

Exploring sources of technological upgrading in Moldova's agri-food sector

Case study: UNECE Innovation for Sustainable Development (I4SD) Review of Moldova

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1. Introduction

1.1. Background - The untapped potential of Moldova's agri-food sector

Despite significant economic progress over the past two decades, Moldova remains one of the poorest countries in Europe. The country's growth so far has been largely driven by pensions and remittances, two economic drivers which are highly unsustainable (World Bank, 2016, p. 75). Poverty in Moldova is mostly a rural occurrence and is prevalent among people depending on agriculture which accounts for 10 percent of GDP and provides 21 percent of total employment. Land privatization after the collapse of communism has led to a highly fragmented farming area in the country; as result, the sector is now dominated by smallholders who are mainly subsistence producers and produce about 71 percent of total agricultural output (Möllers et al., 2016).

In this context, evidence from developing countries shows that the growth of agriculture is strongly associated with poverty reduction, with income gains being derived from multiple channels including the diversification away from agriculture, employment creation in agriculture and the development of the rural non-farm economy (de Janvry and Sadoulet, 2010). Further, agri-food value chains have played a key and largely overlooked role in the economic transformation of low and medium income economies; innovations in these chains have often induced the adoption and diffusion of agricultural technologies, at times generating structural transformation (Barrett et al., 2020). Particularly, domestic small and medium agri-food enterprises in the midstream of value chains (i.e. processing, storage, logistics and wholesale activities) have made significant investments in rural areas and bridged farming communities with rising urban demand in many developing regions¹ (Reardon, 2015; Reardon et al., 2019a). The food processing sector is acknowledged today as a key strategic player for the growth of developing countries, with important contributions to export earnings and employment opportunities (Wilkinson, 2004, 2008).

In addition to creating farmer-market linkages, agri-food SMEs can also contribute to other sustainability objectives (Kelly and Ilie, 2021) such as youth or women inclusion (related to Sustainable Development Goals 5 and 8 on achieving gender equality, and decent work and economic growth respectively), or food and nutrition security (related to Sustainable Development Goals 2 and 3 on achieving zero hunger, and good health and well-being for people). The off-farm employment opportunities that these enterprises offer are particularly important to young people who might otherwise move abroad or migrate to already overcrowded cities (Dolislager et al., 2019). The increase in the availability of affordable, processed food can also substitute for home food preparation, allowing women to free up time to engage in non-farm employment and enhance household welfare (Liverpool-Tasie et al., 2016).

Their expansion in other developing regions has been largely propelled by improving basic conditions: infrastructure enhancement including the intensification and diversification of

¹ The importance of agri-food SMEs has been detailed in the literature on the 'hidden middle' which calls for more attention to be directed to this segment of the value chain (i.e. processing, logistics and wholesale activities) in research and policy formulation.

agricultural production; and policies for reducing transaction costs and investment risks (Reardon et al., 2019a). When these basic conditions are met, agri-food SMEs proliferate and invest to take advantage of demand opportunities.

Currently, Moldovan agri-food enterprises are presented with important market opportunities which, if seized, can allow them to fulfil their role in rural transformation and poverty reduction; the country has experienced increased internationalization and also benefits from privileged access to the European market due to the Deep and Comprehensive Free Trade Area (DCFTA) arrangement (EEAS, 2018). Unfortunately, however, most agri-food enterprises are still not able to meet the relevant standards required to export their products or supply modern retail stores (OECD, 2020); when they do manage to reach international markets, these are assigned to the low-price segment (Moroz et al., 2015).

Even more, a particularity of the Moldovan agricultural sector is that subsistence farming is becoming more prevalent than commercial farming, while farm productivity is also decreasing; this trend is being driven by aging farmer population, migration of young people out of rural areas, and more stringent food standards that smallholders struggle to comply with (IFAD, 2018; Möllers et al., 2016).

Given these challenges, both farmers and agribusinesses risk exclusion from the rapid market growth for agricultural produce propelled by increasing incomes, urbanization and international integration. Considering these economic forecasts, scholars have increasingly highlighted the need for agribusinesses to innovate to stay relevant on the market (Christensen et al., 1996; Sarkar and Costa, 2008). Further, there is a business case to innovate across the whole value chain in order to improve not only productivity but also environmental performance (OECD, 2019). In this context, accessing external sources of knowledge has become a key driver of innovation for many food enterprises as noted in recent literature; these refer to not only universities or research institutes but also supply chain partners, or even competitors (Acosta et al., 2013; Avermaete et al., 2004; Pellegrini et al., 2014; Sarkar and Costa, 2008).

As such, this case study thus aims to explore industry-science linkages but also other potential sources of knowledge and innovation in the agri-food sector of Moldova. Identifying such opportunities for technological upgrading could be a first step towards enabling the agri-food sector to achieve its role in Moldova's poverty reduction and sustainability objectives. For those countries that have a large rural population and important agricultural contribution to the GDP, an understanding of the innovation processes in the agri-food sector can also contribute to its broader science and technology agenda and roadmap for SDGs (Tropical Agriculture Platform, 2016).

The next section presents the conceptual framework upon which this case study is based. Section 2 provides a brief overview of the agri-food sector in Moldova, including its weaknesses and areas of latent potential. Section 3 looks at the current status of industry-science linkages and the role of R&D in the agri-food sector, also introducing some dynamic initiatives that are taking place in this area, and further providing some examples of good practices from other countries. Section 4 then examines other potential sources of technological upgrading in the

agri-food sector that Moldova could tap into. Finally, Section 5 presents the conclusions and derives several policy implications.

1.2. Conceptual framework

In addition to the broader conceptual framework for examining industry-science linkages governing the chapter, this case study further builds on FAO's sustainable food value chain (SFVC) (Neven, 2014), and Agricultural Innovation Systems (AIS) (Tropical Agriculture Platform, 2016) frameworks. This is to better grasp the nature of innovations and technological upgrading that can take place in the agri-food industry which is characterised by several unique attributes.

In most simple terms, **agri-food value chains** are comprised of actors who produce or procure from the upstream level, add value to the product, and then sell it to actors further downstream. The core actors are the agricultural producers (farmers), aggregators (e.g. cooperatives or intermediaries), processors/manufacturers, and distributors. These key actors are further supported by providers of inputs (e.g. seed) and services (e.g. extension, insurance, finance, transportation) who do not take ownership of the product but are essential in adding value to the product (Neven, 2014).

For an agri-food chain to be sustainable, it needs to be profitable throughout its all stages (**economic sustainability**), have broad-based benefits for society (**social sustainability**), and have a neutral or positive impact on the environment (**environmental sustainability**) (ibid.). This implies that agri-food sustainability should be approached holistically; technological upgrading to improve economic outcomes will thus have to be assessed against social and environmental dimensions to ensure that there are no negative impacts.

Governance is a key element in food value chains; elements such as information exchange, price determination, standards, contracting, market power are key determinants of technology upgrading in the chain (Neven, 2014). For instance, ensuring food safety and quality requires strong coordination across the whole supply chain, posing specific demands on governance mechanisms. In this context, "a supply chain is as strong as its weakest member" (Trienekens et al., 2012, p. 56). Improving quality aspects such as for quality certification schemes (e.g. geographical indications) requires institutional, organizational and technological upgrading throughout the chain, such as certified seed, good agricultural practices or enforcement of contracts.

In the context of imperfect technology markets which often characterise less developed countries, various forms of value chain innovations have been established by up and downstream companies to overcome the constraints of farmers who have limited resources to invest in the needed technologies. This type of value chain innovations in developing countries have been particularly pushed by increased (Western) standards, and include for instance, specific coordination mechanisms such as processors providing farmers with technology as part of a supply contract with certain conditions (Swinnen and Kuijpers, 2019).

Furthermore, agri-food value chains operate within a **wider complex economic, social and natural environment** that determine the behaviour and performance of actors in the value chain, and hence the kind of technological upgrading that takes place. For instance, a stylised empirical fact is that with rising incomes, urbanization and globalization, food value chains undergo a transition from traditional to modern; as such, businesses grow in scale, technology shifts from labour to capital-intensive, transactions shift from spot markets to coordinated ones (i.e. characterised by contracts, standards and vertical integration), supply chains shift from short to long, and investment capital shifts from local to foreign direct investment (FDI) (Barrett et al., 2020). Through international trade and integration, agri-food industries in less developed countries are also subject to the socio-economic changes in the developed world such as more stringent food standards, or changing consumption patterns as result of increased incomes (e.g. demand for healthier food, or growing sustainability concerns).

Further, these value chain actors and their interactions operate in a wider innovation system including the **enabling environment, research and education, and bridging institutions** such as multistakeholder platforms (Tropical Agriculture Platform, 2016). Knowledge and innovation in the agri-food sector goes beyond the traditional linear process of technology transfer such as from research to farmers through extension. Innovation will thus be shaped according to the dynamic interactions among these spheres and the actors' capacity to collaborate; reflect and learn; or engage in strategic and political processes (ibid). External factors such as policy constraints, lack of capacities, or structural weaknesses may all hinder innovation, thus preventing countries from realising their potential for agri-food innovation.

