Feeding North America through Agricultural Extension

A Report from the North American Agricultural Advisory Network (NAAAN)

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Introduction

Global Networking in Agricultural Extension

Modern agriculture is a knowledge and information-intensive industry. Nowhere is this more evident than in North America. Science-based knowledge and innovation has driven agricultural progress across the continent—from the wheat breakthroughs of the Green Revolution in Mexico to the mechanical and biological intensification of farming across the fields of northwestern Mexico, the United States, and Canada. These three countries have undergone enormous investments in agricultural research accompanied by substantial growth in agricultural extension. These efforts in turn provide research-generated knowledge and information to increase productivity and profitability across farming communities.

In order to build upon scientific advances and feed a growing population, the need to coordinate the work and knowledge of the extension community globally was identified. In response to this need, the Global Forum for Rural Advisory Services (GFRAS) was established over a decade ago to develop a network of agricultural professionals specializing in the "last mile delivery" to farmers and farming families worldwide. Since its establishment, GFRAS has built a global network of agricultural extension practitioners that has enjoyed enthusiastic participation from its regional networks and advisory service stakeholders in their respective countries. Collectively, the GFRAS's 17 regional networks cover virtually every country in the world.

The Need for a North American Agricultural Advisory Service Network (NAAAN)

Prior to 2020, North America was not a formal member of the global GFRAS network. GFRAS members and partner networks signaled a strong interest in having more opportunities to learn about agricultural advisory services in North America. Accordingly, the leadership of GFRAS suggested the formulation of a North American network to provide a more robust interface and link to extension services globally and share unique perspectives from Canada, Mexico, and the United States. Agricultural leaders in North America were also interested in developing such a network—interaction between the agricultural extension programs of North America, and between the North American agricultural extension programs and the rest of the world was needed. After consultation with all three countries, the North American Agricultural Advisory Network (NAAAN) was formed in 2020.

The NAAAN is the newest of the GFRAS regional networks. The NAAAN Secretariat is hosted by the Colorado State University System (CSUS) and is guided by the NAAAN Steering Committee which is constituted of agricultural leaders from each of the three North American countries.

With the establishment of the NAAAN, a partnership platform has been created among the three countries to: (1) interact and share knowledge and information on agricultural extension programs and practices; (2) develop opportunities for networking and partnerships among stakeholders in North America and with counterparts worldwide; and (3) develop and utilize lessons from research, analysis, experience, and education to create policy advocacy related to agricultural extension and to give voice on extension-related issues for farmer groups and other vital stakeholders. The NAAAN seeks to heighten the discussion among the communities

of practice within the three countries to understand the unique perspectives of each vis-à-vis agricultural extension and related topics of importance. The three thematic areas chosen for shared networking, research, and information exchange for the NAAAN include:

- Biodefense and Biosafety—the NAAAN will coordinate with public and private partners to help mitigate the risk of diseases, natural disasters, and a changing climate;
- Soil Health and Water Management—the NAAAN has an essential role in soil health and water management guidance to limit the effects of climate change on food production; and
- Empowering the Next Generation of Leadership in Agriculture—Working with our partners, the NAAAN will cultivate the next generation of skilled, diverse, and inclusive leaders through career and skill development.

Reviewing Agricultural Extension in North America – A Mapping Exercise

In the summer of 2021, to develop baseline information for the NAAAN's activities, a qualitative and comparative overview of the agricultural advisory service systems in Canada, Mexico, and the United States was conducted. The development of this comparative overview became known as the NAAAN Mapping Exercise. The survey reviewed important characteristics of the publicly supported agricultural advisory services in each country and described and compared the institutional landscapes and historical origins; extension approaches; areas of focus; relationship to agricultural research institutions and agricultural education and training institutions; and sources of funding.

As part of the Mapping Exercise, a country-specific survey was developed and carried out by the NAAAN Secretariat and the Institute for Research in the Social Sciences (IRISS) at Colorado State University (CSU). The NAAAN Country Survey solicited information, comments, and views from agricultural advisory/extension experts from each of the three countries to learn how publicly supported agricultural extension programs are structured and operated. The survey was sent to more than 500 expert recipients across Canada, Mexico, and the United States. Responses were received from 170 participants: 51 from Canada, 64 from Mexico, and 55 from the United States. The full survey and responses are found at the end of this publication.

In addition to the country surveys, teams of experts in each country developed reports telling the unique story of the evolution of extension services in Canada, Mexico, and the United States. These reports capture publicly supported agricultural extension efforts from the perspectives of the content experts and demonstrate somewhat contrasting programs in the three North American countries. Much can be learned from the contrasting experiences chronicled in these reports.

The countries share a variety of challenges to provide extension services, including:

- the definition of the role of publicly supported extension programs with the rapid emergence of private advisory services;
- the evolution of the role of public extension as farming changes in addressing the needs of poorer rural communities and small farms, and how this contrasts with the needs of larger farms and wealthier rural communities; and
- the need for extension to address new topics and challenges such as adaptation to climate change, putting more focus on inclusivity (gender, youth, etc.) in the rural sector, and supporting more effective methods for dealing with bio-security issues.

The information generated through this collection of reports represents a first-time collective contribution from North American farming, research, and extension communities of practice. Together this information

forms the basis for future programmatic activities for the NAAAN. Country convenings and discussions held in 2022 will delve further into the issues raised and the information shared in these reports. This additional information will provide an opportunity to build collaboration, partnerships, and an enriched agricultural advisory service community of practice that operates across the borders of the three countries of North America. The possibility of developing greater collaborations in extension across national borders in North America is an opportunity that remains largely untapped. NAAAN will build from the discussion generated by this collection of reports to launch an exploration to tackle the challenges we face to create stronger coalitions for food security.

NAAAN ex officio leaders

The Honourable Marie-Claude Bibeau, Minister of Agriculture and Agri-Food, Canada

"Improving the world's agricultural businesses and networks relies on effective knowledge sharing and collaboration. We are building a closer partnership between agricultural producers and stakeholders in Canada, the United States, and Mexico through the NAAAN. This study identifies the gaps that exist in agricultural information and research and will add value to the tools available to the agricultural sector across our three countries."

Secretary Victor Villalobos, Secretary of Agriculture and Rural Development, Mexico

"We are convinced that this collaboration will be a game changer to our research institutions, to many small-scale farmers, to indigenous communities, and to our youth from remote communities, by bringing a positive effect in the access to knowledge and science. NAAAN will help to make a difference, so they can definitely change their world."

Secretary Tom Vilsack, Secretary of Agriculture, USDA, The United States

"Never before has agricultural extension had such import to global and national security as it does today. Nearly 15% of people in the world were estimated to be food insecure in 2021, and this year, the impact of Russia's unprovoked war on Ukraine is expected to push as many as 40 million more people into poverty. This study sets the groundwork for developing a generation of agricultural leaders who will provide all our global citizens with consistent access to safe, healthy, affordable food."

The NAAAN Steering Committee

Canada

- The Honourable Marie-Claude Bibeau (ex officio), Minister of Agriculture and Agri-Food
- David Gray, Ph.D., Professor, Dalhousie University
- Mary Robinson, President, Canadian Federation of Agriculture

Mexico

- Secretary Victor Villalobos (ex officio), Secretary of Agriculture and Rural Development
- Carlos Vazquez Ochoa, Minister Counselor, Agricultural Office, Embassy of Mexico to the United States
- Lourdes Cruz Trinidad, General Coordinator of International Affairs, Secretariat of Agriculture and Rural Development

The United States

- Secretary Tom Vilsack (ex officio), Secretary of Agriculture, USDA
- Douglas Steele, Ph.D., Vice President Food, Agriculture & Natural Resources, Association of Public and Land-Grant Universities
- Cathie Woteki, Ph.D., Professor of Food Science and Human Nutrition, Iowa State University; Visiting Distinguished Institute Professor, Biocomplexity Institute, University of Virginia; Former President, Charles Valentine Riley Memorial Foundation
- Tony Frank, Ph.D., Chancellor, Colorado State University System and host institution for the NAAAN Secretariat

For more information, please contact us at NAAANinfo@colostate.edu

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Canadian Chapter

- Bell, Chris, Agriculture and Agri-Food Canada
- Brewin, Derek, University of Manitoba
- Chowdhury, Ataharul, University of Guelph
- Gray, David, Dalhousie University
- Hribar, Kristyn, Agriculture and Agri-Food Canada
- Ip, Wallace, Consulate General of Canada
- Kittilsen, Tracy, Dalhousie University

Mexican Chapter

- Albarran Mena, Leticia, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA)
- Cadena Iñiguez, Pedro, INIFAP (Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias)
- Chávez Suarez, Xiomara, International Maize and Wheat Improvement Center (CIMMYT)
- Diaz Espinosa, Anabell, International Maize and Wheat Improvement Center (CIMMYT)
- Escobar Vega, Francisco, Colegio de Postgraduados (COLPOS)
- Fernández Rivera, Salvador, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA)
- Flores, José Guadalupe, International Maize and Wheat Improvement Center (CIMMYT)
- Legorreta Padilla, Felipe, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA)
- Martínez Senties, Luis, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA)
- Nieto, Alejandra, Centro de Investigaciones Biologicas del Noroeste (CIBNOR)
- Orozco Sánchez, Juan Bernardo, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA)
- Ortíz García, Sol, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA)
- Pérez, Mercedes, International Maize and Wheat Improvement Center (CIMMYT)
- Van Loon, Jelle, International Maize and Wheat Improvement Center (CIMMYT)
- Vázquez Gómez, Raymundo, INCA Rural. Instituto Nacional para el Desarrollo de Capacidades del Sector Rural (INCA Rural)
- Vega, Daniela, International Maize and Wheat Improvement Center (CIMMYT)

United States Chapter

- Alex, Gary, formerly at World Bank and United States Agency for International Development (USAID)
- Frank, Tony, Colorado State University System (CSUS) and Chair of the NAAAN Steering Committee
- Geith, Christine, Extension Foundation
- Henney, Caroline, Extension Committee on Organization and Policy (ECOP)
- McKalip, Doug, United States Department of Agriculture
- Nielson, David, North American Agricultural Advisory Network (NAAAN) Secretariat
- Popara, Rebecca, North American Agricultural Advisory Network (NAAAN) Secretariat
- Steele, Doug, Association of Public and Land-grant Universities (APLU)
- Swanson, Lou, Colorado State University (CSU)
- Weller, Lauren, North American Agricultural Advisory Network (NAAAN) Secretariat
- Woteki, Cathie, Iowa State University (ISU)
- Wright Platais, Kerri, North American Agricultural Advisory Network (NAAAN) Secretariat

NAAAN Survey Report (Mapping Exercise)

- Cantwell, Allison, Colorado State University (CSU)
- Lahoff, Rachel, Colorado State University (CSU)
- Nielson, David, NAAAN Secretariat
- Witinok-Huber, Rebecca, Colorado State University (CSU)
- Kerri Wright Platais, NAAAN Secretariat

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- Mitchell, Carrie, report editor

Overview of the Canadian Public Agricultural Extension and Advisory Service

Dr. Derek Brewin, University of Manitoba, Dr. Ataharul Chowdhury, University of Guelph, Tracy Kittilsen, P. Ag., Dalhousie University

There is no coordinated university or national government-led extension service in Canada. Stemming from constitutional responsibilities, publicly supported extension services have mainly been the domain of the individual provinces without federal government directives. However, both universities and federal research stations have taken a role in the past. The history of extension services is deeply rooted in a myriad of modalities and delivery by many actors. These include schools of agriculture, federally funded research farms, and provincial and federal public service agencies. The elements of the system have evolved over the years to be interwoven into the fabric of many agricultural organizations, both public and private. This chapter outlines several uniquely Canadian features of agricultural advisory services, including its origins and evolution, the role of various stakeholders, and future opportunities.

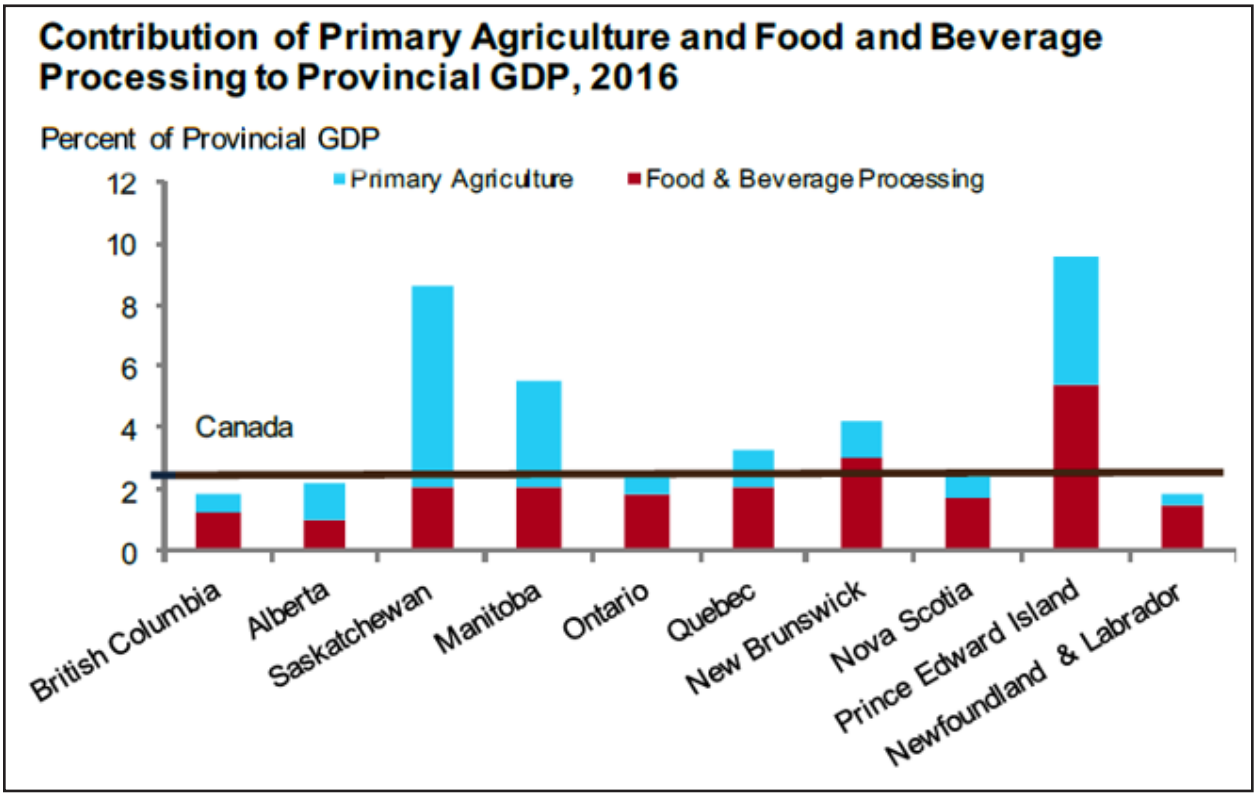
1.0 Importance of Agriculture in the Canadian Economy

Agriculture is an important source of national income and employment in Canada. In their last major overview of the sector, Agriculture and Agri-Food Canada estimated that 7.4% of Canada's Gross Domestic Product was supplied by agriculture, food production, and related services (AAFC, 2020). An estimated 2.3 million people (roughly 11% of Canada's laborforce) worked on 193,492 farms or firms supplying inputs to farms, or firms processing primary production or in food retail and food service.

The allocation of farms and cultivated land varies significantly across the 10 Canadian provinces and three territories. The bulk of Canada's arable land is situated in the three prairies province of Alberta, Saskatchewan, and Manitoba (Stats Canada, Census 2016). However, there is substantial agricultural production in Canada's more urban provinces of Ontario and Quebec. Prince Edward Island, Canada's smallest province in size, receives 10% of its GDP from agriculture and food processing. Figure 1 shows the relative importance of agriculture to each of Canada's provinces. There is also a small amount of agricultural production and/or food processing in all three of Canada's northern territories.

