIDAD CATÓLICA DEL URUGUAY	
Food Technology Postgraduate course	Montevideo
Master in Technology and Management of the Food Industry	Montevideo

Note: Careers that could be related to the agricultural sector or that relate to it through some of the courses offered.

Source: OPYPA and Voss (2020).

Table 16

Courses offered in private universities not specialized in agrarian sciences or agronomy

Private universities: graduate and post graduate courses 2018	
University	**Province**
UCUDAL	
School of Business Sciences	
B.A. in Business Management	Montevideo
B.A. in Logistics Management	Montevideo/Salto
B.A. in Economics	Maldonado
Master in Business Management	Montevideo
School of Engineering and Technology	
IT Engineering	Montevideo
Food Engineering	Montevideo
Master in Technology and Management in the Food Industry	Montevideo
Postgraduate course in Food Technology Specialization	Montevideo
ORT	
School of Administration and Social Sciences	
IT Analyst	Montevideo
B.A. in Management and Administration	Montevideo
Master in Business Administration	Montevideo
School of Engineering	
B.A. in Biotechnology	Montevideo
Biotechnology Engineering	Montevideo
Big Data Analyst Specialization Diploma	Montevideo
UNIVERIDAD DE MONTEVIDEO	
School of Business Sciences and Economics	
B.A. in Business Administration	Montevideo
Professional Master in Management and Business Administration	Montevideo
School of Engineering	
Industrial Engineering	Montevideo

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IT Engineering	Montevideo
B.A. in IT	Montevideo
UNIVERIDAD DE LA EMPRESA	
School of Business Sciences	
B.A. in Business Administration	Montevideo
B.A. in Business Administration	Colonia
Master in Business Management and Administration	Montevideo
School of Engineering	
IT Analyst	Montevideo
IT Engineering	Montevideo
B.A. in IT	Montevideo/ Colonia/ Maldonado
B.A. in Logistics	Montevideo

Note: Courses that might relate to the agricultural sector or that relate at some point during the career.

Source: Authors' elabouration based on data provided by the Ministry of Education and Culture (MEC).

Non-university formal training proposals related to the agricultural sector

Table 17
Non-university tertiary courses

CETP (UTU)
Agronics with an Agricultural Emphasis
Agronics with a Forestry Emphasis
Agronics with a Cattle Breeding Emphasis
Industrial Biotechnology
Preservation and Management of Natural Areas
Environmental Control
Nature – Sustainable Tourism Itineraries Design
Wind Energy
Enology – Enology Module II
Enology – Internship – Final Project
Forestry
Forestry – Binational
Dairy Industries
Logistics
Dairy Production Systems Management
Farming Production
Family Farming Production
Auctioneer
Rice Fields – Binational
Renewable Energy Systems
Meat Technologist
Wine-Making

Note: The EMAD data correspond to 2017, latest data available.

Source: EMAD General Secretariat at UTU.

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Investing in farmers - or agriculture human capital - is crucial to addressing challenges in our global agri-food systems, from sustainably feeding the world's growing population with food that is safe, healthy and nutritious to finding innovative solutions for more resilient and climate-smart agriculture. **UP-SKILLING HUMAN CAPITAL FOR VALUE-CHAIN COMPETITIVENESS IN URUGUAY** was developed by the FAO Investment Centre and the World Bank, with the objective to identify ways to upskill human capital and make Uruguayan agricultural value-chains more competitive. This publication looks at opportunities to increase key value chain efficiency and at the skills that are required to seize such opportunities. It identifies ways to develop human capital through training agricultural professionals - including researchers, agronomists and technicians - to lead the next generation of technology and innovation-driven agribusinesses. It suggests options for fostering a process of continuous development and up-skilling in the agricultural sector in Uruguay. This publication is part of the Country Investment Highlights series under the FAO Investment Centre's Knowledge for Investment (K4I) programme.

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