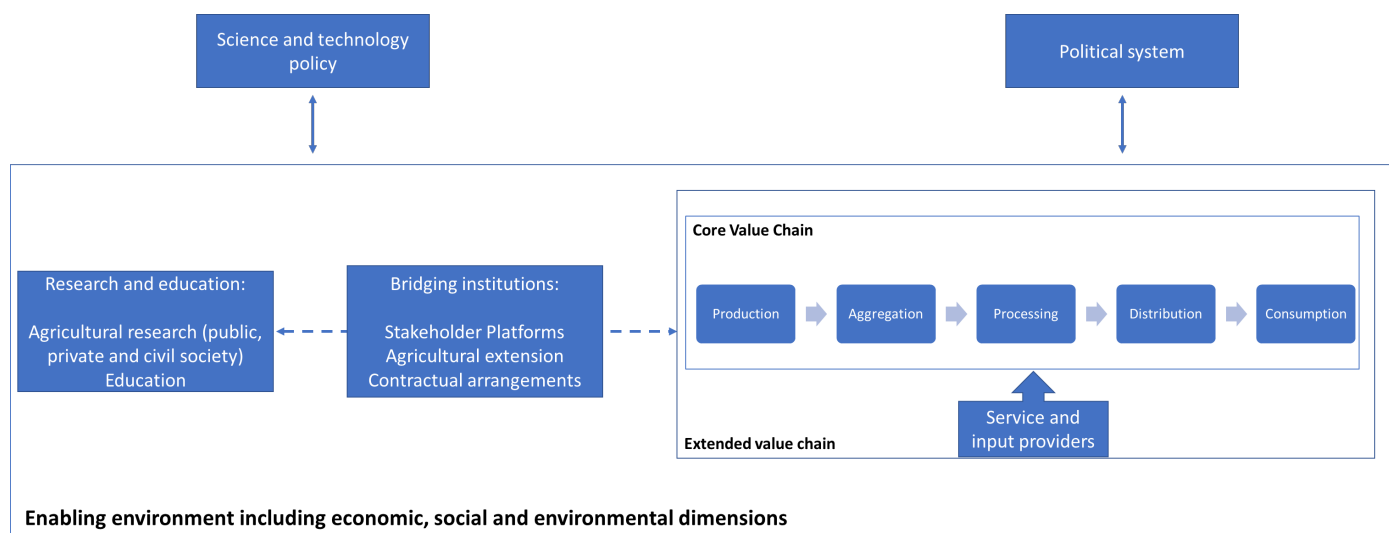


Figure 1: Conceptual diagram of agri-food innovation systems

Source: adapted from Neven (2014) and Tropical Agriculture Platform (2016).

1.3. Research design

The case study examines the issues introduced in the conceptual framework within Moldova's agri-food sector. The development of the case study is based on desk research looking at

country and industry assessments, publicly available national policy documents, country development strategies and national statistics. Additionally, in-depth interviews have been carried out with experts including public and private actors working in agribusiness, as well as civil sector representatives – see Annex 1 for a list of the interviewees. Given the current Covid-19 pandemic situation and travel restrictions, the interviews took place online.

2. Brief overview of the agri-food sector

Similarly to many developing countries around the world, the agri-food sector plays a key role in Moldova’s economy; while agriculture accounts for 10 percent of GDP and provides 21 percent of total employment, food and beverages processing sector comprises 44 percent of total value added in manufacturing and 31 percent of employment in the manufacturing sector.

In 2019, there were 1 214 companies registered as food and beverages manufacturers, the majority of which are micro-sized (68 percent). While only 7 percent are categorized as large², these big players provide 64 percent of total employment in the sector (Moldova National Bureau of Statistics). Table 1 provides a snapshot of Moldova’s agri-food sector.

Table 1: Overview of Moldova's agri-food sector in 2019

Food and beverages manufacturing value added (% of manufacturing)	44
Agriculture value added (% of GDP)	10
Micro-enterprises in food and beverages manufacturing	819
Small enterprises in food and beverages manufacturing	237
Medium enterprises in food and beverages manufacturing	73
Large enterprises in food and beverages manufacturing	85
Number of employees (manufacturing in food and beverages)	34 021 (49 percent women)
Food Exports (% of total exports)	56
Food Imports (% of total imports)	13

² According to Moldova National Bureau of Statistics, a micro enterprise is one that employs fewer than 10 persons and whose annual turnover does not exceed EUR 2 million; a small enterprise is one that employs fewer than 50 persons, with an annual turnover not exceeding EUR 10 million; and a medium enterprise is one with fewer than 250 employees and an annual turnover not exceeding EUR 50 million (ODIMM, 2017).

Employment in agriculture (% of total employment)	21
Rural population (% of total population)	57.3

Source: ILOSTAT, 2021; Moldova National Bureau of Statistics, 2021a; UN Comtrade, 2021.

Currently, these Moldovan agri-food enterprises are presented with an important trade opportunity; the country actively pursues EU membership and benefits from privileged access to the European market due to the Deep and Comprehensive Free Trade Area (DCFTA) arrangement (EEAS, 2018).

As result of the DCFTA, agri-food exports have seen an increase of 52 percent in the period 2015-2018 compared to 2011-2014; the most notable growth is attributed to fresh grapes (6.3 times), wheat (3.7 times), sunflower seeds (2.7 times), wines from fresh grape (1.7 times), and barley (1.7 times) (IPRE, 2019). While the pandemic has led to a general decrease in exports compared to 2019, this does not hold true for agri-food products which have continued their positive trend in 2020 (IPRE, 2020).

Despite these positive trends, there is still considerable room for further leveraging the potential offered by the DCFTA in particular (OECD, 2020) and the increasing internationalization in general. According to the International Trade Centre (ITC), Moldova has an untapped export potential of \$1.9 bn³; the sunflower seeds sector exhibits the largest absolute difference between potential and actual exports in value terms, leaving room to realize additional exports worth \$309.7 million. Other important food products with extensive room for exporting are fresh fruit (apples, grapes, plums, and cherries), wine and spirits, grains (wheat and maize) and walnuts. Additionally, among best options for export diversification in the agri-food sector are fresh vegetables – tomatoes, cucumbers and peppers, citrus fruit, and lentils (ITC, 2021).

Most agri-food enterprises in Moldova are still not able to meet the relevant standards required to export their products; when they do manage to reach international markets, these are assigned to the low-price segment (Moroz et al., 2015). Based on UN COMTRADE data for 2019, about 42 percent of total products exported belong to the agri-food sector. However, these exports are largely driven by products with minimal processing (and thus with little value addition) such as sunflower seeds, corn, wheat, or nuts; wine, however, also plays an important role, accounting for 4.15 percent of total exports (Observatory of Economic Complexity, 2021) but IPRE (2019) also reports that many industrial products processed which are exported are governed by a *lohn* regime⁴ (also known as Outward Processing Trade) thus holding little advantage for the local economy. Figure 2 shows that processed food still occupies only a very small share in total exports.

³ The ITC's export potential assessment methodology is based on a decomposition of a country's potential exports of a product to a given target market into three factors: supply, demand and easiness to trade (ITC, 2016).

⁴ *Lohn* processing arrangements involves the importation of raw materials or semi-finished products belonging to a client/importer to a performer/exporter and processing them within own facilities in order to (re)export the finished products.

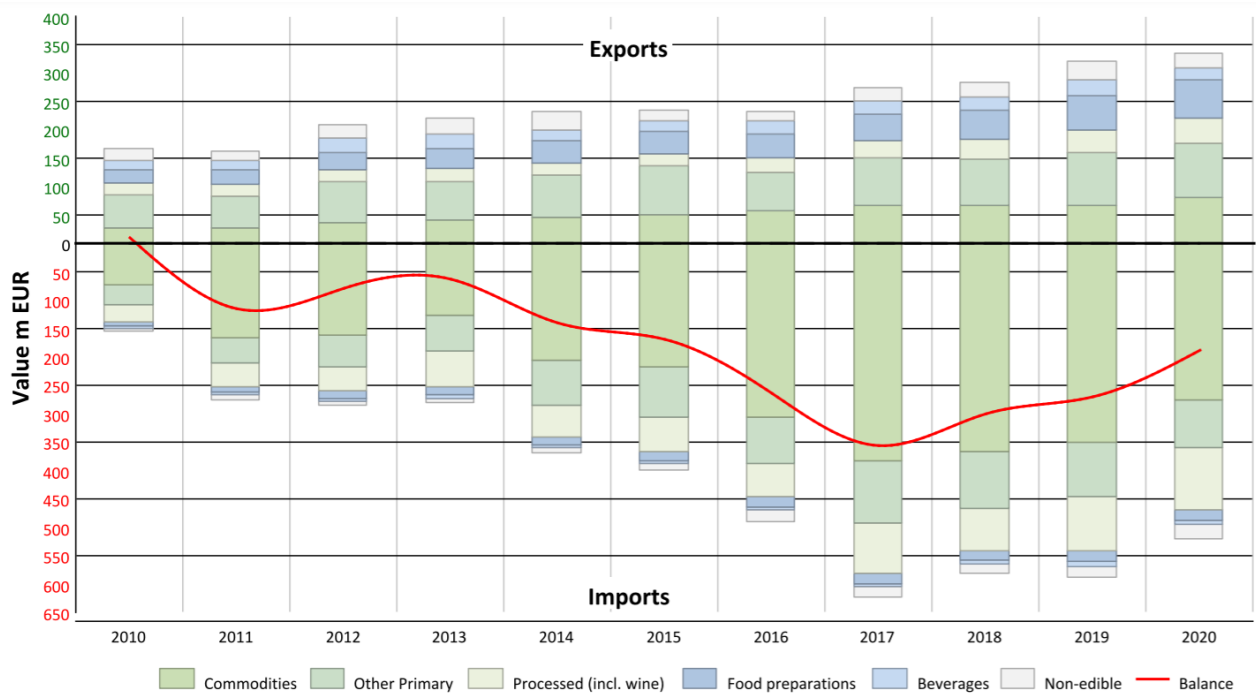


Figure 2: Structure of EU agri-food trade with Moldova, 2010-2020

Source: European Commission (2021).