The sizes of farms in Canada have been increasing for generations. The use of extension services is much lower on smaller farms (revenue of $25,000 to $99,000), with only 24% of farms reporting the service of third parties to be an important factor when preparing to adopt innovation. This contrasts with 61% of larger farms ($1,000,000+) in Canada (Agriculture and Agri-Food Canada, 2016). From 1961 to 2016, the total number of agricultural operations dropped from 480,000 to 193,500, or a 60% decrease. Meanwhile, the total acreage of farm area has only dropped by 8.8% in the same period, indicating that farm operations are getting larger (Statistics Canada, 2016).

Figure 1
The importance of Agriculture by Province in Canada



Source: AAFC, 2018.

Economic viability continues to be a challenge for smaller farms, and the reduction in public extension services means that unconditional services are less accessible (Maynard & Nault, 2005). Currently, provinces with significant agricultural production have civil servants assigned to extend useful agricultural information for farmers related to the types of farms and crops produced in their province. Provincial roles in agricultural programming differ according to their natural endowments.

2.0 History of Agricultural Extension Service in Canada

The early definition of extension focused on information dissemination that supported rational decision-making, mainly by farmers (Swanson and Clarr, 1984; van den Van and Hawkins, 1996; Franz, 2007). Leeuwis and van den Ban (2004) defined agricultural extension as "a series of professional communicative interventions amid related interactions that are meant, among others, to develop and/or induce novel patterns of coordination and adjustment between people, technical devices and natural phenomena, in a direction that supposedly helps to resolve problematic situations, which may be defined differently by different actors." When the Federation of Canada was formed in 1867, education—including the education of farmers—was clearly defined as a provincial role and not a federal focus (Justice Canada, 2021). In most cases, the early role of extension was directly connected to activities with early schools of agriculture, although that changed over time. For example, the agricultural representative (Ag Rep) service was established in Ontario in 1907 as an activity where agricultural students were placed in secondary schools, across the province creating a link between farmers, the agricultural school, and the provincial government. This idea was eventually adopted across the country. In another example, in Manitoba, the former Manitoba Agricultural College organized "Better Farming Trains," which moved throughout the province to provide demonstrations and consultations to farmers (Steppler & Switzer, 2014).

Rivera (1998) linked the history of agricultural extension in Canada to many prominent adult education movements such as the Women's Institute, 4-H, and the United Farmers of Canada. The first agricultural schools to train farmers were established in Quebec (1670) followed by the first English-speaking schools in Ontario in 1874 and Nova Scotia in 1885 (Steppler & Switzer, 2014). Blackburn (1994) discusses accounts of extension in Canada back to as early as 1606 when experimental seed plots were established at Port Royal, Nova Scotia in an attempt to transfer European Farming methods to First Nations communities. He also traces the hiring of the first extension staff to 1906 in Ontario and discusses that the Canadian system has been heavily influenced by the Cooperative Extension System in the USA. There are long-standing relationships in border provinces and states, such as collaborative research in the wild blueberry industry near the coasts and wheat research in North Dakota and Manitoba.

Of note is the development of extension services across the country were not inclusive of Indigenous communities, and that providing direct extension support to First Nations was neglected across the country, even though the Indigenous people kept many of the first European settlers alive (Hambly, 2020). There were other farming rules imposed on the First Nation reserves created by the Colonial settlers and the establishment of an agricultural school for the First nations at Rice Lake near Peterborough, in Ontario in 1836. Hambly (2020) argues that these historical initiatives related to agricultural extension were intended to destabilize indigenous communities' food sovereignty and to create dependency on the settler economy. Most of the numbered treaties that allowed for an expansion of European settlement, mentioned provisions for agricultural development. Hambly (2020) stated, referring to the confederation constitution (1867), that agricultural development was the shared responsibility of the federal and provincial government in Canada. In this setting Canada was created as a commonwealth federation of provinces. The federation also addressed regional differences, especially in French-speaking Quebec and the emerging western territories.

"In each Province the Legislature may make Laws in relation to Agriculture in the Province, and to Immigration into the Province; and it is hereby declared that the Parliament of Canada may from Time to Time Make Laws in relation to Agriculture in all or any of the Provinces, and to Immigration into all or any of the Provinces; and any Law of the Legislature of a Province relative to Agriculture or to Immigration shall have effect in and for the Province as long and as far as it is not repugnant to any Act of the Parliament of Canada." (British North America Act, 1867)

Although education was not constitutionally a federal responsibility, agricultural extension was a central role of the federal Experimental Farm Stations Act of 1887. Federally controlled research stations were built to provide locally specific agricultural advice to help recruit and retain immigrants as farmland in Canada was being made available to immigrants (Hedley, 2015). Canada still has 21 research facilities controlled by the Science and Technology Branch of AAFC. The bulk of the staff is made up of Research Scientists involved in the full spectrum of discovery research activities, with very few federal civil servants across Canada taking an extension role (Canada, 2021; GEDS, 2021). Hedley (2015) suggested the early capacity for tax revenue limited the ability of provincial governments to generate significant local agricultural research or offer much farm extension.

A second significant federal investment related to extension was the Prairie Farm Rehabilitation Administration (PFRA), created in 1935. The PFRA had a mandate to address the threat of drought and soil degradation of the dirty thirties. Although the bulk of this service was focused on water and pasture projects (Marchildon, 2009), extension regarding soil and water conservation was a major part of the activities of the staff up to the mid-1990s (Gilson and Baker, 2020). The PFRA was dissolved in 2009. One last remaining federal arm of agricultural extension resides in the Farm Credit Corporation of Canada (FCC) created in its present form in 1959. Technically a crown corporation funded by interest payments made by producers, the FCC uses significant resources to deliver online extension in financial planning and services (FCC, 2021).

Along with the establishment of federal research stations across the country, several other early provincial initiatives were launched to advance agricultural education and training (Hambly, 2020). The Ontario Veterinary College (OVC) began in 1862 followed by the Ontario Agricultural College, OAC (1874) under the Ontario Department of Agriculture. These two colleges are part of the foundation of the University of Guelph in 1964. The University of Guelph has been committed to providing agricultural extension and advisory service from its inception. The Macdonald Manual Training Fund (now known as the Macdonald Campus of McGill University in Montreal) was established in 1905.

In Atlantic Canada, the School of Agriculture was established in Nova Scotia in 1885 at the Provincial Normal School in Truro. The first provincial farm was established in 1889 at Bible Hill and the School of Horticulture was established in 1894 in the Annapolis Valley. In 1905 these three organizations merged to form the College of Agriculture, later became known as the Nova Scotia Agricultural College (NSAC). The role of the college was deeply rooted in extension. In the 1880s, talks were delivered to farm groups as part of the first extension activities in the region. During the winter, college graduates also delivered talks to farmers (Dalhousie University, 2021) https://www.dal.ca/faculty/agriculture/about/history/our-story.html). In 2012 the Nova Scotia Department of Agriculture relinquished the NSAC. The school then merged with Dalhousie University to become the Dalhousie Faculty of Agriculture, the newest of eight faculties of agriculture in Canada (https://www.cfavm.ca). Until the late 1990s, many graduates from the NSAC entered public services and held roles in extension across the country.

Table 1
Establishment of Agriculture Schools by Date

Year	School
1862	Ontario Vet College (OVC)
1874	Ontario Agricultural College (OAC)
1885	The School of Agriculture (Atlantic located in Nova Scotia)
1905	Macdonald Manual Training Fund (Macdonald Campus of McGill University)
1905	Manitoba Agricultural College
1912	Faculty of Agriculture, University of Saskatchewan
1915	Faculty of Agriculture, University of Alberta
1915	Faculty of Agriculture, University of British Columbia

Source: Steppler and Switzer (2014).

Steppler and Switzer (2014) provide an overview of the birth of the western Canadian schools of agriculture. The Manitoba Agricultural College was established in 1905, building on a foundation of a dairy school that had been part of the Manitoba Department of Agriculture since 1894. In 1924 it was then transferred to the University of Manitoba. In Saskatchewan, the Faculty of Agriculture was developed simultaneously as the university. The first classes were held in 1912. Alberta and BC followed in 1915, with the first students entering agriculture programs. Many colleges that were held within provincial departments of agriculture moved to become part of university or college systems over time.

3.0 Contemporary Practices of Agricultural Extension and Advisory Services in Canada

Canada's public agricultural extension and advisory services have been developed less consistently and pervasively than in the USA (Milburn et al., 2010). As a result, public support for agricultural extension, including funding and services, was drastically cut at the beginning of the 21st century (Maynard & Nault, 2005). By 1985, there were over 1,000 professional staff and nearly 4,000 support staff in federal research and demon-

stration farms across Canada (Hambly, 2020). As per Davis et al. (2020), there were 978 federal agricultural advisory professionals in 1981, which was reduced to 380 in 1991. Indeed, the federal withdrawal occurred with little documentation or press and was deemed to have "disappeared with a 'whimper', rather than a 'bang'" (Milburn et al., 2010). This withdrawal was also observed by those involved in the larger provincial extension efforts. Unfortunately, the authors could find no institutional data to measure the provincial withdrawal.

Gosselin (2009), using Alberta as an example, describes the change in structure and delivery of the extension service over time. Starting in the 1960s, extension staff were decentralized and regional offices were established to offer programming including farm visits, tours, and field days to the community. In the 1990s, because of policy change and attempts to reduce government budgets, the extension service was diminished with closing of offices and the re-centralization of staff. Further "efficiency" was found by the hiring and sharing of specialists, and the delivery of extension services using new methods such as call centers. The reduction can also be attributed to policymakers' views of extension and farming. Small-scale farms were struggling, and the view of extension was that of an outdated system. This was echoed by industry, who felt the extension services were obsolete and not adding real value as farms became more advanced and business-focused. These factors, combined with a downturn in the economy during the 1990s contributed to the erosion of what was left of the extension system's structure. These trends can be extrapolated across the nation.

Milburn continues to note that extension services were seen as outdated and commodity-oriented, leading to a lack of funding and support (p.2). Hambly has argued that these changes did not lead to the disappearance of advisory services in Canada but redirected them in two ways: a) technology "pull" or demand-driven, and to a lesser extent "push" or supply-driven advisory services in the private and provincial public sectors and b) capacities at the individual, organizational, and network-system levels that transitioned agricultural extension toward communications and media (e.g., advocacy and campaign) as well as learning (non-formal, adult education). Thus, agricultural advisory services have shifted toward agri-business advisory and training services operated by the private sector, on the one hand, and more holistic, community-based projects in the not-for-profit sector, on the other hand (Hambly, 2020; AIC, 2018).

Canada's extension audiences are primarily producers, future producers, including students, and commodity groups (Blackburn 1994). As mentioned, the decline in support and funding for public agricultural advisory services in Canada has created a situation in which various other actors, such as producer organizations, private consultants, input dealers, have intervened to fill the gaps in Ontario (Hambly, 2020). Canadian provincial and federal governments started allocating financial support for agricultural research and extension based on the return on investments (ROI). As extension usually has less immediate tangible outcomes and rising costs associated with public extension programmes resulted in decreased support from federal and provincial governments. In turn, the role of the agricultural extension advisor experienced a shift towards agri-business advisory and training services operated by the private sector (Hambly, 2020; AIC, 2018). Indeed, this has led to the system's transformation into what is best defined as a pluralistic system of extension. Pluralistic advisory services in agriculture are characterized as an extension system in which multiple public and private providers with diverse funding streams provide services to farmers and agricultural communities (Birner et al., 2009).

While provincial governments remain important stakeholders of agricultural extension service, their ability to influence the uptake of new technologies has been reduced (Chowdhury et al., 2021). Commodity organizations and private sector advisors, such as certified advisory agents, veterinarians, and feed companies, are all seen as holding more ability to influence decisions around technology adoption on-farm (Chowdhury et al., 2021a & 2021b; Allen, 2021). Although there might be some variations in the speed of transformation, actors, and structure at the provincial level, there is a common trend of the rise of new and diverse

agricultural advisory actors (See Appendix: Table of Organization). Pluralistic systems have many advantages to incorporate diversities of services. However, it provides enormous challenges for the coordination of the initiatives of various agricultural advisory actors (Chowdhury et al., 2021a and 2021b).

Provincial responses to the need for coordination vary. For example, in Nova Scotia, with gross farm receipts of $639.8 million (Statistics Canada, 2017) there is a novel advisory system in place. The Nova Scotia Department of Agriculture in the Agriculture and Food Operations branch delivers general extension services in production, rural leadership, and land protection and programming for youth from K-12. Specialized advisory services are provided in the areas of knowledge translation and transfer (KTT), plant and animal protection, lab services and food inspection, meat inspection, animal welfare, bees, weeds, and pests. The Nova Scotia Department of Agriculture also supports Perennia, a provincial development agency. Perennia provides a vast array of specialized services to the agriculture and seafood industries. These services include but are not limited to, specific crop production and research advice, research services around innovation, and support to increase the industry's competitiveness. Provincial funding accounts for approximately 40% of the organization's revenue stream, the remainder derived from consulting fees, research, and training. (Perennia, 2020).

In other provinces, such as Ontario, the terms extension and advisory services have been replaced by the label of knowledge translation and transfer (KTT). With KTT, which originates from public health, or knowledge mobilization (KM), the field of agricultural extension becomes ever more complicated and obscure (Hambly, 2020). The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and the University of Guelph have long been collaborating on a unique provincial partnership to advance research and innovation that contributes to the success of the province's agri-food sector and promotes rural economic development. The partnership was last renewed in 2018 for another ten years in which the province would invest $713 million to support Ontario's agri-food sector. In this partnership, KTT processes are embedded into research projects and seek to incorporate extension services, despite some notable differences to KTT (Ontario Agri-Food Innovation Alliance, 2018). Proponents of KTT claim that the discontinuation of the term 'extension' does not mean services or targets have been changed; instead, it can now be seen as practiced and continued under different guises (Hambly, 2020).

At the federal level, multi-year commitments of support to agricultural extension have been ongoing. Most recently, a $3 billion-dollar Canadian Agriculture Partnership (CAP) was agreed upon in 2018 based on investments by federal, provincial, and territorial (FPT) governments to strengthen and grow Canada's agriculture and agri-food sector. In these cost-shared programs, provinces and territories offer extension services delivered directly by the provincial government and provide financial support to improve production practices, including to access private-sector delivered agronomic services. The proAction initiative by the Dairy Farmers of Ontario is an example of the extension-related KTT activities supported by CAP. This specific method of KTT utilizes the 'train the trainer' approach by providing education for 128 veterinarians across Ontario to become proAction advisors, later holding their own workshops with dairy farmers and other producers (Dairy Farmers of Ontario, 2021).

In CAP, principles of extension are mentioned and espoused. However, the distinction is made that they are pursuing knowledge transfer, education, and communication with producers. The change in terminology remains evident with most private sector organizations. In addition, the CAP itself parallels these changes as both the Agri-Innovate and AgriDiversity programs emphasize components of knowledge transfer, with no direct mention of agricultural extension (Agriculture and Agri-Food Canada, 2018). While OMAFRA manages the CAP within Ontario, it can be best understood as a supporting program to private initiatives, further demonstrating the waning role of the public sector.

3.1 Funding, Approaches, and Methods of Extension and Advisory Services

Alston et al. (2000) provided a meta-analysis of the returns to investment for research and extension, suggesting an average of 65%, and for extension alone, the average returns were around 80%. This is a remarkable rate of return compared to current deposit rates. But the process has lagged due to research time and adoption, so it experiences large upfront costs followed by very large benefits. The returns were high enough in non-public areas to attract private investments in agricultural advisory services globally. Once considered to be mainly a public good (See Davis et al., 2020), significant aspects of agricultural advisory services have been taken on by various private-sector agri-business firms, particularly in the industrialized countries including Canada (Figure 3). Canada has seen a similar type of privatization as seen in Australia, with some continuation of public funding for extension. However, there are some provincial variations, for example, half of Quebec's agrologists work in the private sector, while the government still leads the delivery of agricultural extension services in Saskatchewan according to Canada's main agricultural accreditation bodies (AIC, 2018).