3. Industry-science linkages

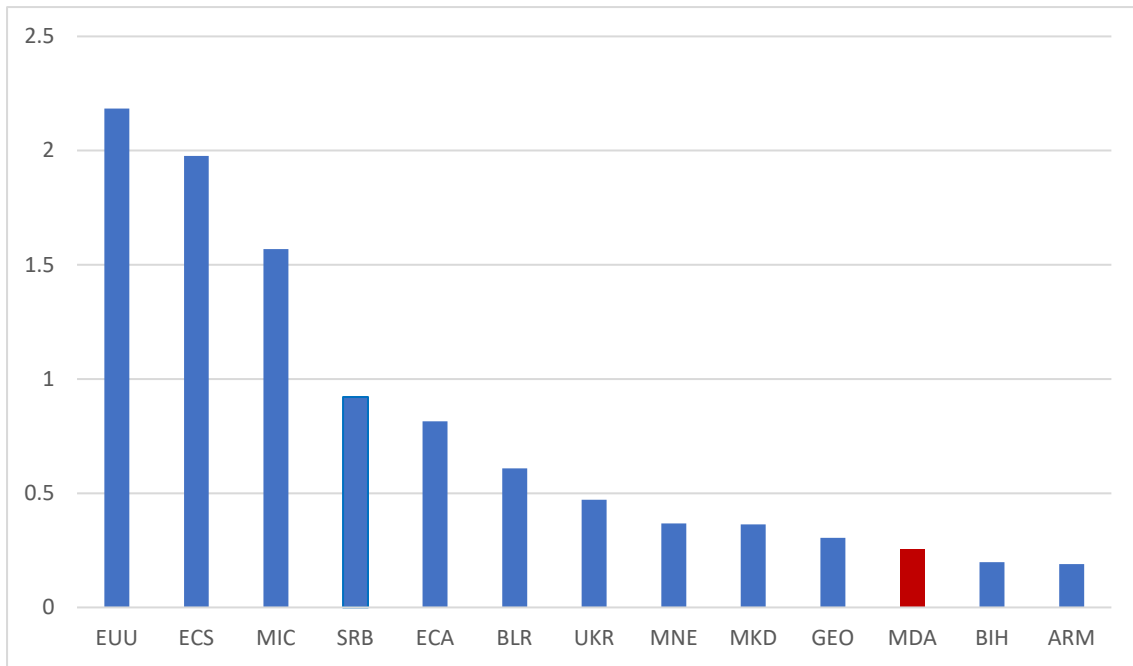
There are several facts that motivate the need for less developed countries to invest more in their own agricultural research instead of relying on technological spillovers from developed economies. First, the research agenda in developed economies is shifting to issues that are not readily applicable to developing countries (e.g. from yield improvement to health aspects). Second, technologies in developed countries may be less accessible due to intellectual-property protection particularly since many companies are not interested in pursuing markets in less developed countries. And third, those inventions that are available may require even more extensive local development and adaptation than in the past (Pardey et al., 2006). A meta-analysis of almost 300 studies show that returns to agricultural R&D spending is generally high; additionally, since social returns are much higher than private ones designate its results as a form of “public good” (Fuglie et al., 2019). Scholars have thus increasingly called for developing countries to invest in agricultural R&D (Pardey et al., 2006; Fuglie et al., 2019).

Over the past 50 years, governments of middle-income countries have been increasingly allocated expenditure to agricultural R&D, even exceeding that of high-income countries for the first time in history (Pardey et al., 2016). Private-sector spending on R&D in developing countries is also catching up with public sector spending, being both a cause and a result of the increasing importance of agri-food value chains that proliferate and adapt farm-level innovations to match downstream demand (Barrett et al., 2020).

Agricultural R&D does not represent a priority for Moldova's government; key stakeholders indicate that this is because the sector is characterised by many more urgent issues that need to be addressed. Further, the research and innovation domain in Moldova (see UNIDO, 2020 for a comprehensive overview) is characterised by several well-known and reiterated constraints including outdated equipment, insufficient funding, aging labour, low salaries, and intense brain drain (Radosevic et al., 2016; Spiesberger and Cuciureanu, 2015; UNIDO, 2020), also confirmed by our interviewees. The transition to a project-based, competitive funding of research has also created instability due to downsizing which is in line with other developing countries with a high share of project-based funding (OECD, 2019). International projects are one way out of the rigid regulations and poor national financing as these provide research institutes with the opportunity to invest in their own infrastructure, to publish internationally and improve the visibility of their activities.

Research in agriculture is currently covered by eight scientific institutes, including the State Agrarian University of Moldova which are under the supervision of the Ministry of Agriculture, Regional Development and Environment. Additionally, the National Agency for Research and Development established in 2018 fulfils the role of fund allocation for research projects on a competitive basis. For the period 2020-2023, about 12 percent of the total funding for competition-based projects was awarded to agricultural research institutes; 39 percent of this was awarded to the Institute of Horticulture and Food Technologies, followed by 21 percent awarded to the State Agrarian University of Moldova (ANCD, 2021). There is also an additional small fund for Technological Transfer projects, amounting to 13 806 thousand MDL (about 643 700 EUR) for the period 2019-2020. Twelve projects have been approved, out of which four are related to the agri-food domain.

Public R&D activities in Moldova are negligible, with a rate of 0.25% - one of the lowest in the region as Figure 3 shows. Even more, national statistics reveal that only 4.6 percent of R&D expenses in 2020 consisted in capital investments, while the remaining 95.4 percent were current expenditures (Moldova National Bureau of Statistics, 2021b). Nonetheless, this represents an improvement from 2019 when the figures were 2.7 and 97 percent respectively (Moldova National Bureau of Statistics, 2020).



EUU: the European Union; ECS: Europe and Central Asia; MIC: middle income country; ECA: Europe and Central Asia (excluding high-income).

Figure 3: Research and development expenditure (% of GDP)

As Figure 4 shows, agriculture sciences rank the third in the budget for R&D activities after natural sciences and engineering, receiving 14.2 percent of total current expenditures; most of the budget is dedicated to applied research and almost no expenditures go into technology development for agriculture. Since 2008, agriculture has lost importance in the country's R&D activities, a trend which is reflected in several indicators. For instance, the share of agricultural sciences in total researchers and current expenditures has been decreasing, as Figure 4 reveals, though the past year has seen a significant increase in the number of researchers in agriculture, from 352 in 2019 to 453 in 2020. This decreasing trend is in line with low-income countries which have seen a shrinkage in R&D investment over the past decades (Pardey et al., 2016).

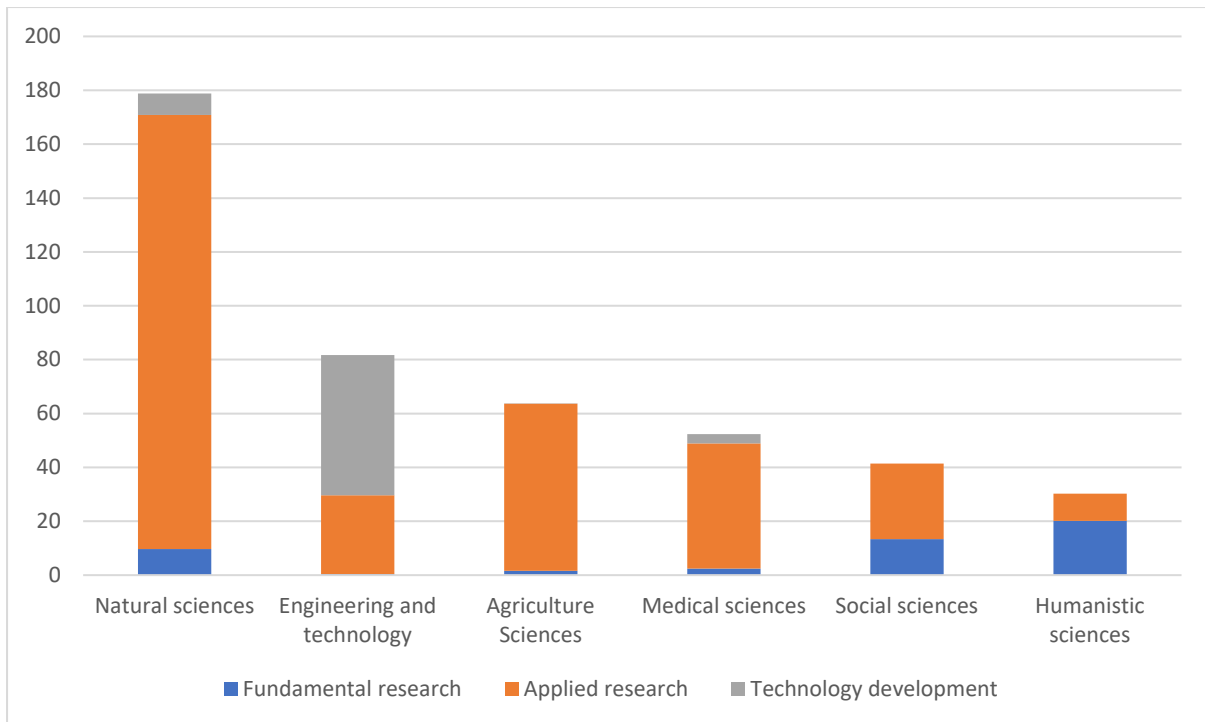


Figure 4: Operational expenditures distributed per scientific domains in 2020, million MDL

Source: Moldova National Bureau of Statistics, 2020.

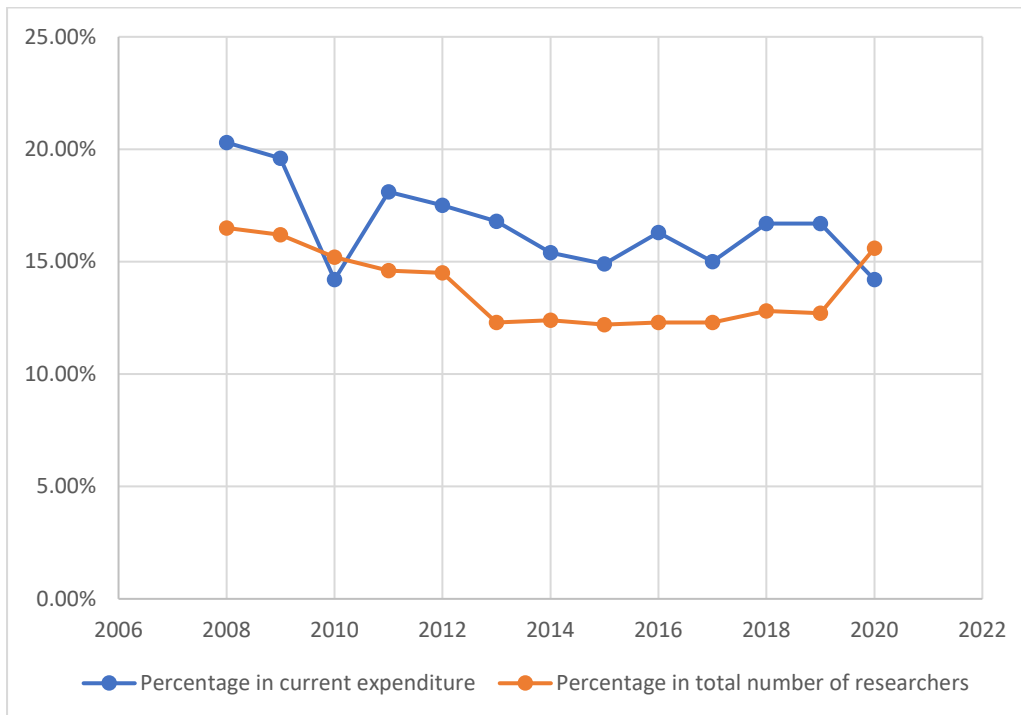


Figure 5: Agricultural sciences share in current expenditure and total number of researchers

Source: Moldova National Bureau of Statistics.

In line with many other developing countries, particularly in Africa (Pardey et al., 2006), Moldova is facing significant funding and institutional constraints that inhibit the returns and effectiveness of R&D which depend on the availability of complementary inputs to research such as rural infrastructure, insurance or capital markets, or extension services to farmers, thus

requiring a comprehensive approach in terms of policies for agri-food development (Fuglie et al., 2019). Many of these complementary inputs to agricultural R&D are lacking in Moldova; several indicators can provide a snapshot of these weaknesses. For instance, Moldova performs poorly with respect to financial infrastructure when compared to its regional or middle-income counterparts, as Figures 6 and 7 reveal.

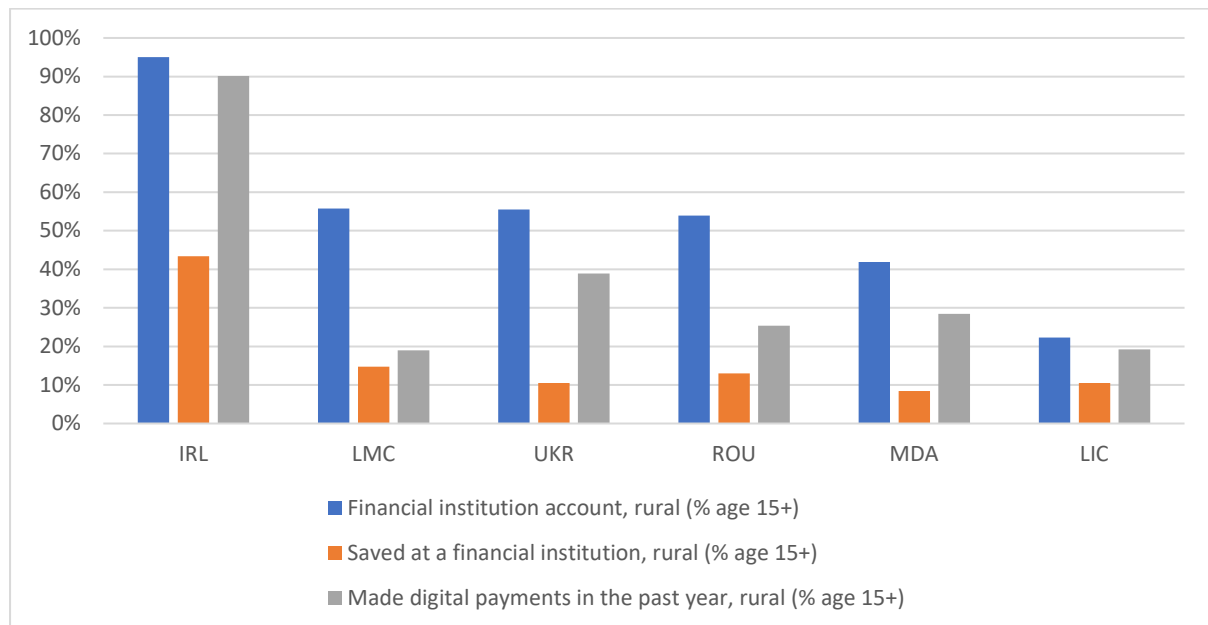


Figure 6: Financial inclusion indicators

Source: Global Findex Database.

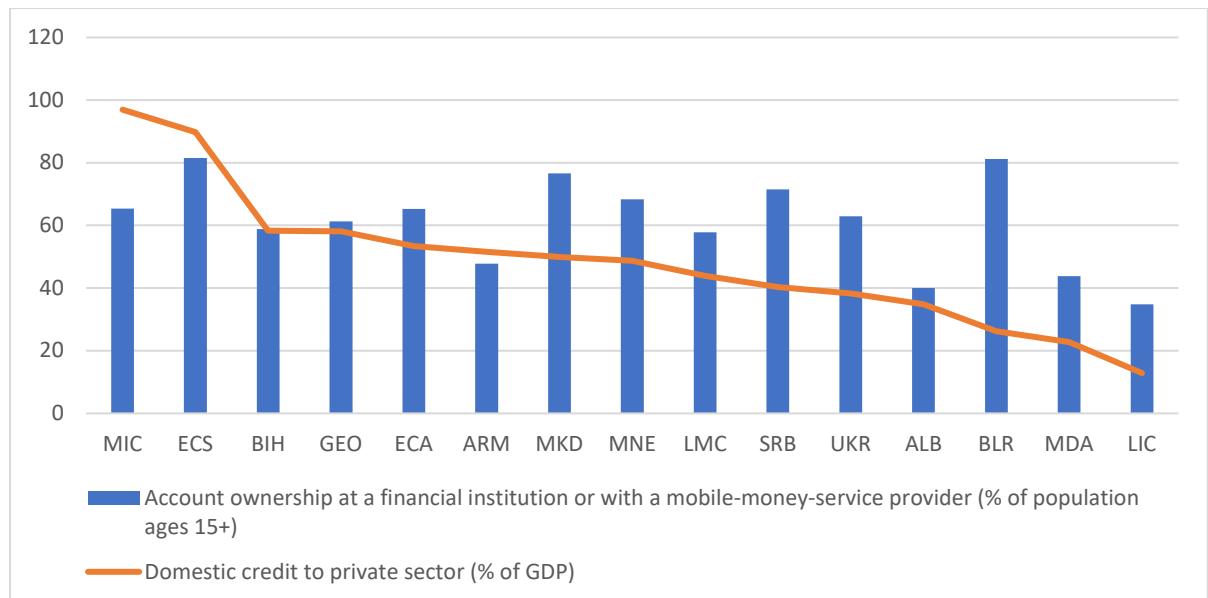


Figure 7: Financial infrastructure indicators

Source: World Development Indicators.