More recently, Hurley, et al. (2015) calculated the internal rate of returns for agricultural research and extension based on various studies conducted to evaluate agricultural research and development initiatives between 1958 and 2015 (Table 2). Investments in extension received the highest median return, 46.0 percent per year, followed closely by applied R&D investments and investments in basic and applied types of R&D.

Table 2
Internal rate of returns per year for agricultural research and development (R&D)

R&D orientations	Number of observations	Average (% per year)	Median (% per year)
Basic research	16	42.9	29.8
Applied research	208	139.5	43.5
Extension	20	72.2	46

Source: Hurley et al. (2016)

A recent study in Ontario (Chowdhury et al., 2021a and 2021b) indicates that soil, crop, and livestock advisory services are supported by a range of funding sources, such as direct funding from provincial and federal government, federal/provincial partnership, and municipal support grants. A major source of funding is service tied to product sales and promotion by private sector industries. An additional avenue is from membership fees and indirect funding (e.g., charity and donation) through various organizations. Farmers also pay fees for service provided by individual consultants, such as veterinary agents and certified crop advisors.

Hambly summarized Canada's contemporary agricultural extension and advisory services as being characterized by three major approaches. The first, Agricultural performance, focuses on advisory and financial support to start new agricultural ventures (Hambly, 2020). Examples of this approach include Agri-Innovation Program Stream B: Research, Development and Knowledge Transfer (AAFC, 2017) and CAP (AAFC, 2018). The second approach is rural and community capacity development. In this approach, rural and co-operative development projects allowed recipients to leverage significant funding from other sources. This approach includes the Canadian Rural Partnership Initiative and Canadian Co-operative Development Initiative. The third approach is networked information and non-formal education. In this approach, citizen-centered responsive programs and services allow the federal government department, AAFC, to deal directly with the public in various ways (electronic and in-person visits).

As the agricultural extension and advisory services went under various structural transformations described above, the methods and tools of service delivery evolved over the years. A general trend is to move from one-to-one, such as in-person contact to one-to-many and many-to-many (e.g., various group and train the trainer methods) with the adoption of online and electronic forms of delivery (Chowdhury et al, 2021a and 2021b, Hambly, 2020). Some common methods used for extension and advisory services include the following:

- One-to-one meeting
- Tours/Demonstration
- Workshop/Panels/Regional Information days
- Peer-to-peer learning, such as focus Farm (Roche, 2014)
- Social media, website, and listserv emails
- Call centers
- Print publication, e.g. newsletter, farm magazine, factsheets, etc.
- Trade shows

3.2 Sectoral Focus

Agricultural and advisory services focus on the service needs of various sub-sectors of agriculture (See Appendix). The major sectors are crop and soil, livestock, environment, and conservation. There are some differences in service deliveries in various sectors. For example, in Ontario, the livestock sector relies more highly on a fee-based advisory service than the soil and crop sector (Chowdhury et al, 2021a and 2021b). Also, the type of organizations and service providers differ from one sector to another. For example, in addition to provincially funded staff members providing extension service to farmers across the country, many other organizations, non-profits, and others, have an extension mandate and provide service for the public good to various audiences.

3.3 Extension Service Providers Focusing on Youth

3.3.1 4-H Canada (age 6-25)

In Canada, there are 23,000 youth members and 8,700 volunteers in 1,800 clubs. 4-H members still participate in special projects to develop skills, but the overall program has a broader focus. The 4-H Canada website states:

"Together with our partners, we offer innovative, youth-centered programs that provide meaningful, positive experiences designed to build confidence, positive self-identity, self-esteem, and a sense of achievement."

Early 4-H programs were linked closely with provincial departments of agriculture, with public servants providing much of the programming content and expertise (https://4-hontario.ca/about-4-h/history). Starting in the 1990s, provincial governments started to remove themselves from directly supporting and staffing 4-H, therefore 4-H had to develop a model to operate independently. Although some funding comes from various provinces, most funds are realized from member sponsorship, fees, fundraising, and endowment building. 4-H Canada lists the Federal Government, Farm Credit Canada, and RBC as their main supporting partners at the national level. Others listed, such as BASF, CN, and Syngenta are lead partners on key initiatives

(https://4-h-canada.ca/about/partners). Of note is that expertise, extension, education, and materials may be sourced from within the 4-H organizations and their partners, and not necessarily from provincial extension agents as in the past.

3.3.2 Agriculture in the Classroom (AITC) (Grade K–12)

From their website, AITC identifies as the "national voice for agricultural education" (https://aitc-canada.ca/en-ca/who-we-are/about-us). AITC is a charitable organization with provincial branches across the country that helps students understand and appreciate the agricultural industry. With a clear extension mandate - geared toward elementary and secondary students, AITC promotes the industry and food systems and provides teaching tools, curriculum, and other resources to teachers and students. AITC partners with many organizations across the country to enable students to see farming and agriculture as a viable career choice. Programming includes curriculum and resources for teachers, outreach programs, conferences, and at-home study of agriculture, including factsheets, among other items. AITC also provides access to "thinkAG" which is an online career decision-making tool focused on ag careers (https://thinkag.ca/en-ca/about-thinkag)

Funding models for the provincial organizations vary across the country, either as part of provincial departments of agriculture (delivered by public employees) or delivered by an agricultural non-profit industry association.

3.3.3 Canadian Young Farmers' Forum (CYFF) (Age 18–40)

The Canadian Young Farmers' Forum (CYFF) was established in 1997 to support young Canadian agriculture producers of every commodity, across Canada. The organization's main goal is to provide information and encourage the exchange of ideas to ensure the success of the agricultural industry. CYFF's main functions are to promote networking, education, leadership training, agricultural awareness, and funding to support capacity building of its' members (https://cyff.ca/).

CYFF provides support and guidance to 11 provincial young farmers' associations across the country. Funding is secured through the sale of memberships to young farmers, alumni farmers, and industry partners as well as through the Canadian Agricultural Partnership (CAP) Program and the federal government of Canada.

3.4 Colleges and Universities

As previously mentioned, colleges and universities were at the heart of early extension efforts in Canada. Over time, the decentralization of extension services across universities has happened both because of need and necessity. Some programming is being offered in concert with research activities and some semblance of extension programming is left either to continuing education units, departments, or faculties. University continuing education is the term used, mainly in North America, and other parts of the world, to refer to the administrative division within many universities which offers courses and programs, usually to persons at a distance from the university… "continuing education" implies that many of the students are casual and enrolled in time part-time courses. (English & Mayo, 2012)

Much like the extension paradigm, the current reality of continuing education is one of constant organizational and economic challenges and changes, including institutional restructuring, financial restrictions, and the growing expectation of revenue generation and on-demand programming (McRae, 2012). Topics related to extension and advisory services are offered in various forms by the college or university, including:

- Workshops and field days presented by researchers and institutes
- Short courses (f2f hybrid, online)

- Professional certificates. Credentialing CEU's
- Competency-based programming
- Micro Credentialing
- Apprenticeship programs
- Diploma and Degree programming

As per Hambly (2020), among 22 universities offering agriculture and related degrees, only two universities, the University of Saskatchewan and the University of Guelph offer a graduate degree related to agricultural extension. The MSc in Capacity Development and Extension at the University of Guelph is the only degree in which components of agricultural extension education are emphasized. Eight universities that offer agricultural economics undergraduate degrees. Seven of these schools also offer graduate-level degrees (Masters and PhD). The elements of agricultural extension are incorporated in several other degrees across Canadian universities, such as a Ph.D. in Rural Sociology (Brandon University), Ph.D. in Rural Studies (University of Guelph), and communication and technology (University of Alberta). According to Hambly (2020), seven non-agriculture certificate and degree training programs incorporate agricultural extension education components under names such as, "technical and scientific communication" (Dalhousie University undergraduate certificate), "science, technology, and society" (16 universities), "systems science and theory" (graduate programs at Trent University and University of Ottawa) and "community organization and advocacy" within schools of public administration (12 universities primarily offering certificates and undergraduate studies).

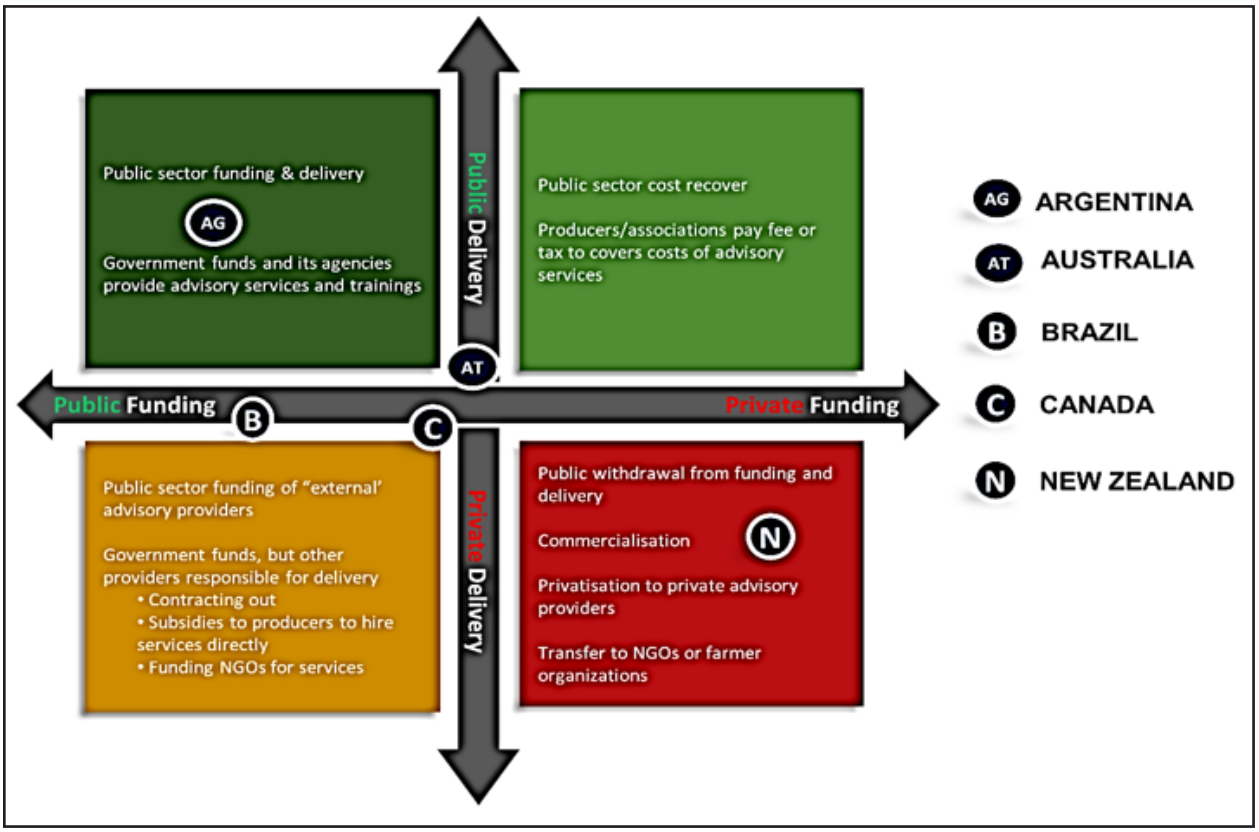
Several colleges across the country offer diploma and degree programming and advanced professional development in agriculture. Some of these include Lakeland College and Olds College in Alberta, CEGEP programs in Quebec, and other provincial community college systems. These schools are members of the Canadian Association of Diploma and Agriculture Programs (CADAP) (http://cadap-apdac.ca/).

3.5 Non-Profit and Commodity Associations

Non-profits and commodity boards play a significant role in the provision of agricultural extension and advisory services across the country. There are various non-profits, ranging from producer, market, cooperative, and charitable organizations. These organizations collaborate with academic, provincial, and federal partners on various funding schemes and implement various extension and advisory projects such as research projects, conferences, and speaker sessions. Many organizations also employ staff to support group and individual advisory services to their members. The types of organizations, and description of their services are presented in Appendix Table.

Figure 3

Delivery and funding alternatives of agricultural advisory services (Modified from Turner et al, 2021, and based on AIC, 2018 and author's judgment)



Source: Modified from Turner et al (2021), ad based on AIC, 2018 and author's judgment.

3.6 Professionalism of Advisory Service

Agrologists Agronomes Canada (AAC) (2021) oversees the profession of agrology in Canada and consists of nine provincial regulators. The two main initiatives of this organization are to improve labor mobility to assist in the movement of professionals between provinces and to promote the role of agrology and agrology professionals in Canada. AAC only oversees the Professional Agrologist (P. Ag.) and associated designations such as Technical Agrologist (T. Ag.) and Articling Agrologist (AIT, A. Ag.).

The Government of Canada uses a National Occupation Classification (NOC) system to classify jobs based on skills and duties. This system provides a repository of linked labor market information including wage rates, education levels, and job prospects (Government of Canada, 2021). Agrologists (NOC 2123) are defined as:

Agricultural representatives, consultants, and specialists who provide assistance and advice to farmers on all aspects of farm management, cultivation, fertilization, harvesting, soil erosion and composition, disease prevention, nutrition, crop rotation, and marketing. They are employed by businesses, institutions and governments that assist the farming community, or they may be self-employed.

Government of Canada, 2021. (https://www.jobbank.gc.ca/marketreport/requirements/15315/ca),

In an occupation report by the Ottawa Employment Hub (2019) there was a prediction of a 19.5% increase in the number of agrologist jobs across Canada by 2021. Data from the Government of Canada (2021) indicates

there were 26,300 working in this profession in 2018. Prospects for this growth vary across the country with Alberta, New Brunswick, and Saskatchewan showing good opportunities for growth. Quebec, Manitoba, and Ontario are rated as fair with the remaining provinces and territories undetermined. As of August 10, 2021, there were 53 vacant jobs available in Canada with the majority being posted in Saskatchewan (https://www.jobbank.gc.ca/marketreport/requirements/15315/ca).

AAC (Table 3) data highlights that the actual number of agrologists registered with the various provincial regulators, and practicing agrology is less than what is indicated in the labour market data. Comparing the 2018 Labour market data shows 26,300 in the national classification compared with only 9,884 registered as agrology professionals (AAC, 2021). It can be concluded that the occupational data includes both professional agrologists and others working in the field of agrology, but not necessarily registered, or eligible to register, as professional agrologists.

Table 3
Registered Agrology Professionals—by Province (Weir, 2021)

AGROLOGISTS AGRONOMES CANADA

Registered agrology professionals – by Province (Information provided to AAC by provincial regulators)						
Institute (regulator)	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Alberta Institute of Agrologists[1]	2,562	2,552	2,609	2,533	2690[1]	2595[1]
British Columbia Institute of Agrologists[2]	1,198	1246[2]	1293[2]	1,379	1,418	1,466
Manitoba Institute of Agrologists	660	649	635	685	678	657
New Brunswick Institute of Agrologists	140	136	128	119	118	110
Newfoundland & Labrador Institute of Agrologists	30	30	30	30	30	30
Nova Scotia Institute of Agrologists	235	219	208	182	175	176
Ontario Institute of Agrologists	308	270	256	247	230	235
Ordre des Agronomes du Quebec	3,118	3,087	3,021	3,027	3,049	3,048
Prince Edward Island Institute of Agrologists	67	66	79	90	90	86
Saskatchewan Institute of Agrologists	1,341	1,365	1,459	1,592	1,440	1,759
Total	**9,659**	**9,620**	**9,718**	**9,884**	**9,918**	**10,162**
Figures represent agrology professionals registered with and under the regulatory control of the provincial body regulating agrologists(the Institutes).Data submitted by provincial Institutes (regulators) either represents membership as at the organization's financial year-end or data following its annual registration renewal process to 2017. Beginning in 2018, all data is as at the organization's financial year-end.						