With respect to extension services, while they are present in rural areas and deliver knowledge that is in accordance with the modern needs of the sector, there are only few institutional linkages between agricultural research, extension organizations, education and training institutions, each having their individual agenda (Stratan et al., 2018). The National Agency for Rural Development (ACSA⁵) and the National Federation of Agricultural Producers “FARM” (former “AGROinform”⁶) are among the most active extension service providers in Moldova, both non-profit and apolitical organizations established under the aegis of projects funded by international donors beginning of the 2000s. Their activities are largely funded by donors including foreign governments or international agencies under projects which may also involve cooperation with foreign research institutes. Local research institutes are also collaborators at times but ACSA prefers to contract individual researchers in order to avoid the overhead costs

⁵ <https://acsa.md/?lang=en>

⁶ <https://www.agroinform.md/>

which are considered excessive. Box 1 provides an overview of the activities of ACSA, the

The National Agency for Rural Development (ACSA) was established in 2001 as an executive unit under the Rural Investments and Services Project (RISP) initiated and funded by the World Bank and the Government of Moldova. The main aim of the project was to establish a network of rural extension service providers in order to stimulate rural development in the country. The project lasted until 2012 and in 2013, ACSA began to be funded only by the Ministry of Agriculture and Food Industry (MAFI); this collaboration ended in 2016 and the agency has not received any funds from the Government since then. As such, over the past years, ACSA has been mainly financed by donors through projects, with a small share of its budget also coming directly from farmers who ask for extension. However, the Agency also provides pro-bono, informal advisory services at the request of farmers who may not afford their services. During its 20 years of activity, ACSA has implemented more than 100 projects with funding ranging from \$10k to \$5 million from the national government, World Bank, USAID, USDA, SIDA, UNDP, FAO, UNICEF, IFAD, CehAid, PolishAid and other donors.

ACSA is present in all Moldova's administrative territorial units (raioane) including the autonomous Gagauzia, through a nationwide Network of Service Providers of Rural Extension Services (RES); out of a total number of 430 consultants, 80 are based regionally, and 350 locally; the district and local offices are placed within the premises of local public authorities. All consultants have been trained as general practitioners but also specialize in various domains such as olericulture, animal husbandry, agricultural marketing and legislation, or agro-ecology; training to consultants has been largely made possible due to support from the World Bank or other donors during their first years of operations and has taken place within specialized institutions from abroad, including Romania, Czech Republic, Israel, or Poland.

ACSA's consultants provide about 250 000 services each year, out of which 3500 training seminars; more than 3000 written recommendations or specialized materials disseminated to stakeholders; 3500 round tables, and over 35 000 field visits. These activities are related to four main domains: i) modern technologies for crops cultivation and reproduction of livestock; (ii) agricultural economics (the management of agricultural holdings, business planning, bookkeeping, fees and taxes, etc.); (iii) agricultural marketing (mediation of agricultural inputs purchasing, facilitating the establishment of formal and informal groups of marketing and other farmers associations, etc.); (iv) and agricultural legislation (mediation and support provided at land transactions). Their annual portfolio of clients comprises about 300 000 small and medium agricultural producers or agri-food entrepreneurs of various sizes and legal organizational forms, as well as local public authorities.

The Agency reports that the main challenges currently faced by the agri-food sector are climate change issues impacting agricultural production; and constraints in accessing international markets.

Box 1: The National Agency for Rural Development (ACSA)

largest extension service provider in Moldova.

Source: Interviews with key stakeholders.

The weak connection between the scientific community and the business environment is recognised in the country's 2020-2023 National Program for Research and Innovation, an issue which was further confirmed by our interview participants. As a result, research bodies perform research that does not have links with the market and develop technologies that are not commercialized, further hindering the financial sustainability of their activities. According to Moldova's National Bureau of Statistics, only 13 percent of innovative enterprises have universities or research institutions as collaborators, while 28 percent indicated the equipment, materials, components or software providers as cooperation partners, 26 percent – other enterprises and 25 percent – clients or buyers (Moldova National Bureau of Statistics, 2018).

The poor cooperation between agribusinesses and research institutes can be attributed to many factors including: a general lack of demand for innovation from the industry due to low levels of knowledge about innovation and its importance for competitiveness; the lack of a culture of collaboration; low levels of absorption; and weaknesses in the business enabling environment. The long-time horizon for investments to pay off, makes R&D spending unattractive to both businesses and politicians. Further, one interviewed firm has engaged in such collaboration with a research institute but the project was deemed unsuccessful largely because of the overhead costs absorbed by the institute, with only 15 percent of the expenses dedicated to the actual research activities. On the research community side, networking and knowledge transfer activities are not valued since the evaluation and promotion of researchers rely mainly on scientific publishing.

Nonetheless, despite these challenges, it was reported that the business environment has become more open towards collaboration with researchers over the past years. As reported by the Institute of Genetics, Physiology and Plant Protection which every year engages in about 25 contracts with economic entities, their portfolio of clients is 60 to 70 percent comprised of local SMEs, typically family-owned agricultural producers who want to differentiate themselves on the market. Figure 8 shows that Plant Variety Protection applications⁷ have seen a slightly increasing trend over the past decade. However, to obtain EU recognition and avoid the costs of international registrations, at times patents are registered in Romania's registry.

⁷ Plant Variety Protection (PVP) is a form of intellectual property rights (IPR) for new plant varieties which is similar to patents (Srinivasan, 2004), and thus can be used as a proxy for domestic research capability in agriculture.



Figure 8: Plant Variety Protection (applications filled by)

Source: UPOV database.

Despite the low level of funding going into R&D activities and the weak industry-science linkages, there are interesting and dynamic projects related to innovation and technological transfer initiated by the civil society often with support from international donors; some examples are worth to be mentioned. For instance, InnoCenter (see Box 2) – a subdivision of Comrat State University (KSU) - acts as an intermediary between research and industry and was initiated by KSU to improve the competitiveness of the Gagauzia region. The Center mainly works with the agri-food sector and notes that it has always been the industry initiating the collaboration process and approaching them for innovation purposes and never researchers wanting to commercialize their R&D outputs. The main constraints to its activities are the low demand for innovation particularly since the region is characterised by micro-enterprises with limited resources and a poor understanding of research; and also a prevalent lack of financing for innovation purposes – since the transition to project-based model of innovation in 2018, there is no institutional funding available for the Center.

Moldova can learn from other countries' practices with respect to models of industry-science linkages in the agri-food sector. Ireland provides some examples of alternative thinking with respect to promoting linkages and innovation in the industry. Up to the 1970s, the Irish agri-food sector held a number of similarities to Moldova, including its economic reliance on agriculture, dominance of smallholders, aging farming population, and limited access to opportunities for value addition. During the 1990s, the food sector began its transformation, ultimately becoming a global leader in food safety and traceability, and entering high-value markets around the world. The transition was the result of multiple drivers, policy actions and investments; some notable actions or practices are presented in Box 3. In particular, Ireland has integrated multi-stakeholder collaboration into the institutional mandate of agri-food relevant actors, including the Food Safety Authority, the research institute responsible for agricultural research - Teagasc, and the Irish Food Board. In order to tap into export markets,

Ireland's strategy has been centred around two key aspects: ensuring the safety and quality of agri-food products "from farm to fork"; and feeding consumer demand back into the industry with its agricultural research institute being responsible for translating consumer insights into knowledge that can be assimilated by farmers and agri-businesses.

InnoCentre was established in 2012 as a subdivision of Comrat State University (KSU) of Moldova; its activities are governed by the law "On Science and Technology Parks and Innovation Incubators" and are directed at increasing the competitiveness of Moldova's Gagauzia region through the development of high-tech SMEs, commercialization and transfer of science-intensive technologies. Its activities are diverse and involve not only brokerage services but also the provision of an online lifelong entrepreneurship education programme for SMEs; launching a Digital Innovation Hub in 2020 with various partners, organizing round tables, conferences, and general networking activities for SMEs and the science community; provision of an Agrochemical Laboratory; the development of innovation infrastructure projects in cooperation with the local public administration. Among its partners are the Government of Moldova, the National Agency for Research and Development, the Investment Agency of Gagauzia, and the Technical University of Moldova.

Throughout its eight years of operation, the center has played an important role in matching demand of the business sector with the available technology and innovation at the Universities and Research Institutions. The Center fosters cooperation between firms and R&D providers through an understanding of the enterprise's expertise needs, followed by a mediation action between the industry and the relevant science actors. Once the technological solution is found and financial component agreed by all parties, InnoCenter prepares the project and applies to NARD competitions; in 2020 they have won two out of three projects.

Since 2017, the center has been mainly working in relation to the agri-food sector. Some innovative projects they have been involved in include: the implementation of an energy efficiency project in wine production; the introduction of a technological line for the processing of grape pomace for waste-free production; a study of modern processes for obtaining cheeses with a high content of omega fats; the development and implementation of technology for the production of gelato with increased nutritional and biological value; or the development and implementation of innovative drying technology for aging beef.

The Center is financing its operations through participation in NARD project competitions and fees charged for providing services to companies. However, finance is still a challenge and six to seven people work on a semi-voluntary basis; most are employed by the university and perform activities in InnoCenter as volunteers with some potential additional revenue – up to 10 percent of salary - when winning projects within NARD competitions. With the country's transition to a competition-based model of research and innovation in 2018, institutional funding is no longer available from NARD.

InnoCenter remarks that only people with PhD titles can teach at universities in Moldova, impeding practitioners from sharing their expertise in different fields. They would thus like to establish a Competence Centre that would provide informal education (lectures taught by the practitioners, businessmen) mainly to young people on topics of local priority such as IT or agri-food.

Box 2: InnoCentre linking research and industry in the Gagauzia region

Source: interviews with key informants.