[1] Terminated membership in May 2019. Information obtained from AIA 2020 annual report
[2] Withdrew from membership in 2015, re-joined in 2018. Information obtained from BCIA 2020 annual report

Source: Weir (2021).

3.7 International Collaboration on Extension and Advisory Service

Agri-food schools at various universities are involved in various international partnerships for research and practices of agricultural extension and advisory services. This includes partnership projects, and initiatives to advance the knowledge and practices on various topics related to agricultural extension and advisory services. The initiatives receive support from the Social Science and Humanities Research Council of Canada (SSHRC), International Development Research Centre (IDRC), and Global Affairs Canada (Formerly known as Department of Foreign Affairs, Trade and Development, and Canadian International Development Agency). Canada has been active in its support to agricultural extension and advisory-related research and development initiatives globally in collaboration with other global partners, such as World Bank, OECD, Food and Agriculture Organization, and International Fund for Agricultural Development (IFAD).

4.0 Future challenges and opportunities of agricultural extension

This report summarizes the origins and evolution of agricultural extension in Canada. As noted throughout, Canada has seen diminished public sector investment, staffing, and activity in agricultural extension over the past couple of decades—and at the same time, vibrant growth in private sector agricultural advisory services of many types. The agricultural sector is now confronted with important challenges and opportunities (climate change, changes in the structure of the farming sector, the rapid development of digital tools, etc.) that suggest the need for ever more sophisticated management of farms and other lands across the country. A comprehensive review of the public sector and private sector agricultural advisory services from the past two to three decades would be most valuable at this juncture to understand how this new institutional landscape for agricultural advisory services has served the sector. Correspondingly, a forward-looking discussion of the type of public sector support for agricultural advisory services that would be needed to meet the various challenges and opportunities facing Canadian agriculture would also be manifestly warranted.

The challenges for the future of agricultural extension and the sector are many. Climate change and consumer concerns are likely areas that could constrain the sector and challenge the industry to produce in new ways. Agricultural extension and advisory services in Canada have been experiencing trends, also observed globally, which Klerkx (2020) described as ‘plurality’ and ‘disruption’. We have discussed current pluralistic agricultural advisory services in Canada. The ‘disruption’ highlights how extension services need to adapt to changes in technologies, vision, and mission in agricultural production. To respond to the ongoing disruptions, especially along with the digitalization of agriculture and the emergence of new technologies, such as synthetic protein, aquaponics, and vertical farming, agricultural extension, and advisory services need to transform existing capacity. For example, with the progress of digitalization and SMART FARM initiatives discussed below, agricultural extension professionals find that misinformation and the complexity of contentious issues are most challenging when communicating with clientele (Klerkx et al., 2021; Leal et al., 2021). There was a recent call for developing critical digital literacy to combat misinformation in agriculture (Alam and Chowdhury, 2021).

Soon, we may have to find ways of capturing the gains from sector-wide shifts like reduced carbon emissions, improved soil management, generational transfers, or more satisfied consumers. The public goods associated with these thematic development areas may be less likely to find extension champions in the private sector. This is evident in other jurisdictions, for example, privatization does not help to ensure inclusive agricultural advisory services, especially for small and medium-scale farmers in the European Union (Labarthe & Laurent, 2013).

Apart from the above arguments, the public role in extension is well justified from the perspective of economics of the public investment. The studies above show huge gains to public agricultural extension. If

Canada is looking for a good public investment—extension is a winner. Huge payments made to compensate for climate change may be reduced with modest investments in the extension of risk mitigation strategies. AIC (2018) noted that Canadian and global benefit-cost ratios for public and private agricultural research are also reported to be high, estimated to range from 10:1 to 20:1. Therefore, Canada needs more policy engagement and attention for funding research and engagement of the public sector in delivering agricultural extension.

The private sector is also evolving. There is an emerging role for private sector advisors to help improve data collection at the farm—preeminent firms like Farmers Edge. There is a new focused energy on funding and programs to support SMART farming, data collection, analytics, and innovation. Nationally there is an initiative to support the development of "SMART FARMS" on ag campuses. Olds College established the first and is leading the organization of smart farms in Canada (https://www.oldscollege.ca/olds-college-smart-farm/index.html). The Canadian Agri-Food Automation and Intelligence Network (CAAIN) has $2.9 Million to support the Pan-Canadian Smart Farm Network and is led by Olds College in Alberta and includes Glacier Farm Media Discovery Farm located at Langham, Saskatchewan and the Lakeland College Student-Managed Farm in Alberta. The Smart Farm Network intends to accelerate the development and adoption of agricultural technologies across Canada. The network will build a collaborative framework for sharing data and expertise to help farmers, industry, and developers to understand, use and implement emerging technology.

To summarize, policymakers, researchers, and practitioners need to pay more attention to how extension services can build human capacity. A strategy should be found to facilitate coordination among agricultural extension communities of practices, their diverse capacities, and values at provincial and national levels. Investment in extension can add value and capacity, providing accessible skills in challenging circumstances. Retention of core agricultural extension capacity and expertise in the public sector should therefore be a strategic objective for community stakeholders, industry, and government policymakers.

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Case Study on Agricultural Extension in Mexico as Part of the North American Agricultural Advisory Network Strategy Extension and Farmer Support in a Multi-Faceted Environment

Jelle Van Loon, International Maize and Wheat Improvement Center, Mercedes Pérez, International Maize and Wheat Improvement Center, Salvador Fernández Rivera, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA), Felipe Legorreta Padilla, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA), Raymundo Vázquez Gómez, Instituto Nacional para el Desarrollo de Capacidades del Sector Rural, Francisco Escobar Vega, Colegio de Postgraduados, Pedro Cadena Iñiguez, Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias, Alejandra Nieto, Centro de Investigaciones Biologicas del Noroeste, Juan Bernardo Orozco Sánchez, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA), Xiomara Chávez Suarez, International Maize and Wheat Improvement Center, Anabell Diaz Espinosa, International Maize and Wheat Improvement Center, José Guadalupe Flores, International Maize and Wheat Improvement Center, Daniela Vega, International Maize and Wheat Improvement Center, Sol Ortíz García, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA), Leticia Albarran Mena, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA), Luis Martínez Senties, Secretaria de Agricultura y Desarrollo Rural (AGRICULTURA)

Message from Secretary Victor Villalobos

"When we received the invitation from USDA Secretary, Tom Vilsack, and the System Chancellor of the Colorado State University, Dr. Tony Frank, to integrate the North America Agricultural Advisory Network, we were very enthusiastic to be part of an initiative that will strengthen the collaboration of Mexico with our closest trading partners, by closing the gap of our agricultural universities and Research Centers with Land Grant universities in the United States and the universities in the Provinces of Canada.

At first, we saw this as a challenge, nevertheless it was very much of an interest to us, given the fact on what our industries and rural areas in our three countries are currently facing: the aging of the rural population, the migration of young people, either to urban areas or to other countries, and the challenge to produce more for a rising population amid a never-seen climatic adverse environment.

We realized that Agricultural Extension Services and Technology Transfer and their role within agricultural production, food supply chain and rural development, are different and therefore in our perspective it was fundamental to understand the various elements involved in the North American regional ecosystems. This will facilitate, not only our understanding, but the exchange of experiences and a common adoption of best practices, technology transfer, and a better promotion and advocacy of agricultural advisory services in the region.

Extensionists must be at the core of the agrifood system and its constant transformation; and be also maintained as a solid and strong link in the food supply chain, so that innovations generated at the research level can be brought to farmers, ranchers, and fishermen, making food production more efficient, safe, reliable, sustainable, profitable and friendlier with the environment, while having the ability to respond to constant challenges and build resilience for future generations.

We are convinced that science and innovation are key elements to face the challenges on producing efficiently, sufficient, nutritious, safe and affordable food while facing a challenging climatic environment, and significant components to preserve our natural resources, manage our soil and water and protect our biodiversity for future generations.

Building synergies between research institutions, scientists and extensionists and advocating and promoting international cooperation is fundamental to achieve these goals.

Similarly, we must foster leadership building and strengthen the entrepreneurial spirit of young boys and girls, so they can, not only be active participants, but vocal in orienting the much-needed changes to transform them into sustainable agricultural and food systems.

We are very excited of the progress done at the North American Agricultural Advisory Network, and we believe that having the advice and experience of experts, such as Dr. Cathie Woteki, David Nielson, Doug Steele, Matthew McMahon, and Francisco Escobar Vega, among other will be instrumental in encouraging a dialogue to design efficient public policies for a sustainable agriculture, and be able to attract new generations to an active participation within this industry, as well as in productive activities in rural areas, bringing economic, environmental and social development in their respective communities.

We must allow and evoke the young to dream, to be inquisitive, and to foster and nurture their thriving spirit.

The country chapter studies on extension networks and agricultural advisory services in Canada, the United States and Mexico prepared by their respective country teams will also provide important elements and insights for discussion and proposal-building, and we certainly look forward to the next steps under this scope of cooperation.

We are convinced that this collaboration will be game changer to our research institutions, to many small-scale farmers, to indigenous communities, and to our youth from remote communities, by bringing a positive effect in the access to knowledge and science. NAAAN will help to make a difference, so they can definitely change their world.

Thank you very much."—Secretary Villalobos

1.1 Context and Scope

Because of its location, Mexico provides an entry point for agricultural trade for all of North America, in addition to its strong business ties with Central and South America and features tremendous culinary and cultural diversity. The country's stretched geography, rugged topology, and long coastlines along two oceans results in multitudinous microclimates, agroecologies, and crop production systems, most of which are found at tropical and subtropical latitudes. Accordingly, Mexican agriculture is rich but complex to systematize and improve, generating the need for in-depth multidisciplinary research and experts with an ample range of specialties, along with solid, flexible and interlinked exchange and knowledge transfer programs.

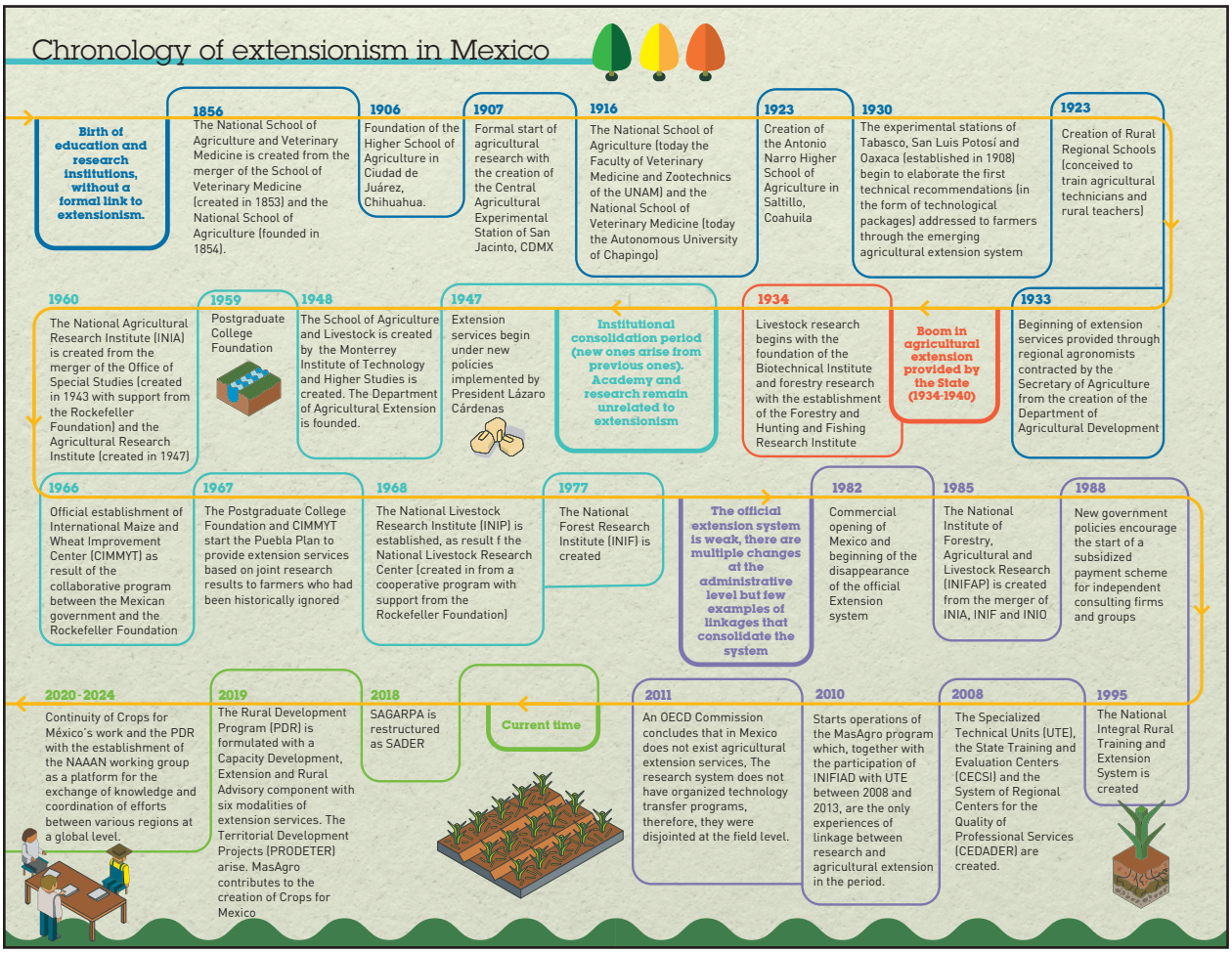
Mexico also struggles with severe socioeconomic challenges, starting with a highly-urbanized (80%) population concentrated in a few cities and dependent on food supplies from rural areas whose residents are ageing and rapidly diminishing (FAOSTAT, 2018). Mexico is the 11th ranked country in the world in terms of agricultural production, representing 3.7 % of its GDP (CEDRSSA, 2019), and with 21 million hectares of arable land it provides employment for nearly 7 million of its 130 million inhabitants (SIAP, 2019). Furthermore, although Mexico has improved its Human Development Index (currently with an HDI of 0.774), in 2018 42% of its population was impoverished and 1 in 5 Mexicans suffered from hunger (FAO, 2021), and in 2016 70% of the population was found to be overweight or obese (INSP, 2018). These data confirm Mexico's paradoxical situation (FAO, 2021) and explains the government's agri-food policy, which focuses on increasing overall well-being while attending to the needs of small- and intermediate-scale farmers (owning on average land less than 5 and 15 hectares, respectively), who represent 85% of the nation's farmers. Most of the latter

are only informally organized and many pursue subsistence agriculture, in contrast to the market orientation of Mexico's larger-scale and more politically influential farmers.

Although Mexico invests more public money in agriculture than any other Latin American country, in relation to its GDP, the lion's share of this budget consists of direct transfers to farmers as income support or farm input subsidies (Govaerts et al., 2019). The last decade the budget for agricultural extension has not exceeded 1.7% of the primary sector budget, with the highest amount during 2016–18, and representing an average annual value of USD 63.5 million. With such limited resources applied over such a large territory and facing significant socioeconomic adversity -including outmigration and organized crime in rural areas (Läderach et al., 2021), it is easy to understand the difficulties of establishing consolidated extension programs that produce sustainable and scalable long-term impacts. More so, according to the National Agricultural Census, only 1.3% of all rural productive units have access to farm assistance and training services, which is 15% fewer than in countries with a more developed agricultural sector.

To establish a systematized approach to agricultural extension in Mexico that pursues modernization within a reality of great disparity is a complex challenge. This document aims to provide an overview and history of Mexico's multi-faceted agricultural extension effort, as managed by the country's public sector and partners over the last century, with a graphical timeline given in Figure 1.

Figure 1
Graphic chronology of agricultural extension in Mexico



Source: CIMMYT/Mayra Servin.

1.2 Origin of Public Agricultural Extension in Mexico

Agricultural research in Mexico initiated formally in 1907 with the creation of the Central Farm Experimental Station in San Jacinto, in the Federal District about 30 miles outside of Mexico City and which was then the seat of the National School of Agriculture and Veterinary Medicine (Urbina Hinojosa, 2017). In 1908, three more experimental stations were established in the States of Tabasco, San Luis Potosi, and Oaxaca. During the 1930s, following the Mexican Revolution and the establishment of a stable national public administration, the main goal of the experimental stations was to generate technologies and elaborate recommendations in the form of "technological packages" for delivery to farmers through a nascent agricultural extension system. With this idea, throughout the twentieth century multiple national centers and institutes were established to build technical and research capacity, and with them the renowned National Autonomous University of Mexico (UNAM, hosting today the Faculty of Veterinary Medicine and Zootechnics), the Autonomous University of Chapingo (UaCH, an outgrowth of the National School of Agriculture) and the Superior School for Agriculture Antonio Narro (now Autonomous Agrarian University Antonio Narro, UAAAN). In 1985, Mexico launched the National Institute of Forestry, Agricultural and Livestock Research (INIFAP), an integrated body of all research related to livestock and biotechnical topics, forestry, hunting, and fishing, and farmland studies (Cervantes Sánchez & Román de Carlos, n.d.; Terán y Terán, 2008; Universidad Autónoma Chapingo, n.d.; Urbina Hinojosa, 2017).

Additionally, given the vast natural biodiversity of maize, Mexico was destined to become a global center of excellence for this important staple crop (Damania, Valkoun, Willcox, & Qualset, 1998). In the case of wheat, the country's agro-ecological diversity led to the creation of breeding schemes involving multiple cycles per year phenotyped at contrasting locations, known as "shuttle breeding" (Ortiz et al., 2007), which accelerated improvement and broadened wheat's adaptation. Breeding research in Mexico for tropical maize, including the first widespread collection and cataloguing of related genetic resources, and to develop high-yielding and rust-resistant wheat, gained tremendous impetus under the joint Mexico-Rockefeller Foundation "Office of Special Studies" established in 1943 (Byerlee, 2016). The successes of that program led among other things to the launch in Mexico in 1966 of the International Maize and Wheat Improvement Center (CIMMYT), a 1970 Nobel Prize for wheat scientist Norman E. Borlaug, and the establishment of CGIAR, the leading, global agricultural research-for-development partnership. The Mexico-Rockefeller Foundation program also influenced the format and approaches of INIFAP's predecessors, which included seeking international partnerships, particularly with US experts and organizations. Benefiting from Mexico's genetic and ecological diversity and development experience, CIMMYT has generated and shared improved varieties of maize and wheat, as well as related genetic resources, knowledge, and improved cropping system practices to benefit farmers and consumers worldwide (Krishna et al., 2021; Lantican et al., 2016). Its presence in Mexico has helped offer responses to the changing local demands of agri-food systems and actors, as well as consolidating a strong relationship with Mexican farmers in co-development and co-learning for rural development (Camacho-Villa et al., 2016).

In line with Mexico's Agricultural and Rural Development Sector Program (ARDSP) 2020-2024 (Secretaría de Agricultura y Desarollo Rural, 2020), INIFAP contributes to the three, primary ARDSP objectives: 1) Achieve food self-sufficiency by increasing agricultural, livestock and aquaculture production and productivity; 2) Contribute to the well-being of the rural population by including historically excluded farmers in rural and coastal productive activities, taking advantage of the potential of the territories and local markets; and 3) Increase the use of sustainable productions practices in the agricultural and aquaculture/fishing sector in the face of agro-climatic risk. The third objective favors innovation management and transfer using fourteen technology transfer models, of which seven are participatory models in a context of direct agricultural extension. At present INIFAP has developed technical support activities for the programs issued by

the Secretary of Agricultural and Rural Development, in the field of rural extension called PRODETER[1] (Spanish acronym for Projects of Localized Development) and within the Technical Support Strategy of the Well-being Production Program. For their implementation, INIFAP works in 30 Mexican states and 11 SADER-supported food production chains (maize, beans, rice, wheat or bread, chia, amaranth, sugarcane, coffee, cocoa, honey, and milk), offering technical support and technologies to farm advisors and farmers related to agriculture, livestock and forestry.

Several other Mexican research institutes and educational centers play essential roles for agricultural extension. Founded in 1959, the Postgraduate College (COLPOS) pursues teaching and research together with capacity building and technology transfer services for actors in the primary production sector and, especially, smallholder farmers, in accordance with ARDSP and its institutional program. Finally, the Centre for Biological Research of the Northeast (CIBNOR), established in 1957, generates scientific knowledge through research that responds to the needs of the agricultural sector, leveraging as well strong private sector relationships. CIBNOR operates mainly in the North, with its headquarters in La Paz, Baja California, and branch offices in Baja California Sur (Guerrero Negro), Sonora (Guaymas and Hermosillo), and Nayarit.

2.0 The Evolution of Agricultural Extension in Mexico—Divergence and Convergence

Although public agencies began conducting limited extension activities early in the 20th Century, formal agricultural extension services were launched in 1933, with the founding of the Department of Agricultural Development. From 1934 to 1940, agricultural extension boomed through President Lázaro Cárdenas del Rio's support of land distribution to farmer organizations. According to Terán y Terán (2008), public extension services consolidated officially in 1947, building on Cárdenas policies and when the department of Agricultural Development renamed the Department of Agricultural Extension in 1948 (Reyes Osorio, 2013). At that time, the USA had been operating agricultural extension services through land-grant universities for several decades. Lacking a similar system, Mexico started an "extension experiment" by contracting regionally based agronomists through the Secretary of Agriculture (Terán y Terán, 2008). So, rather than being provided by universities, extension services are offered by the government. In Mexico, "extension" is understood as instruction, technical guidance and practice made available to farmers, while "technical advisory service" refers to an intervention at individual farmer level. Because the challenges faced by rural inhabitants in Mexico are not only agri-technological but also socio-economic, a new concept of "rural extension" emerged (Vázquez Alvarado, Solé Salgado, Gutiérrez, & Trinidad Ruiz, 2015), aiming at the informal education of rural populations and requiring multidisciplinary knowledge and practices that strengthen an integrating and motivational vision regarding tradition and where communication has much to contribute.

The present-day situation reflects administrative changes begun in 1982, with a new economic paradigm based on competitiveness, opening to external markets, and a new vision for development that included a heightened role for the private sector and, even, the privatization of parastatal enterprises and public services for agricultural. With this came a reorientation of extension toward productivity, in accordance with the demands of international markets and the elimination of longstanding trade barriers that had been fashioned to protect Mexican agriculture (Salcedo, 1999), as well as the removal of the official extension system. In 1988, government policies promoted the creation of enterprises and independent consultant groups under a subsidized payment scheme, where in some cases the accredited farmer was obliged to gradually absorb the cost of technical assistance (Salcedo, 1999). In other words, agricultural extension became a practice where sector professionals guided the knowledge transfer and productive processes for rural development.

[1] Of 420 PRODETER regions, INIFAP operates 128 directly and 110 in collaboration with state governments.

Thus, with a focus on developing practices and tools to increase productivity, extension in Mexico evolved during the second half of the 20th century towards a centralized model of accredited professional service providers paid with public resources. As a result, today there is no single extension model in Mexico, as signaled by the OECD in 2011 in the publication 'Analysis of the Agriculture Extension in Mexico (McMahon & Valdés, 2011), but a multitude of schemes operated by independent entitites (INIFAP, COLPOS, CIMMYT, CIBNOR, UaCH, among others) that offer technical assistance to farmers as part of distinct support programs of the Secretary of Agriculture and which depend on the context, budget and local demands and are aligned with federal policies. With the "Law of Sustainable Rural Development" passed in 2001 as regulatory law of Article 27 of the Mexican Constitution, the federal government continues to develop capacity building schemes for the rural population and their organizations to improve agriculture, foster sustainable rural development, and increase rural entrepreneurial skills. During this period a service fee was put in place for training, technical assistance and consulting to stimulate the emergence of a market for private extension in support of locally-oriented governmental programs. Because of this, in Mexico someone who carries out extension work for the government is called "an extensionist," whereas those contracted by other actors are denoted "professional service providers" (Vázquez Alvarado et al., 2015).

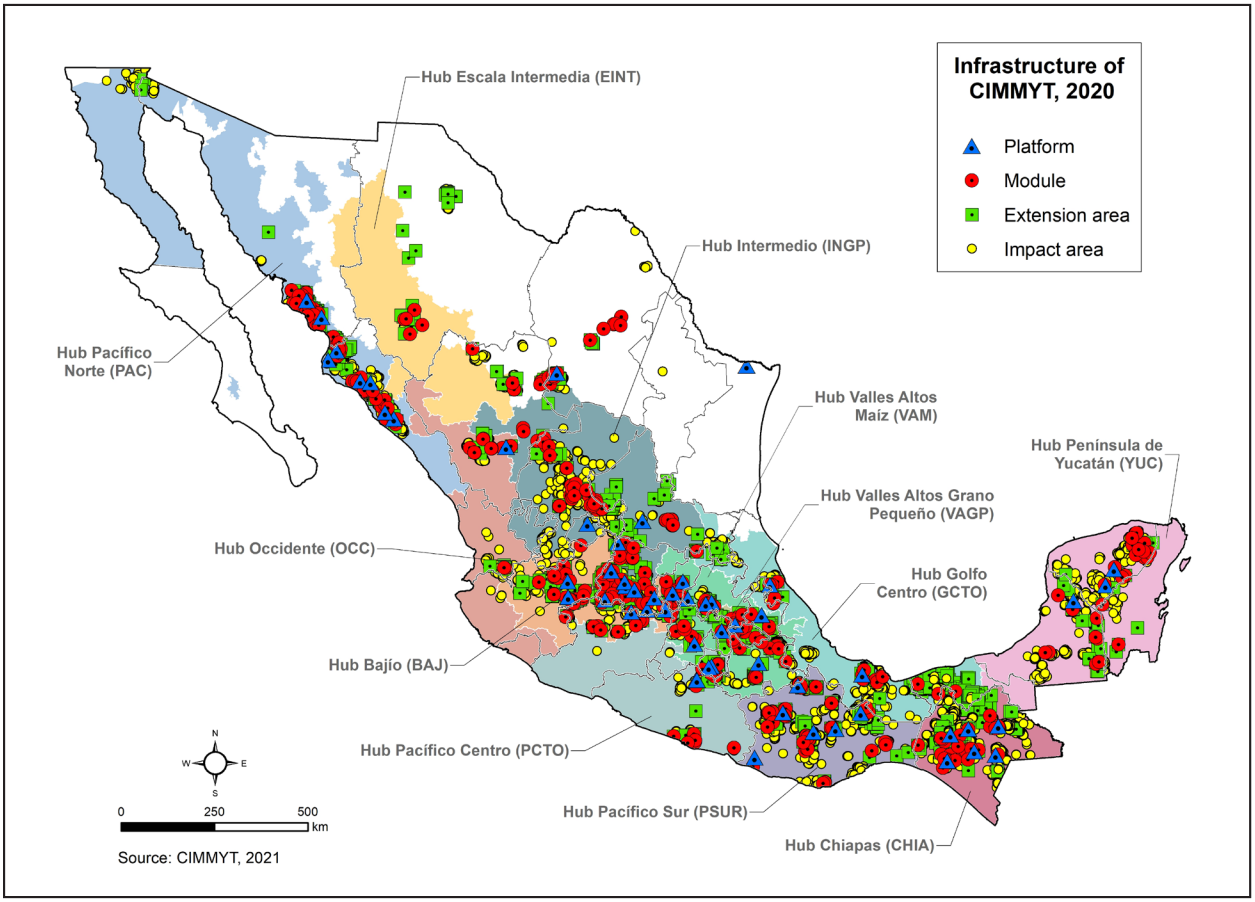
These institutional changes have generated a broad panorama of structures and elements to catalyze innovation under particular conditions and in specific settings, but lack the ability to generate feedback loops or systemic evaluations of quality and learnings to foster institutional interaction (Govaerts et al., 2019). Moreover, except for INIFAP's Specialized Technical Units[2] (STU) for livestock services during 2008-12 and the STU for agricultural services during 2011-13, there has been no formal linkage between research and extension in Mexico. However, responding to this need and in view of its commitment to increase the productivity of maize and wheat crops, CIMMYT has developed a methodology that promotes collaboration among local actors through participatory schemes, with farmers as the main agents of change. The MasAgro initiative started in 2009 as a model based on design thinking, through which CIMMYT, as an independent broker, coordinates public-private partnerships involving INIFAP, state universities, and companies, among others, as well as integrating service providers by agroecology. The aim is to consolidate efforts attending to farmers' needs, according to their scale of operation, production systems, technology level, and socioeconomic circumstances (Liedtka, Salzman, & Azer, 2017).

The model interprets agricultural extension as a technical mentoring in support of experimentation and adoption of good farming practices by leading farmers, researchers, and change agents. This operates through innovation nodes or hubs located in agroecological zones defined by crop (maize, wheat and associated crops) and farming system. Each hub features an infrastructure of learning spaces including research platforms, modules, and extension and impact areas that facilitate networking, knowledge exchange and co-creation (IICA, 2016). In research platforms, local scientific partners evaluate technologies and local knowledge to develop recommendations for farmers. In the modules, farmers are connected to peers, farm advisors and other value chain actors. Together they implement and adapt best practices from research platforms and compare them with conventional practices. Extension areas are fields where farmers test solutions in connection with modules or research platforms. Impact areas are where farmers have adapted and adopted similar innovations on their own. This network of stakeholders seeks to innovate and improve the sustainability of agri-food systems, through increased awareness, knowledge sharing, and the alignment of value chain actors (Gardeazabal et al., 2021). Each component of this infrastructure is built upon an agreement of collaboration and shared commitment in response to farmers' needs.

[2] The Specialized Technical Units (STU) were created in 2008 under the guidance of the Under-secretariat of Rural Development, now the General Coordination of Rural Development, of the Secretary of Agriculture and Rural Development (SADER) to create a strategy for training, technical support, monitoring and evaluation of the subsidized professional services farmers receive.

Thus, through the hubs agricultural extension becomes a dynamic social process involving farmers, farm advisors (or professional service providers) and extensionists, researchers and their institutes, and companies, to exchange information and knowledge and increase innovation and productivity, without losing a local focus and ensuring feedback for quality control (Liedtka et al., 2017). CIMMYT operates 12 hubs covering 29 of 32 states, with 38 active experimental platforms connected to 308 modules and 790 extension areas in 2020 alone (Figure 2). From 2010 to 2020, farmers on more than 1.3 million hectares have adopted innovations transferred through the innovation nodes.

Figure 2
Infrastructure of CIMMYT's 12 innovation nodes or Hubs in Mexico for 2020



Source: CIMMYT (2021).

Simultaneously, INIFAP has promoted extension services provided by national institutes, building on more traditionally implemented participatory models. At present, through its 38 experiment stations throughout Mexico, technicians and farmers are trained in the use of technologies and related processes for agriculture, livestock and forestry. INIFAP shares its own science and that of others through the publication of agriculture, livestock and forestry journals, along with teaching materials based on the published findings, for use by farmers and technicians and more general distribution to the target audience; materials to support testing activities and backstop demonstration plots. Perhaps INIFAP's most successful and long-lived transfer model has been the Ranchers Groups for Validation and Technological Transfer (Spanish acronym, GGAVATT), focused on livestock ranchers and operating in all Mexican states up to 2018. It featured three key agricultural extension components: field research, technical support, and linking extension workers with farmers and ranchers. INIFAP's transfer models in support of technicians, extensionists, facilitators, and innovators have operated on diverse financing (national or international, public or private, or combinations of these), along

with state-level support to ensure continuity and distribution of money transfer to the farmers. The INIFAP models have been replicated abroad under bilateral agreements between Mexico and Belize, Brazil, Colombia, Nicaragua, and Paraguay.