In 1997, the first multistakeholder collaboration for developing agri-food sector policies was launched and has been a key policy instrument since then. The entity in charge of the strategy is a High Level Committee, chaired by the Ministry of Agriculture, and has the mandate to negotiate the objectives and actions for the coming period and also oversee implementation and ensure cross-sectoral alignment. The 2025 strategy, for instance, was developed by such a committee consisting of 35 leading figures from research organizations, business schools, private sector including multinationals and local food firms, government agencies, farmer community, retail and nutrition groups. Members were selected based on a number of criteria that included having in-depth knowledge on sub-sectors but also an ability to see the big-picture.

While Ireland benefits from the presence of strong farmer organizations, consumer representation has been weak. As such, during the early years of the development of the food strategy, the committee has turned to companies such as Tesco and Sainsbury for consumer intelligence with the help of the embassy network in Britain. In the continued absence of strong consumer associations, the strategy committee relies on the country's Food Marketing Board which is responsible for developing consumer insights.

Due to its size, the committee was divided into five groups covering: meat and cereals; milk and infant formulae; seafood; prepared foods, horticulture, beverages and retail; environment, forestry and climate change. Key factors in the success of the strategy have been having clarity on responsibilities, a well-respected chair able to achieve consensus and also annual progress reports on achievements against the targets set which also have placed pressure on various units to deliver. Further, the wide-stakeholder involvement means that the strategy is able to resist government changes and is also protected from political interference. Back-to-back strategies are also more likely to build upon the success, and address the weaknesses of the previous period. To obtain industry buy-in, the Ministry had to clearly communicate to businesses the benefits of getting involved.

To stimulate partnerships and avoid fragmentation or isolation of activities, the country has integrated stakeholder collaboration into the mandate of relevant agri-food institutions including the Food Safety Authority of Ireland (FSAI), the Agriculture and Food Development Authority (Teagasc) and the Irish Food Board (Bord Bia). While these institutions have different responsibilities with respect to the agri-food sector, they are nonetheless well-connected with all relevant stakeholders including farmers, businesses and the research community.

The establishment of Ireland's Food Safety Authority (FSAI) in 1998 was a key factor in launching Ireland's success. FSAI actively engages with the industry, scientists, consumers, the civil society and other government agencies to uphold Ireland's food safety credentials which are seen as a non-negotiable prerequisite. Through the establishment of the agency, the Irish government has prioritized safety standards and the traceability of agricultural products from farm-level to retail shelves. A high-quality food safety compliance system has enabled the country to enter high-value agri-food markets in Asia, the European Union and the United States.

Teagasc is the institute responsible for agricultural research, as well as advisory and education services to the sector and rural communities; seventy percent of Teagasc's funding comes from the government whilst the remaining thirty percent is earned from research contracts, or extension fees and trading income. Its priorities are set by 11 members appointed by the Ministry for Agriculture, Food and the Marine who are representatives from the farming organisations, the food industry, the universities, the Department of Agriculture, Fisheries and Food and Teagasc staff. Teagasc has seven research centres based around the country, each focused on different parts of animal or food production sectors in Ireland.

As opposed to academic institutions, all research conducted within Teagasc must consider the consumer insight to ensure that findings have links to market demand and that the scientific output can be commercially exploited. Teagasc is also responsible for translating research results and evidence into information that can be easily assimilated by farmers and companies. The collaboration with the industry is facilitated through the development of a technology market portfolio which is updated on a six-month basis. Agri-food businesses can use the portfolio to become familiar with products and tools such as novel technologies, technical services, pilot plant facilities, and key contact points. Further, Food Innovation Gateways events are organized twice per year to bring Irish food companies together, and facilitate their engagement with Teagasc.

Box 3: Ireland's multi-sectoral approach to agri-food sector development

Source: Brower et al. 2021; FAO, 2019; Kelly and Ilie, 2018.

4. Technological upgrading in the context of poor industry-science linkages

A better understanding of technological upgrading in Moldova's agri-food industry requires a look at several trends following liberalization. With the fall of communism, the former state-controlled agri-food chains had begun a process of privatization, price liberalization, and international exchanges, increasing the participation of the post-Communist nations in world trade (Swinnen and Maertens, 2006).

The reform process induced significant FDI flows in retail, triggering a dramatic increase in the share of supermarkets in the CEE (Dries et al., 2004; Dries and Reardon, 2005). Similar to other developing regions (Reardon et al., 2003), the traditional retail system comprising small shops and open-air or central markets, entered a process of dissolution in favour of a modern sector consisting of supermarkets, hypermarkets and discount stores⁸. As these foreign investors transfer their business models to the host market (Gow and Swinnen, 1998; Walkenhorst,

⁸ There has been a growing scholarly interest on the 'supermarket revolution' in developing regions; examples include Reardon *et al.* (2003); Neven *et al.* (2006); Reardon and Hopkins (2006); Reardon, Timmer and Minten (2012).

2010), they start imposing food quality and safety requirements that are often higher than national standards (Dries et al., 2004; Gorton and White, 2007; Hanf and Pieniadz, 2007).

Dries, Reardon and Swinnen (2004) provide one of the few studies on the transformation of the retail industry in the region. The authors categorise countries according to the year they entered the retail globalization process; countries such as the Czech Republic, Hungary, and Poland belong to the first “wave”, and have experienced a rapid expansion of their modern retail sector – from 5 percent of food retail in the mid-1990s to 40-50 percent by 2003. Croatia, Romania and Bulgaria pertain to the second “wave”, reaching about 20-30 percent by 2003. And last, the lower income countries of Europe such as Ukraine and Russia are third “wave” countries where the increase was negligible. The trend observed by the authors is that retailers first penetrate the best prospect first wave countries, establish their procurement system for the region as a whole, and then move into second wave and lastly, third wave countries. While not examined in the study, it is pertinent to assume that Moldova belongs to the third wave category, expecting increased investments from the modern retailers already established in the region.

Indeed, large supermarkets are now on the rise in Moldova; Arndt & Lozan (2021) report that in 2020, the supermarket turnover jumped for the first time over the 50 percent mark of formal food retail; Kaufland, for instance, has entered the country in 2019, and already established a second store in 2020. The rising trend is reflected in the fact that small producers are losing domestic markets in which they previously held strong positions due to being unable to meet the new stringent requirements (OECD, 2020). According to OECD Enterprise Surveys, Moldovan SMEs face important challenges in supplying to modern retailers and accessing foreign markets; only 50 percent of SME food processors supply to supermarkets and more than 40 percent do not generate any turnover from exports (OECD, 2020). Several of the most widespread constraints that agri-food processors face are: ineffective or inappropriate market governance; challenges in procuring agricultural raw materials; increasing stringent demand from international markets; limited managerial skills or lack of export support programmes (OECD, 2020; White and Gorton, 2005).

These challenges, however, highly differ according to commodity sectors and value chains. Several of the most dynamic value chains in Moldova today – such as the wine, horticulture or organic sectors - have benefitted from FDI and/or significant donor support over the past decades.

Foreign investment played an important role early during transition as an initiator of institutional innovation in the value chain. The initial privatization and reorganisation of farms and companies in the agri-food sector disrupted relationships along the chain, leading to constraints in accessing inputs and selling products (Swinnen, 2005a). Non-payments or long payment delays, low quality of supply, along with poor legal enforcement, created an impetus for agri-food companies - mostly large and foreign ones - to increasingly adopt vertical contracting with suppliers in order to gain greater control over farm-level production. In this context, FDI in food processing and retail has triggered the expansion of contract farming in the CEE which involved farm assistance under the form of inputs, credit, and extension services, in return for guaranteed quality and supply (Swinnen, 2005a; Swinnen and Maertens, 2006; Gorton and White, 2007; Swinnen and Demuth, 2011)

This trend has also been confirmed for Moldova's wine/brandy, fruit and vegetables and sugar sectors by White & Gorton (2005). The number of support measures offered by processing firms to farmers through contract farming was particularly higher in Moldova than in Russia and Ukraine, perhaps reflecting the higher level of FDI and the orientation of these sectors to international markets; credit was the most widely used support measure in the country. The authors find that these farm-processor contracting schemes have indeed led to improvements in agricultural yields and the quality of output. Follow-up research can be conducted to understand how these arrangements have progressed since White and Gorton's initial study, along with other analyses on the potential that contract farming holds in different sectors in Moldova.

Several of the sectors examined above have also benefitted from significant donor support over the past decades.

Williams (2020) provides a comprehensive overview of Moldova's wine industry trajectory. Following liberalization, USAID made significant investments in Moldova's wine industry; the sector started to take off only after land distribution⁹ obstacles were overcome which took more than a decade. As such, in 2005, USAID followed with another 10-year programme largely aimed at strengthening Moldova's wine sector competitiveness and enhancing its position in the global market; this also included bringing a team of international wine experts to establish objectives to improve enology and viticulture while also reducing systemic corruption and bureaucratic red tape. Moldova's National Office of Vine and Wine (ONVV) reports that continuous investment from USAID has been essential in improving quality; 30 percent of vineyard area has been modernized and parallel measures also being taken in wineries. The total investment in the industry has been \$600 million over ten years. Even more, in 2008, USAID contributed to the enactment of the Small Wineries Association which is reported to produce some of the best wines in the country. The association also advocates for lessened and cheaper certifications procedures for small winemakers via the Wine of Moldova lobbying platform (USAID, 2020). Along a whole decade of work, independent producers have also found that progress can be achieved by working together; whereas about 15 years ago, the sector was characterised by the presence of many small producer associations, today these have merged only into a couple. The only Moldovan products protected by Geographical Indication certifications belong to the wine industry (EU IPO, 2021), standing as proof for the success of the sector relative to the others in the country.