As part of its distinct vision, CIBNOR promotes its staff's strategic agroindustry research as the basis of its extension-related activities and services. These have operated as of 2019 by way of its "Coordination of Linkages, Innovation and Knowledge Transfer to Society" programs (Spanish acronym, COVITECS) to generate and disseminate scientific knowledge and innovations and develop technology and human resources, addressing the needs of farmers, organizations, institutes, and companies at regional, national and international levels. CIBNOR's broad coverage owes partly to extensive partnerships with universities, public research institutes and government agencies, NGOs, and international organizations.

The more traditional agricultural extension strategy of COLPOS balances scientific research and the preparation of academically trained specialists with the field-based services of training and technology transfer towards farmers. The implementation of "Plan Puebla"[3] in 1967 proved the effectiveness of combining scientific research with extension services and working directly with farmers and their families to promote innovations with demonstrated potential to increase productivity. Building on this nationally and internationally recognized experience, COLPOS has updated its strategy to extend capacity building and technology transfer to social groups in areas near its campuses and, especially, those considered highly marginalized, designated "Priority Care Microregions."

These approaches have converged as of 2018 under the guidance of the current federal administration and building on a national "diagnosis" by the Secretary of Agricultural and Rural Development to design a "Program for Rural Development," within the framework of the National Development Plan 2019–2024. The diagnosis included an extensive review of extension services and the capacity building requirements to address the needs of smallholder farmers and fishermen. The Program for Rural Development aims to sustainably increase the productivity and incomes of rural households, designated "Family Production Units," in highly marginalized locations including Priority Care Microregions (Diario Oficial de la Federación, 2018). The Program is implemented through the Secretary of Agricultural and Rural Development's 191 Rural Developments Districts and 713 Rural Development Support Centers in 32 states and in coordination with state-level governments. The Program also designated 420 PRODETER intervention areas in which since 2019 a five-year intervention is underway to achieve established goals established.

3.0 Capacity Building as a Requirement for the Continuity of Extension Work

3.1 Field Schools Under the Motto "Learning-by-doing"

A key part of the INIFAP agricultural extension models is the formation and training of technicians, farmers, and children of farmers through practical, learning-by-doing courses and seminars conducted in field schools. Work and demonstration modules allow technicians, farmers and other local actors to interact and facilitate adult learning, which are especially important considering that the average age in rural communities 53 and many inhabitants are functionally illiterate or do not speak Spanish (technicians are often from the communities and speak the local languages). Targeted support tools include flyers and other print materials, along with audiovisuals and on-line resources (see, for example http://clima.inifap.gob.mx/lnmysr).

[3] This work was done in collaboration with CIMMYT

3.2 Mutual Capacity Building Through Applied Research for Higher Education

Although COLPOS's activities on training and technology transfer are mainly for higher education and research, they also provide a feedback pathway regarding the relevance of academic work, helping to ensure that professors or research reflect reality in the field and remain updated on context-specific social and economic techniques. The institution's applied research takes place through seven campuses, but locally-imparted farmer courses can be highly relevant for a region and important for Mexican agriculture. Topics of interest have included small-scale agriculture and climate change, soil conservation and integrated water management, high-yielding crop varieties, postharvest storage practices, biotechnological innovations for disease control, livestock genetics and nutrition, organization of the farmer-production-marketing chain, and the need for sustainable, environmentally-friendly production (Tables 1 and 2).

Table 1
Number of training courses per COLPOS campus delivered to respond to the Priority Care Microregions (PCM)

Campus	Year					
	2015	2016	2017	2018	2019	2020
Campeche	23	0	36	35	18	44
Córdoba	54	148	130	15	58	31
Montecillo	32	79	15	37	22	0
Puebla	196	58	56	142	165	150
San Luis Potosí	21	5	5	4	12	8
Tabasco	20	8	5	6	3	3
Veracruz	35	28	86	32	24	10
TOTAL	381	326	333	271	302	236

Source: Personal Communication with Dr. Francisco Escobar Vega (www.colpos.mx).

Table 2
Main technology transfer activities and thematic for COLPOS, related to activities in the PCMs

Campus	Activities
Campeche	Management of high-density fruit trees Nursery production of forest species and use of GPS in the field Production of edible mushrooms in contribution to food security Biological crop control: Maize, Sugar Cane, Chihua pumpkin and cattle Business strategy for the production system: Chile habanero Tilapia farming in rural systems
Córdoba	Production and soil conservation Coffee roasting Integrated sheep management Beekeeping and meliponiculture Compost and vermicompost production Adding value to products from the beehive
Montecillo (State of Mexico)	Greenhouse flower production Mushroom production Production and commercialization of back-yard garden produce Dairy products and artisanal cheeses Industrialization of pig meat
Puebla	Demonstration modules for staple food crops Promotion of family and back-yard livestock production Agroecological management of fruit trees mixed with maize (MIAF) Pruning and orchard management (walnut, peach, hawthorn, etc.) Smallholder farmers organization

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San Luis	Use of Higuerilla for bio-energy and its by-products
Potosí	Participatory stratified mass selection of native maize for arid regions
Campus	**Activities**
Tabasco	Back-yard vegetable production module and poultry in subtropical regions In situ cocoa breeding Vermicompost and vegetable production Organo-ponic modules
Veracruz	Demonstration module for Malayan shrimp larvae production Demonstration module for edible mushroom production Hydroponics and soilless crops demonstration module Demonstration module for Moringa oleífera

Source: Personal Communication with Dr. Francisco Escobar Vega (www.colpos.mx).

3.3 Extension as an Integral Part of Scientific Research

The objectives of the different advisory, training and extension activities that are carried out for farmers by CIBNOR respond directly to its mission, vision and strategic objectives mentioned above and are reflected in its Academic Programs for Scientific Research (Table 3). All extension activities and services are aligned with the National Development Plan, as well as state- and municipality-level plans for food production.

Table 3
Research programs and strategi research lines for CIBNOR's intervention areas (La Paz, Baja California Sur and Northeast of Mexico)

Academic program for scientific research	Strategic research lines	Intervention area
Aquaculture program	Plankton biotechnology. Biology and development of techniques for the production of mollusks. Biology and development of techniques for the production of Crustaceans. Biology and development of techniques for fish production.	Guaymas
Dry zone agriculture program	Organic agriculture. Phytosanitary and food safety Agrotechnology and energy resources. Water, soil and climate for agriculture in arid regions. Biotechnology and the use of genetic resources.	Guerrero Negro
Fish ecology program	Effects of fishing in socio-environmental systems. Exploration, planning and sustainable development of new fisheries Variability and vulnerability of marine ecosystems. Maximizing the economic value of fishery products. Recovery, management and sustainability of new fisheries.	Guaymas
Environmental planning and conservation program	Ecosystem processes and environmental services. Oxidative stress. Coastal Systems and their environment. Biodiversity in Mexico: Problems, uses and conservations. Research for sustainable Development. Environmental microbiology Natural history museum: Taxonomy and systematization.	Hermosillo, Nayarit and Guaymas

Source: CIBNOR/Alejandra Nieto.

Most CIBNOR extension is an integral part of specific scientific research and transfer programs, so it is the investigators and technicians who conduct it and these people have become experts in their specialty. The academic profiles of most CIBNOR researchers includes postgraduate degrees (MSc and PhD), while farm technician profiles are more diverse. Researchers and technicians play complementary roles. The core vocation of CIBNOR is scientific research; extension is seen as complementary and a voluntary pursuit of researchers.

3.4 Extension to Mentor for Innovation and Human Capital Development

CIMMYT implements agricultural extension through a community-based approach and mentoring for innovation, seeking the long-term transfer of knowledge and fostering adoption of efficient practices for field-level innovation. This differs from traditional extension, in that it aims to consolidate and accelerate technical farm assistance supported by an enabling, knowledge management environment in which the farmer is co-proprietor and co-developer of innovative solutions. Key features include the following:

- Hub infrastructure is functional, dynamic and adaptable to different public policy programs for technical assistance and in accordance with the diverse needs of small-, intermediate-, and large-scale farmers.
- The direct, continuous and timely mentoring of farmers to co-develop and adapt innovations and encouraging farmer-to-farmer adoption for greater impact.
- Networks of collaborators-trainers constantly update their knowledge and skills for tutoring, monitoring, and evaluating farm advisors or technicians.

The development of human capital and the positive impact on rural social cohesion fulfills a strategic role in this framework and ensures that extensionists meet quality expectations, connecting science and technical expertise through farmer interactions. In this way, the innovation hub and network of collaborators-trainers offers pluralistic trainings as described in various studies (FAO, 2010; Missika, 2006; Otoo, Agapitova, & Behrens, 2009), able to focus simultaneously on the individual, organizations and the social setting, while giving equal priority to all three. The formation of individual leaders and change agents helps to develop stronger institutions; these institutions provide alternative norms and develop conducive environments for staff to develop those skills and, subsequently, individuals and institutions with a greater capacity to effect change (Gill, Jones, & Hammett, 2016).

As part of capacity building, CIMMYT pursues joint research with the National Agricultural Research Systems (SNIA) and involving national and international students from undergraduate and graduate degrees, to promote knowledge and a sense of vocation in present and future generations of scientists, while also offering training for agri-food system professionals and value chain actors, aiming to develop management and agronomic skillsets.

As part of the above, the Center conducts the “training-of-trainers” (ToT) and a “certified technician” program in sustainable agriculture. The ToT scheme connects theory with farmers’ traditional knowledge through in-person interactions and learning spaces in innovation hubs, constituting continuous learning for farm advisors and technical service providers and allowing them to make informed, creative relevant, and flexible decisions in diverse contexts and use their knowledge, ability and attitude responsibly. The certified technician course offers prospective or experienced farm advisors high-level, specialized training in sustainable agriculture, developing the technical and methodological knowhow to speed the spread of profitable, climate-smart farming tailored to local conditions. The course enables graduates to prioritize innovation, results, and accountability, following international guidelines such as those of the OECD (McMahon & Valdés, 2011) and standards of specialized research centers for technology transfer and agricultural innovation (Aguilar Ávila, Altamirano Cárdenas, & Rendón Medel, 2010). Regular interaction among trainers and

the expert assistance of certified technicians enriched through farmer feedback foster continual monitoring how improved practices and innovative technologies are applied throughout the crop cycle. Since 2009, CIMMYT has trained 449 certified technicians in 7 hubs and built a network of 24 trainers, all contributing to an average 400 field demonstrations and farmer training events annually, with a cumulative reach of over 300,000 participants.

In addition, through the federally funded support program "Technical Assistance to Beneficiaries of the PROAGRO Productivo Component," MasAgro has provided technical mentorship to nearly 35,000 farmers working on more than 68,000 hectares, including personalized assistance with agronomic planning, in 16 Mexican states (Campeche, Chiapas, Estado de México, Guanajuato, Guerrero, Hidalgo, Jalisco, Michoacán, Oaxaca, Puebla, Querétaro, Quintana Roo, Tabasco, Tlaxcala, Veracruz, and Yucatán) during 2017–2018.

4.0 Attention to Farmers in a Changing, Multidisciplinary and Globalized Environment

4.1 Innovation Management Model for Competitiveness

Working with marginalized farmers in south-southeast Mexico, INIFAP aims to create innovation empowerment or appropriation among farmers by matching technology offerings with available natural and farmer resources, as well as providing training for agribusinesses, working through iterative improvement and building on the institute's technology portfolio, as well as that of partners and farmers themselves. Technicians play a pivotal role to bridge farmers and research and therefore must be able to further the requisite interactions. Agribusiness training is critical to add value to produce and increase farm household income, particularly regarding the choice of products to grow/market and how to launch and run a business.

4.2 Specific Attention to Priority Regions

The work of COLPOS operating 14 PCM across agroecological zones has received special attention in recent years, with the UN and FAO emphasis on uplifting family farms and smallholder production systems to foster food security in developing nations. PCM activities in part aim to address decades of rural outmigration by working-age males in Mexico, with training and technology transfer targeted to women and older men who increasingly lead households and agriculture. Updates on this work are submitted regularly to a special government commission on the issue and feature in presidential reports.

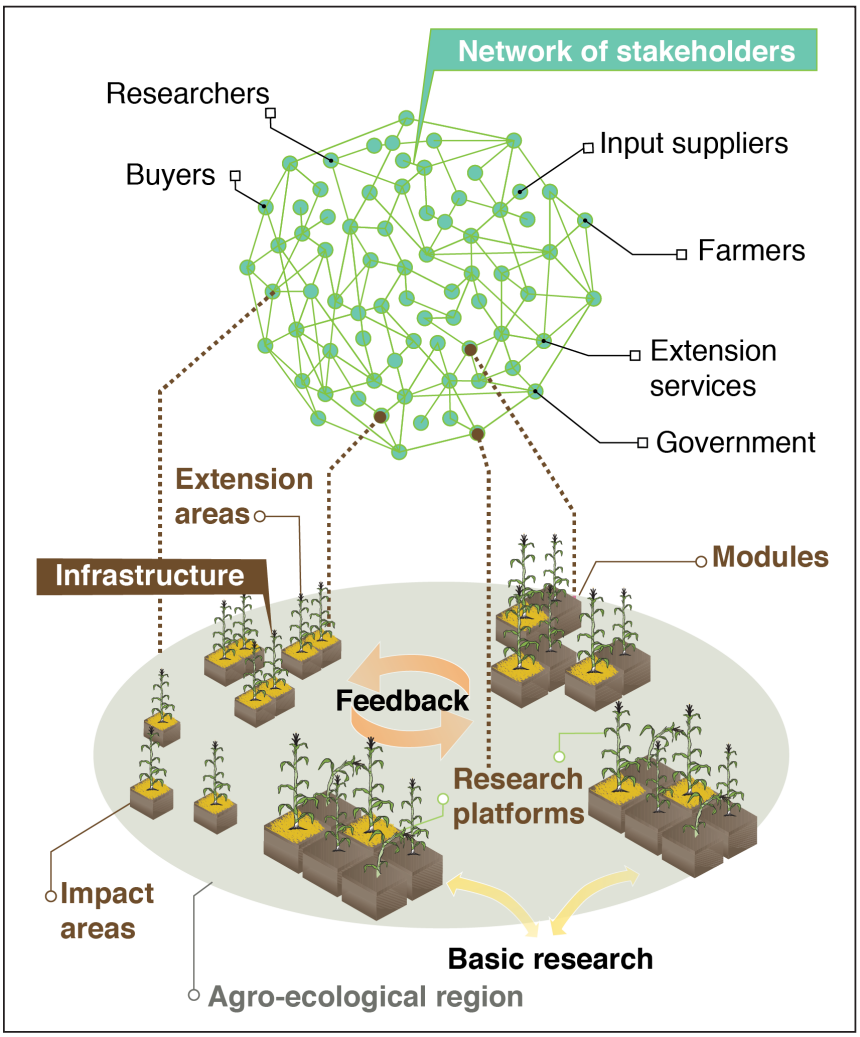
4.3 Demand-Based Service Delivery

To attend to stakeholders' extension needs, CIBNOR works to deliver on-demand services requested by farmers, public organizations or companies. COVITECS coordinate such requests based on perceived needs for innovation as articulated by their scientists and technicians, as well as students, entrepreneurs, and social and production sector actors. Such services may or may not be charged and can include courses and workshops, technical or scientific assistance, diagnostic services, lab and other analyses, transfer of biological materials, or knowledge or technology transfers. Services are usually provided through personal interaction or group events and digital and written materials, including technical manuals, educational brochures, and outreach materials.

4.4 Innovation Networks and Knowledge Management for Agri-Food System Innovation

MasAgro and its innovation mentoring model have established a network for effective communication regarding maize and wheat agri-food system innovation among farmers, independent practitioners and academics from national and international research communities (Figure 3), featuring diverse channels for social interaction and catalyzing cross-border knowledge flows and digital access (Gardeazabal et al., 2021; Govaerts et al., 2019).

Figure 3
Graphical representation of the innovation networks emerging from CIMMYT's HUB model (adapted from Gardeazabal et al., 2021



Source: Gardeazabal et al. (2021).

The network is complex, with intensive, interrelated processes that require adaptive and integrative knowledge management and a high awareness of actors' priorities and relationships and of the linkages among technologies, practices and proposed solutions (Camacho-Villa et al., 2016; Schut et al., 2016). Its operation also requires an open attitude to support knowledge creators and disseminators, including local and regional intermediaries (Hellin & Camacho-Villa, 2017), as well as to facilitate feedback and overcome barriers to an holistic application of science, policy, and practice. The preceding is supported by a data capture system, as well as other digital science and communications technologies, to monitor progress, analyze outcomes and

generate recommendations at the field, landscape, country, and regional levels and within technical, commercial and political spheres (Gardeazabal et al., 2021).

For Mexico, CIMMYT has setup a monitoring and evaluation dashboard to capture learning and support accountability from field level data for up to 500 variables loaded by farmers, technicians and partners (CIMMYT, 2020). Data for activities from more than 200,000 fields have been registered, helping to hone agronomic recommendations and this is considered a frontier technology for agricultural extension (Analytics, 2020; SDNS & TRENDS, 2019). With such technologies, CIMMT strives to strengthen knowledge management for innovation, improve the understanding of the complexity of agricultural extension in Mexico, and face the challenges of the country's diverse environment.

Government support of MasAgro helped to drive a paradigm shift in agricultural extension toward increased innovation based on an inclusive model of shared knowledge. A renewed commitment under the umbrella program "Crops for Mexico," led by CIMMYT and Mexico government through the Secretary of Agriculture and Rural Development, will replicate this model in multiple production systems and their value chains in order to broaden efforts to attract and leverage public-private co-investment to scale it Mexico-wide (Govaerts et al., 2019; IICA, 2016).

4.5 Extension Services Based on Strategic Planning and Participatory Diagnosis

From the federal government, the Program for Rural Development has started work in 420 PRODETERs with 100 extension workers specialized in strategic planning, to unite farmer groups of farmers and conduct participatory planning, identifying local problems and investment priorities for increased household productivity and income. In parallel, research and technology transfer activities are being led by competent institutions with local presence, experience, and technologies, including INIFAP, the National Fisheries Institute, COLPOS, UACH and several state universities.

Diagnostic and the planning exercises by locally-bound extensionists and farmers groups have defined relevant projects to strengthen primary production and economic integration, for implementation by 400 investment project development specialists. Best-fit extension profiles and technicians will be chosen for each project and value chain, the latter corresponding mainly to those that can ensure local food supplies in each PRODETER (e.g., maize, beans, milk, honey, coffee, fruit trees, meat and aquaculture-fish).

In the 420 PRODETERs, 2,600 extension workers from diverse agricultural, livestock, fishery and socioeconomic disciplines have taken part in strategic planning, investment project development, and project operation, as requested and endorsed by farmers. These efforts have afforded support to more than 123,000 farmers in over 550 priority care and highly marginalized municipalities in 32 states.

5.0 Discussion: Extension in a Development Context

The national extension strategy reflects the aims of improving livelihoods and increasing food security in rural communities, by stabilizing basic food production and access to healthy diets (Swanson, 2008). Institutions such as INIFAP and CIMMYT reflect the national vision, helping to coordinate and integrate of multiple interventions and targets programs. The need to remain flexible to enable context-specific implementation and delivery is nonetheless clear, and this is where institutes like COLPOS and CIBNOR fit in.

Public-led extension for resource-poor farmers differs great from that targeting commercial scale farm enterprises (Swanson, 2008). Located in the North, where large commercial agri-businesses dominate farming, CIBNOR follows an outreach model tailored for private extension service providers. Export-oriented value chains, such as avocado, tomato and berries, generally receive no attention from public extension. Other

highly productive and commercially oriented value chains in the same region have often depended on farmer associations, in the absence of a privately organized extension services, and these have contributed significantly to Mexican research and extension.

Private-led extension in Mexico has focused on market demand, whereas public agricultural extension services have been linked to rural development goals and tackle issues such as food security and increased productivity, viewing "public goods" concerns such as social cohesion and natural resource management as of secondary importance.[4] Notwithstanding, in recent years several federal initiatives of the Secretaries of Well-being and Education, with support from the Secretary of Agriculture and Rural Development, have also addressed the later.

Besides COLPOS, which has a strong research and extension arm, and several others[5], universities do not play a significant role in technology transfer or even the formation of future professionals in this field. Mexican agrarian universities have no mandate for extension, mainly due to the scarcity of representative educational institutes in rural communities and the lack of finances.

Perhaps because of this, similar to the farmer associations' support in the North filling the void of private-led extension, CIMMYT took on the role of linking its research for development capacity with extension in Mexico to scale innovations and strengthen agri-food innovation systems, given its close relationship and longstanding collaboration with Mexican policymakers and organizations. State governments also have a strong role in organizing and supporting extension services, as exemplified by the state of Guanajuato providing strong support for MasAgro and operating its own version of the MasAgro model since 2013.

An interesting question is if Mexico's agro-ecological diversity accounts for the country's varied state-level extension approaches or if it's the national development context that results in a lack of coordination between state and federal governments?

6.0 Public Policies and Extension in the Agri-Food Sector

6.1 Areas of Opportunity and "Disruptive" Improvement

The ARDSP 2020–2024 mentions extension as a strategic policy instrument toward sustainable agriculture, aquaculture, and fisheries, encouraging in farming the efficient water and soil use and their long-term availability, as well as integrated disease and pest management, the conservation and recuperation of ecosystems services and the effective coaching of diverse farmers. Aims for the latter include changing farmers' mindset and improving their skills, while acknowledging their culture and incorporating traditional know-how to preserve natural resources and stabilize or increase productivity.

In addition, to shake up the paradigm that extension should focus solely on production activities directly related to field operations and limited to the field itself, the idea of extension with a localized vision is proposed, recognizing the reciprocal connections of land use with the natural environment and landscapes. In fact, the natural resources and ecosystem services of landscapes are an integral part of agricultural, aquaculture and fisheries, so considering their availability and limits is one of extension's great challenges.

From this perspective, agricultural extension must promote sustainable practices that maintain or increase productivity while conserving and integrating the biodiversity of its production systems. This approach will contribute to climate change adaptation strategies and farmers' resilience by taking advantage of all available

[4] With notable exceptions being the work of CONABIO (https://www.gob.mx/conabio) and CIMMYT's effort for sustainable and climate-smart approaches

[5] The universities of Chapingo and Chiapas are part of the Interinstitutional Groups for Extension presented in 2018 (Cadena-Iñiguez et al., 2018), while others, like the UAAAN, at present actively collaborate in the diverse rural development and agricultural extension projects.

practices, knowledge and technologies and shaping production according to farmers' local environmental and socioeconomic conditions. The main challenges for extension are to understand which tools and practices can be used for each production system and to ensure that each practice in the proposed menu of solutions has a sound scientific and evidence base and fits the socioeconomic context.

For this holistic vision to become reality, universities and the National Centers of Higher Education centers for agriculture must shape professionals able to address multidisciplinary challenges related to agroecologies, climate smart ecosystem management, and establishing competitive value chains in local and regional agri-food systems. Research centers should support the demand-based development of landscape-level alternatives through dialogue with farmers, considering traditional knowledge and share sustainable innovation with farmers and their communities.

Finally, agricultural extension "delivery" must be supported through effective communication and in a permanent dialogue with famers, extension workers, technicians, researchers and governmental authorities. The channels established for this should enable continual (rather than occasional), open communication and motivate farmers to learn about innovations and incorporate new practices but holistically facilitate the integration of effective traditional know-how and techniques. Extension should also include youth and women in the extension work force and as part of the target population, considering the shifting demographics of rural communities and to stimulate generational renewal and the inclusion of women in the dialogue for productivity, if the way of life linked to primary production is to survive for those that choose to remain in the Mexican countryside.

6.2 Vision for Extension Services in the Framework of the 2020–2024 Sector Program

The Mexican countryside requires a continuous redesign of extension in line with arising challenges in the agricultural sector. Extension services can offer a solid avenue for improved smallholder productivity and incomes in poverty prone areas, but only when integrated and implemented in a coordinated manner, as described in the Program for Rural Development, avoiding unarticulated participation in the value chain participation that perpetuates the current, unequal distribution of income and wealth.

The new vision for national agriculture is one of food self-sufficiency, while safeguarding natural resources and growing food with a sustainable and inclusive focus, building on knowledge-based agriculture and capacity development through extension. Accomplishing this transition will require specialized extension service agents able to catalyze greater productivity in agriculture, aquaculture and fisheries, incorporating science and sharing know-how for innovative research, technical coaching, advisory services and capacity development. National markets and participants need to be strengthened through organization and association, the development of entrepreneurial skills, access to finance, functional local markets, and the promotion of common goods for rural distribution, supply, and consumption. Localized interventions based on strategic participatory planning will contribute to the well-being of rural populations through the inclusion of historically excluded farmers. Finally, the promotion of sustainable production practices through new knowledge-management, technology, and methodological models will help reduce farmers' agroclimatic risk.

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Overview of the United States University-based Public Cooperative Extension Services

Dr. Lou Swanson, Colorado State University, David Nielson, NAAAN Secretariat, Dr. Doug Steele, Association of Public and Land-Grant Universities, Dr. Cathie Woteki, Iowa State University

Agriculture is increasingly a knowledge- and information-intensive industry. As such, there is an important public good element to the support of the agricultural sector. Accordingly, for more than a century, the public sector in the United States has invested heavily in agricultural research, agricultural education, and agricultural extension. This chapter discusses the origin, nature, and evolution of public sector support for these endeavors, particularly on public support for agricultural extension.

Agriculture, and the need for public support for agricultural extension, have evolved a great deal over the past century—and the private sector has emerged as an essential source for many aspects of agricultural knowledge and information. However, the public sector continues to provide substantial support to agricultural extension. The role of publicly-supported agricultural extension in the United States is summarized on the Cooperative Extension Section page of the website of the Association of Public and Land-grant Universities (APLU) in the following way:

"Extension provides trusted, practical education to help people, businesses, and communities solve problems, develop skills, and build a better future. Campus-based faculty members are disciplinary specialists with doctoral degrees whose primary responsibility is to develop curricula that translate science-based research results into language (written, verbal, and electronic) appropriate for targeted audiences. County-based educators (most of whom have graduate degrees) work with local citizens and interest groups to solve problems, evaluate the effectiveness of learning tools, and collect grassroots input from prioritizing future research. By living and working in communities, county educators respond to local needs, build trust, and engage effectively with citizens. Program Areas include but are not limited to 4-H Youth Development, Agriculture, Family & Consumer Sciences, Health and Nutrition, Community Development, Water and Natural Resources, Forestry, Emergency Preparedness, Climate Variability, Volunteerism, and Human Sciences."[6]

Publicly supported agricultural extension in the United States is wholly owned by the states (not the federal government). Extension in each state is based in, and managed by that state's land-grant university (LGU) or several LGUs. For most LGUs, the director of Extension reports to a Dean or a Vice President. Although publicly supported agricultural extension is a program of each LGU, funding for each state's agricultural extension system comes from a variety of sources, typically including, among other things, funding from federal, state, and county governments. Of these funding sources, the state government is the most important in most, if not all, states. While public agriculture extension in the U.S. is state-owned, a collaboration among all the state services, and support from the United States Department of Agriculture (USDA), have led the collection of state extension services to be seen as a national US Cooperative Extension System.

The state-owned, university-based structure of the US Cooperative Extension System is unique compared to public agricultural extension programs in other countries. Most public agricultural extension systems around the world (with some exceptions) are the province of national (not state or provincial) governments and, correspondingly, are typically situated within national ministries of agriculture rather than within agricultural universities. Further, agriculturally oriented universities worldwide are most often situated institutionally

[6] https://www.aplu.org/members/commissions/food-environment-and-renewable-resources/board-on-agriculture-assembly/cooperative-extension-section/

within national ministries of education. They often have only modest if any formal engagement with public agricultural extension.[7]

How did general agricultural extension in the United States evolve so differently from other nations' public agricultural extension systems, even though it was the first national agricultural extension system? Public agricultural extension in the United States grew out of many 19th century local and state initiatives to create state-based higher education institutions that harness science to serve agriculture's practical needs and demands. A series of federal acts (discussed further below) provided support and a certain level of structure for these state and local initiatives. In their association with each other and with the support they receive from USDA, the state agricultural extension systems form a globally unique national system, consistent with the country's political structure of strong state governments.

1.0 History of Agricultural Extension Service in the United States

At the beginning of the 20th century, the earliest public-sector-supported agricultural extension efforts were linked with then-fledgling Agricultural Experiment Stations (AES) of the LGUs. Agricultural research offices and demonstration fields were created during the last two decades of the 19th century by the States (with support from the national government) and their young public agricultural and mechanical colleges. During the first years of the 20th-century, these agricultural and mechanical colleges conducted field days at local (often on-farm) venues. By 1905, states were experimenting with establishing county Extension offices funded by their state and local governments.

The modern US extension system is the product of LGUs' institutional innovations with fiscal support from their states and counties. USDA and the US Congress did not create this system, rather it was created by the States themselves. Still today, public agricultural extension services in the United States are state-owned and reside only at LGUs.

The institutional innovation to create public agricultural extension programs and situate them within LGUs was born simultaneously (and to some extent independently—state by state) at the 19th and early 20th-century LGU colleges. In 1914, the US federal government began to provide financial support to these state-owned initiatives. In 1887, the US Congress passed the Hatch Act that provided federal funding for applied research that advanced local agriculture to the States, with accountability for these federal funds to the LGUs overseen by USDA (The Hatch Act of 1887 | National Institute of Food and Agriculture, 2018). Later, in 1914, the US Congress passed the Smith-Lever Act that provided federal funding, overseen by USDA, supporting the emerging LGU 'university-based Extension services' (The Smith-Lever Act of 1914, n.d.). Examples of late 19th-century field days and the first county Extension offices are in Iowa.

"In 1906, the Iowa Legislature enacted the Agricultural Extension Act making funds available for demonstration projects. It is believed this was the first specific legislation establishing state extension work" (Extension Service: A Historical Perspective | Dubuque County, Iowa, n.d.).

In summary, both LGU AESs and Extension services were initiated by the states and their farmer and rancher constituencies.

The Smith-Lever Act provided federal funding support for the emerging state-owned LGU Extension services. These funds required federal funding to be matched by the States. Since 1914, Smith-Lever Act

[7] This country chapter focuses on publicly-supported university-based agricultural extension. Public agricultural extension is only one part of the overall agricultural advisory service universe in the US—private and not-for-profit agricultural advisory services are also important. Discussion of these services outside of the public elements of the US Cooperative Extension System will be developed in follow-up stages of NAAAN's Mapping Exercise.

created an enduring federal government, state government, and LGU university partnership to support Extension programming. Accountability for LGU expenditure of federal government funding, but not for State and local funding, rested with USDA. This federal accountability mandate eventually provided the incentive for all the LGUs to work together in delivering standardized reports on their use of Smith-Lever Act and Hatch Act funds. Developing standard reports to USDA was in the LGUs and USDA's interest. It provided an early incentive to create a national organization for collaboratively developing programs and standardization of reporting. The States and their LGUs created extension services in collaboration with their AESs to disseminate knowledge and information (including the results of practicable agricultural research) to farmers and ranchers. A typical early form of collaboration among LGUs was sharing AES and Extension Bulletins among their libraries.

The seemingly rapid emergence of LGU AES and extension services was the product of the United States' 19th-century local and national level interests in creating knowledge that could improve agricultural production and productivity. US LGUs are the product of a national commitment to science and public higher education teaching, research, and engagement/outreach. This 19th-century push for higher education and science was embedded in an emerging national cultural belief that the creation and dissemination of knowledge produced wealth and social prosperity.