Horticulture is another sector which has been heavily supported by donors along the years (UNDP, 2013), now emerging as one of the most dynamic agri-food sectors in Moldova; the Fruit Garden of Moldova programme is one such recent initiative. Moldova Fruct is the largest association advancing the interests of the sector and consists in more than 180 members who

⁹ The Land Privatization Support Project in Moldova, funded by USAID started in 2003 and aimed to address land title problems that occurred after the privatization of agricultural land and the registration of private land ownership. During the implementation of the project, requests were received to address agricultural land fragmentation. In response, consolidation activities started with a pilot project in a village the Southern part of Moldova. Over 200 landowners participated and around 160 ha were consolidated via 25-year lease agreements to a single winery. One hundred new jobs for the villagers at the winery were promised as a result. Several other similar projects followed in other areas (World Bank, 2006).

are producers or processors of fruit. As opposed to most agricultural commodities in Moldova which are dominated by small farms, fruit plantations are concentrated on larger holdings (World Bank, 2015). Since this is a sector characterised by large producers, standardization has not been a challenge for them as they are sufficiently large to afford the expenses associated with international or multiple standards.

Berry producers, on the other hand, are mostly small in size and report that the main challenge in the sector is the double certification required to export produce into the high-demand markets of the EU. The sector has also benefitted from extensive donor support which have facilitated value chain coordination. However, Moldova still makes use of the Soviet GOST standards (*Gosudarstvenny Standard*)¹⁰ which were reported as being outdated and also costly to be met by a small producer; there is no special regime in place to make it easier and less expensive for SMEs to obtain certifications, an approach often adopted by other countries. Obtaining international certifications such as ISO or GlobalGAP is virtually impossible for many food SMEs because of the costs involved; one company pursuing the ISO noted that UNDP support was pivotal in this case. While the country's SME Agency also provides support, there is less bureaucracy involved in working with international agencies.

The organic sector is another dynamic sector which has achieved a good extent of value chain coordination due to both donor support and private investment (see Box 4, and Arndt and Lozan, 2021 for such examples) led by increased demand from international markets; the sector is now impeded from growing mainly by constraints in legislation. There have been efforts from the side of the government to improve the regulatory framework such as by introducing the Law Nr.115-XVI on Ecological Agro-Food Production (Government Decision No. 149) in 2005 which includes protections on the word "organic" based on EU regulations or regulations on the methods of organic production. In 2008, the "Organic agro-food production and labelling of agro-food products" regulation was also introduced, requiring certification bodies to be accredited in accordance with the European standards. Despite these efforts, however, Moldova's organic certification system is still behind the requirements of major organic export markets, creating an additional burden for firms who have to individually apply for the certifications imposed in their destination markets (UNEP, 2018). Organic producers in Moldova are thus in need of double certification by both Moldovan and EU-accredited certification bodies to be able to export and benefit from subsidies for organic production (Arndt and Lozan, 2021). One respondent emphasizes that the legislation and lack of government support and communication is the main problem hindering the growth of the organic sector noting that if they were based in Romania but still procuring raw materials from Moldova, their business would grow two to three times in a short period of time.

¹⁰ With Moldova's approximation to the European Union, the country initiated the process of identifying and withdrawing the GOST standards and original Moldovan standards (SM) that were conflicting with European and international ones or were technologically outdated; about 14 300 GOST standards were withdrawn in the period 2012-2017 but the process is still ongoing (Socol et al., 2017). Further progress has been made recently in this area, with the European Commission having authorised Moldova to export milk and dairy products to the Union (Moldova National Agency for Food Safety, 2021).

Prograin Organic is the first Moldovan company which has invested in the value chain of organic grains, seeds and pulses in the country. Their business approach has been to integrate in the whole value chain from the farming level to the processing; measures provided by the company to farmers through contract farming arrangements include input supply for the organic cereals cultivation (seeds, fertilizers, biological plant protection products); assistance and monitoring of the certification process of fields cultivated in organic system; ensuring of collecting and storing logistics of the organic cereals; investment in organic grain processing lines; access to the markets of organic cereals; exports of products both on trucks, and on ships and barges. The value chain integration has started with investments in infrastructure with the help of the Netherland Enterprise Agency.

Box 4: Moldova agribusiness investing in value chain coordination

Source: Interviews with key informants.

The entrepreneur behind MoBerry came up with the idea for “fruit leather” inspired by her childhood in the Caucasus where this is a household traditional product. The product is made by women in the villages who crush the plums, turn them into a paste and then stretch it in a single layer on a wood board which is then left to dry in the sun. The product is traditionally produced from apples and plums but the business improved the recipe, enhancing it with quince and adding various other fruit (raspberry, blackberry, currant, chokeberry, sea buckthorn, wild rose); what conserves product is its dryness, so there are no artificial preservatives. As such, it is a 100 percent natural product and can also be consumed by diabetics and vegans.

The firm conducted taste rounds with potential consumers, then submitted the product for conformity testing to the Institute for Food Technologies in order to obtain the national mandatory certification and develop the branding. The entrepreneur notes that the regulatory framework in Moldova is not conducive to the operations of food SMEs which often cannot assume the costs associated with obtaining safety and quality standards, even the mandatory national ones. MoBerry is now pursuing the ISO certification with financial support from UNDP.

Source: Interviews with key stakeholders.

Box 5: Product innovation in Moldova's agri-food sector

Businesses in these sectors now pursue to differentiate themselves on the local and foreign markets based on quality aspects (including product or process innovation based on traditional methods or local varieties), pursuing certification schemes such as ISO, BIO, or GIs (as seen in the case of wine above) – see Box 4 and 5 for such examples. Competing on quality

characteristics is only possible because some extent of value chain coordination has been achieved due to the efforts described above; quality certification schemes require efforts from all actors in the chain including processors, farmers, logistics providers and distributors who jointly agree on, and comply with collective rules for quality purposes.

Nonetheless, even in its most dynamic sectors, Moldova still has much work to consolidate its position on the world market; for instance, wineries still suffer from limited resources to dedicate to marketing, and have to rely on commercial bank loans with high interest rates, putting them at disadvantage compared to their international competitors (UNECE, 2017), thus impeding Moldova from developing a local brand on the international market. Further, there are still important lacunas in legislation, particularly for SMEs which cannot bear the high transaction costs imposed particularly with respect to obtaining standards certifications.

Additionally, those actors who have managed to mobilize themselves in these industries report that communication with the government has been a hindrance. As noted in Box 3, it was specifically the inception of dialogue among all three sectors – public, private and civil – that has triggered the transformation of the agri-food industry in Ireland. The Smart Specialization¹¹ exercise in Moldova stands as proof for the absence of governmental actors from the dialogue with the private sector and the general lack of cooperation culture in the country – see Box 6 (Ilie and Radosevic, 2021). These challenges are added to the well-known farm-level constraints such as unfinished land consolidation, small size of farmers, climate change affecting production, unfavourable demographic trends (e.g. aging of farmers) - all of which increase the transaction costs for agri-food firms on the supply side, and impede them from growing despite their relative success. Furthermore, any growth experienced so far has generally not translated into sustainability outcomes; poor access of rural women to high quality jobs, low wages in agriculture and high rural-urban disparities and migration, are still prevalent issues.

¹¹ Smart Specialisation (S3) is a place-based approach to innovation policymaking, characterised by the identification of strategic areas for intervention based on the analysis of the strengths of the economy and also on a continuous engagement with stakeholders, including the private and civil sectors. S3 is adopted on a voluntary basis by the countries interested in applying it, who will receive methodological support from the European Commission to do so; Moldova registered to the Smart Specialisation Platform at national level in 2016. The priority areas identified by the country are Energy, ICT, Agriculture and Food processing, and Biomedicine and Biopharmaceuticals. S3 forms an important part of the National Programme for Research and Innovation for the period 2020-2023 which is under the mandate of the Ministry of Education, Culture and Research (European Commission, 2021b).

There have been attempts at opening up the dialogue for policy purposes in Moldova as part of the Smart Specialization Programme. Within the agri-food thematic area, discussions were mainly captured by research institutes and many actors were missing from the dialogue despite their important role with respect to innovation in the sector including relevant ministries; extension providers; food safety authorities; or farmer organization representatives. Nonetheless, it was also noted that despite a general reluctance to discuss or collaborate, there are always some actors who are willing to. The networking opportunity was appreciated by participants and there is evidence that the S3 workshops resulted in collaborations between the industry and research community; some active actors identified are the Moldovan Chamber of Commerce and Industry, the Lavender Association or research institutes within the agricultural domain (Ilie and Radosevic, 2021).

In some sub-Saharan Africa countries characterised by a lack of public-private dialogue, the involvement of the private sector has been stimulated by documenting success stories, disseminating them and using experiential learning and field visits (FAO, 2019). Thus, showing concrete results from the first round of S3 could encourage actors to build trust and get involved in further iterations.

Box 6: Opening up the policy process for the transformation of the agri-food sector

5. Conclusions

The weak industry-science linkages in Moldova's agri-food sector are due to multiple factors including low levels of business sophistication resulting in low demand for innovation but also the lack of incentives in the research community for connecting with the industry. Further, spending on agricultural R&D is unattractive because of the long-term horizon of its benefits and the more urgent issues that are prevalent in the sector, such as the outdated legislation and obsolete equipment. However, international evidence points to the fact that to ensure the long-term sustainability of its agri-food industry, there is an imperative need for Moldova to redress its perspective on agricultural R&D. Currently, this does not represent a government or business priority and the issue has even been losing importance over the past decades.

The country can learn from international best practices which have made agricultural R&D work in deficient environments. These include, for instance, establishing institutional autonomy for agricultural research institutes; providing incentives to scientists for pursuit of knowledge that is directly relevant to the local context (e.g. plant breeders being remunerated based on the plantation of varieties they develop); diversifying sources of financing to ensure more stable budget (e.g. through producer levies); establishing public-private partnerships to make sure R&D efforts match the needs of farmers, agribusiness and consumers alike; connecting institutes and farmers to global knowledge such as by linking their national research programs with the CGIAR (Consortium of International Agricultural Research Centers) (Fuglie et al., 2019). Ireland's experience in particular, showcases the importance of feeding consumer insights back into agricultural research and translating market intelligence into knowledge that can be assimilated by farmers and agribusinesses.

These investments will only materialize in the long-term but international evidence points to the fact that they will pay off both socially and economically. Public R&D should also reflect wider societal goals taking into account the specific challenges that Moldova faces - for instance, climate change is nowadays of particular concern to the country's agricultural production. Another specific problem is the loss of humus content - about 0.7 t/ha of humus, accumulated over millennia, is lost annually in Moldova due to unsustainable farming practices such as intensive cropping with tillage and no crop rotation (Arndt and Lozan, 2021). Extension providers undertake the dissemination of technologies dealing with such challenges, but these are limited to donor projects and generally disconnected from the national research community.

Any R&D investments will also need to be integrated into holistic policy packages which aim to fill in weaknesses in complementary inputs such as rural infrastructure or extension services. The country also faces brain drain; agricultural sciences in particular are not attractive to young people, having experienced a decrease in the number of researchers over the past decades. In this case, Master or PhD programmes could be initiated by the academia in collaboration with the industry to ensure that skills respond to the modern-day needs of the sector but also that jobs in agricultural sciences are more attractively perceived by the youth.

Nonetheless, innovation in the agri-food sector is not only driven by R&D. As discussed, agri-food value chains have played a key and largely overlooked role in the economic transformation of less developed economies; governance innovations (such as contract farming) in these chains have often induced the adoption and diffusion of agricultural technologies, at times generating structural transformation. Achieving food safety and quality which is key in accessing international markets relies on value chain coordination. Currently, investments by food businesses in food safety and quality are cumbersome and costly, particularly for SMEs; as such, government intervention will be needed to guide and oversee adherence to good practices, especially given the increasing complexity of standards demanded by globalized value chains.

As Reardon et al. (2019b) notes, governments and donors in developing countries do not need to “reinvent the wheel” to stimulate the growth of the agri-food sector. Improving basic conditions to reduce transaction costs through infrastructure and policy will stimulate private sector investment, particularly from processors in the middle of value chains. As evidence points out, these actors will invest in rural areas, add value to agricultural products, connect farmers with urban demand, provide off-farm employment and contribute to other development objectives such as food nutrition and security. Nonetheless, the achievement of sustainable development goals needs to be safeguarded by the government and donors such as by providing incentives to agri-food processors to green their operations. Building on green reputation can also allow the sector gaining a premium, particularly from Western consumers who are increasingly placing value on sustainability aspects.

So far, technological upgrading along certain value chains – particularly wine, sugar, berries and other horticultural, and some chains within the organic sector – has been largely triggered by FDI and/or supported by international donors. In these sectors which have achieved a certain extent of value chain coordination and basic quality and safety, there is evidence of incremental innovations emerging as firms pursue quality certifications such as GIs, BIO or ISO. Their growth now depends on further improving the regulatory framework to reduce transaction costs particularly as they seek more supply of raw materials. Several of them such as large producers or associations, have managed to lobby and change legislation in their favour. However, food SMEs which inherently face higher transaction costs than large ones, still suffer from lacunae in legislation and have to rely on donors or fragmented SME programmes for financial support.

Overall, there are dynamic initiatives occurring nationally with respect to industry-science linkages, value chain coordination, or other horizontal associations, but these remain fragmented and isolated. The government or donors could tap into the presence of these islands of success in the country and connect institutions or dialogue fora that do not typically communicate with one another. These include, for instance, producers organizations in the wine, organic and horticulture sectors; innovation brokers such as InnoCenter which benefit from good connections with the industry and research community alike; extension providers such as ACSA which has established far-reaching relationships with farmers; the Chamber of Commerce which represents the interests of businesses; lead firms such as retailers or agri-food processors who are investing in value chain coordination; or other relevant actors that have been active in the policy dialogue within the Smart Specialization programme. As Ireland’s

case has shown and also the experience of other developing countries (Loconto et al., 2017), good leadership is essential for mobilizing actors and facilitating collective action. Integrating multisectoral collaboration into the mandate of key agri-food organizations such as research institutes, or food quality and safety authorities, can also trigger dialogue and facilitate the development of a shared vision and ownership over the strategic direction of the sector. Eventually, multisectoral efforts could converge into a hybrid-governance institution responsible for representing the interests of the industry and undertaking the promotion, development, and marketing of Moldovan agri-food products domestically and abroad.

Documenting success stories resulting from existing dialogues, disseminating them widely, and using experiential learning, hold the potential to build credibility and trust, ultimately stimulating other actors to join efforts for the transformation of the agri-food industry in the country.

Table 2 summarizes some key recommendations based on the above analysis.

Table 2: Key recommendations

Recommendation 1: Improving basic conditions to reduce transaction costs for agribusiness.
The lack of effective standards and certification systems and the weakness of broader legal systems limit the development of markets for high-quality produce. Further, as firms grow, they will seek more supply of raw materials which can be addressed by investments in infrastructure and the right regulatory framework.
Actions
1.1 Strengthen the oversight system and establish a harmonized system of traceability from farm to fork that is widely understood and utilized by actors in the value chain.
1.2 Introduce a food safety and quality certification system that is sensible to the needs and financial possibilities of SMEs.
1.3 Invest in the farming sector and rural infrastructure to ensure that buyers (e.g. processors) can obtain the needed quality and quantity as they seek more supply of raw materials.
Recommendation 2: Improving industry-science linkages.
Little public investment in agricultural R&D, low levels of business sophistication and the lack of incentives in the research community for connecting with the industry, have resulted in very weak science-industry links. To ensure the long-term sustainability of its agri-food industry, there is an imperative need for Moldova to redress its perspective on agricultural R&D.
Actions
2.1 Increase the public budget for R&D in agricultural sciences.
2.2 Explicitly include environmental and social challenges that are specific to Moldova within the criteria for the selection of projects funded under NARD.
2.3 Provide incentives to scientists for pursuit of knowledge that is directly relevant to the local context, the needs of agribusiness and demand from consumers.
2.4 Establish mechanisms to feed consumer insights back into the industry and to translate market intelligence into knowledge that is easily understood by farmers and agribusinesses.

2.5 Invest in the capacity of agricultural research organizations to broker innovation and clarify the role of researchers in multistakeholder processes.

2.6 Raise awareness among agribusinesses about the benefits of research such as by organizing networking events, open days or field visits.

2.7 Update university curricula based on the needs of the industry.

2.8 Attract young researchers in agricultural sciences such as by establishing study programmes (Master's, PhD) in close collaboration with the industry.

Recommendation 3: Facilitate the development of a shared vision and ownership over the strategic direction of the agri-food sector.

Moldova benefits from dynamic initiatives with respect to industry-science linkages, value chain coordination, or other horizontal associations, but these remain fragmented and isolated. The government or donors can support the mobilization of these various networks to enable them join up efforts for the development of the agri-food industry.

Actions

3.1 Establish a dialogue forum for the industry's most active actors that typically do not communicate with one another. Use a leader – either based on moral authority or market authority – to trigger dialogue, seek consensus, balance power differences, and build collective commitments among actors. Use lead actors such as extension providers or large retailers/processors as leverage points to reach smallholders or SMEs.

3.2 Invest in the capacity of relevant agri-food actors (research institutes, extension providers, food safety and quality agencies) to engage in, and facilitate group processes.

3.3 Develop policies for agri-food sector development by using inputs from such a forum.

3.4 Establish avenues for sharing success stories, lessons and experiences to demonstrate the value of collaboration.

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Annex 1

List of interviewees

Tudor Robu	Food and Agriculture Organization, Moldova office
Anatolie Fala	National Agency for Rural Development (ACSA)
Alla Levitcaia	InnoCenter
Moldova Competitiveness Project (MCP) representatives	
Aneta Ganenco	Berries of Moldova Association
Tekwill representatives	
Spartac Chilat	Prograin Organic
Igor Malai	Ministry of Agriculture, Regional Development and Environment
Vadim Iatchevici	National Agency for Research and Development
Larisa Andronic	Institute of Genetics, Physiology and Plant Protection