The national coordinating association of LGU extension services is the Extension Committee on Organization and Policy (more on ECOP below). This is an administrative platform managed by the LGUs as they collectively standardize their typical relationship with USDA. Today, USDA continues to oversee the expenditure of Smith-Lever Act funds. USDA works collaboratively with the LGUs on this, and, together, USDA and the LGUs report to Congress. In turn, the LGUs lobby (in part, through APLU) for continued Congressional funding for USDA's partnership with the LGUs for Smith-Lever Act funds and AES Hatch Act funds.

1.1 19th Century science, technology, and public universities

Mid-19th century America was a divided nation, one so divided that the most cataclysmic event in its history, the Civil War, nearly broke it. It also was a time when America was alive with European visions of science and technological innovations driving industry and improving agricultural production. The US was greatly influenced by emerging European science, particularly in agriculture. As in Europe, US science emerged unevenly and regionally. It was driven by intellectual challenges to rationally understand nature and apply natural laws to the economy and the creation of wealth.

Roger L. Williams' (2018) biography of Evan Pugh, one of the visionaries in the creation of the agricultural and mechanical colleges (LGUs) and first President of what is today Pennsylvania State University, offers a detailed account of Pugh's commitment to institutionally establishing science as a foundation for public higher education. Williams' biography of Pugh emphasizes the importance of higher education in Europe as an example for agricultural and mechanical colleges in the US. Vermont Congressman Justin Morrill was the most recognized American visionary to advocate creating public colleges that advanced scientific knowledge and applied education for progressive farmers. His vision championed production enhancing agricultural and mechanical sciences. He and other visionaries saw applied science as the key to diffusing knowledge and technologies (https://www.psupress.org/books/titles/978-0-271-08017-8.html).

Two principal challenges for late 19th century US agriculture were declines in agricultural productivity due to 'soil exhaustion' and the need for improvements in animal husbandry. Congressman Morrill's vision was well known among highly decentralized local scientific societies throughout much of the nation. These small voluntary science societies amounted to a national social movement that advocated for the applied benefits

of scientific farming. They were community-based science education organizations. Many were very familiar with science research and development at US elite private universities and the globally leading European universities. These agricultural societies would become key local advocates for county Extension offices during the first quarter of the 20th-century. Roger Williams' history of establishing what became Penn State University is an excellent historical account of these types of local science societies in mid-19th century Pennsylvania (Williams, 2018).

Congressman Morrill's vision prior to the Civil War was that of a partnership between the federal government's proposed Department of Agriculture, on the one hand, and the state governments, on the other hand, to support the creation of agricultural and mechanical colleges that would educate agriculturalists in advancing the 'arts' of farming. These public colleges were conceived to be the 'people's universities.' Only later, toward the last quarter of the 19th century, was applied research added to this federal-state government partnership with the Hatch Act (1887). Another half-century later, the federal government supported new agricultural extension services with the Smith-Lever Act (1914).

On May 8, 1862, as the US Civil War intensified, President Lincoln signed Congressional legislation that established the USDA (USDA Celebrates 150 Years, 2012) (https://www.usda.gov/our-agency/about-usda/history). On July 2, 1862, President Lincoln signed the Morrill Act (https://today.tamu.edu/2020/07/02/the-morrill-act-still-has-a-huge-impact-on-the-u-s-and-the-world/). Created within weeks of one another, USDA and the LGUs have co-evolved together.

1.2 20th and 21st Century's Continued Development of LGU Extension

Social institutions can be judged by their resiliency over long periods. In most States, Extension was at the beginning comprised primarily of county agents located in county-funded offices. LGU Extension services were local from the start. By this measure, locally-based Extension services are remarkable 19th and early 20th-century institutional responses for public agricultural research and disseminating this research through local offices. Extension has been nimble enough to continue to serve almost all counties in the US for more than a century. This suggests some institutional agility to remain relevant in supporting an evolving agricultural sector and in incorporating new communication technologies, including 21st-century social media. There also are noticeable stresses. Extension started as locally-based university outposts in both rural and urban areas. Presently, Extension continues to be locally anchored with considerable local financial support. An American political adage is that 'all politics is local.' Extension's political resiliency over more than a century is tightly connected to its embeddedness in and responsiveness to changing local conditions.

Throughout the 20th-century and into the 21st-century, communities and the agricultural sector have undergone significant economic and social changes. Extension has been an important factor in instigating change in both domains—economic and social. Extension has also weathered and adapted to significant challenges and even criticism from within the LGUs. LGUs have evolved from relatively small agricultural and mechanical colleges to globally recognized research and teaching universities. World War II, the post-war expansion associated with the GI Bill, massive Cold War investment in university research, and the second rapid increase in scale caused by the baby boom produced qualitative changes on LGU campuses (1945–1995). Among these university institutional dialectics has been the simultaneous expansion of non-agricultural academic colleges and the priority for faculty research. Yet, phenomenal episodic growth experienced by many parts of the LGUs during this period was uneven for Extension and other LGU outreach and engagement functions. These programs have not expanded as rapidly. If budgets are indicators, support for Extension has receded as a university priority (see the section on Sources of funding for public agricultural extension below). The last decade of the 20th-century and the first two decades of the 21st-century were periods of fiscal stress for all US public universities (and for the Extension function within them). For

example, State contributions to in-state student tuition shifted to the student, which has created concern for access to public higher education.

USDA's research portfolios, including the National Institute of Food and Agriculture (USDA-NIFA), expanded greatly through most of the 20th-century as Congressional funding for agricultural research increased. Since then, however, publicly funded agricultural research plateaued and then declined so that today publicly funded agricultural research measured in inflation-adjusted dollars is now below 1980's levels. However, privately funded agricultural research has grown steadily and surpassed public funding. Correspondingly, the nature of the research conducted under public funding has become more focused on topics that have public goods attributes (i.e., issues that the private sector is less likely to explore in their research activities). Just as publicly funded agricultural research at LGUs has declined, AES's applied research and extension's outreach have not kept pace with the nation's other investments in science. In contrast, private sector applied research and development, and corporate 'outreach' has increased, providing many of the functions once only available from the extension.

Public agricultural extension focuses on public good areas and has morphed as many of its earlier services are assumed by the private sector. In earlier years, public agricultural extension featured a strong focus on-farm productivity and profitability. With the growth and modernization of the farming sector, the focus of public agricultural extension has featured a stronger emphasis on topics such as natural resource management, resiliency and mitigation of climate change, nutrition, and other issues that fall under the rubric of public goods —while much of the advice available to farmers concerning productivity and profitability is increasingly available from private sector advisors.

At the beginning of the 21st-century, the Association of Public and Land-grant Universities (APLU) identified public higher education challenges for the new century. In a series of publications entitled 'returning to our roots,' university engagement and outreach were highlighted as a mission-critical challenge for all public universities (Returning to Our Roots, Kellogg Commission, n.d.). These reports singled out public universities' service to their citizens for particular attention. The report on The Engaged Institution provided constructive advice for university-wide outreach and engagement, including LGU Extension (Returning to Our Roots: The Engaged Institution (February 1999), n.d.) (https://www.aplu.org/library/returning-to-our-roots-the-engaged-institution).

Today, university-wide engagement has received much attention, if not significant new resources, from governing boards and senior administrators. This public university social movement to enhance engagement is both an opportunity for Extension and a challenge for equal status within their universities with research and teaching missions. This section touches on the significant characteristics of LGU extension and its many enduring partnerships and challenges (Journal of Community Engagement and Scholarship, 2022, Volume 14, Issue 3) (https://digitalcommons.northgeorgia.edu/jces/vol14/iss3/).

LGU extension and AES have had a collaborative partnership with USDA historically. While USDA does not have its own extension service (unlike most ministries of agriculture worldwide), it does have excellent research facilities. USDA's Agricultural Research Service (USDA-ARS) and Natural Resources Conservation Service (USDA-NRCS) are federal agricultural and natural resource research institutions. Until the last decade, USDA-NRCS even had regional offices providing outreach services for conservation programs. NRCS also oversees USDA environmental programs, including reporting on-the-ground compliance by farmers receiving financial support for participating in federal conservation programs.

LGU extension services does not have regulatory functions associated with USDA programs or state programs.[8] This is in contrast to many public agricultural extension programs worldwide that do have a role in enforcing a variety of government regulations and other policy-related functions.[9] This is a significant difference between the US extension system and many other nations' extension services. LGU extension services are primarily focused on university engagement and outreach. US extension programs are not complicated by the additional function of enforcing government regulations.

Both USDA and LGUs have extensive research facilities. Since World War II, US universities have greatly expanded their research portfolios, including agriculture and natural resources. LGU AESs conduct both basic and applied research but are historically focused on the practical application of science to the specific needs of their states.

Funding for LGU extension services is primarily dependent upon their State and Counties. Smith-Lever funding as a percentage of total individual LGU funding for Extension fluctuates between 8% to 15% (varies by state, county, and non-government revenue such as grants and contracts). The US Congress, via USDA Smith-Lever funds, establishes requirements for fiscal accountability and support of Congressional mandates for these federal funds. USDA's Research, Education and Economics (USDA-REE) division oversees Smith-Lever funding through its National Institute of Food and Agriculture.

This partnership between the federal government (Congress and USDA) and the States and US Territories LGUs' is unique among nations. This is the only solely university-based extension system globally. While typically representing only a small proportion of LGU Extension budgets, Federal Smith-Lever funds provide significant incentive for LGUs to follow Congressional mandates associated with Smith-Lever Act funds. US LGUs have considerable political support within their States and with their Congressional delegations (House of Representatives and Senate). Consequently, LGUs have provided significant political support for USDA research, teaching and outreach programs.

Another unique characteristic of US LGU extension is their youth development 4-H programs. What eventually became 4-H was birthed at LGUs to meet demands for isolated rural youth programs to develop science-based and practical training in agricultural practices and civic responsibilities and leadership. It is impossible to overstate the importance of LGUs co-creating their university-based extension service and their youth development 4-H programs. They emerged together, symbiotically.

2.0 Organization of Land Grant University Extension services: national and regional associations

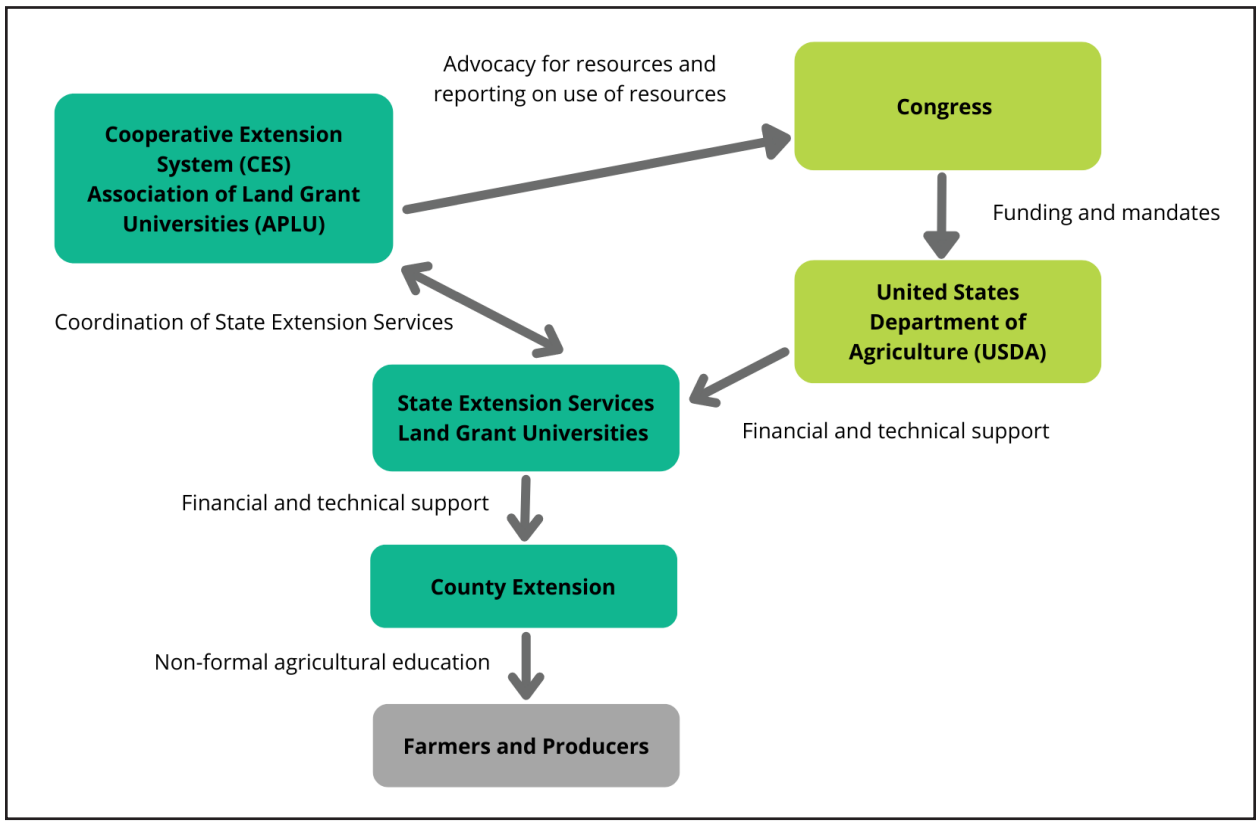
Today, US LGUs benefit from the visions and organizational investments, and structures of their 19th and 20th-century predecessors. Over the past century, LGUs intentionally developed a highly functioning network of collaboration and unified voice for their partnership with USDA and, even more importantly, among themselves. The historical path to its current national organization, ECOP, was episodic, formalizing over time collaborative functions and voting on how they taxed/assessed themselves to support national priorities. This is like the principle of subsidiarity noted above. The national structure took on functions that individual LGUs or even regionally associated LGUs could not accomplish independently. In this way, extension's national system is the product of continuing emerging discussions among its member LGUs.

[8] While extension does not have regulatory functions, it may be responsible for providing education related to the regulation. For example, although extension does not have a role in implementing federal or state pesticide regulations, extension does provide guidance to stakeholders regarding such regulations and also imparts knowledge pertaining to safe use of pesticides.

[9] For example, in many countries public agricultural extension agencies have been tasked with implementation of subsidization of agricultural inputs (such as seed and fertilizer). Such arrangements have often been seen to create a conflict of interest for both extensionists and for farmers themselves.

ECOP, as noted above, is part of the US Extension Service at the national level and does not have the authority to govern any of its members' universities' Extension programs, but there is a strong organizational commitment to all 112 of them. This is a 'complex' system that even insiders seem to find unusually difficult to fully understand. An organizational chart for the Cooperative Extension Services which is situated at APLU can be found online: https://www.aplu.org/members/commissions/food-environment-and-renewable-resources/organizational-chart.html. A simplified diagram of the relationships between farmers, local extension programs, the States and LGUs, APLU/CES, and USDA and Congress is provided below. The US LGU's national 'system' is very diverse, representing a punctuated evolution mirroring some of America's worst and best moments. This system rests on the accomplishments and failures of those who came before. It is a decentralized group of loosely similar colleges and universities that work with USDA to sustain a university-based coalition before Congress.

Figure 1
Key elements of the U.S. Extension System



Source: Provided by the authors.

Within their universities, extension services are administered either as a college-level unit reporting to an academic Dean (Colleges of Agriculture) or as a university-wide division reporting to the Provost or President.[10] In most states, AES and extension have statutory status as official state agencies. As state agencies, extension services are more than a division within their universities but also are divisions of State government. Presently, a national system of collaboration and collective action in agricultural extension among the US LGUs is situated at the national level in the Cooperative Extension Section within APLU. This

[10] At the 1890 LGUs, heads of extension services hold the title Associate Extension Administrator or Extension Administrators while at the 1862 LGUs, heads of extension services hold the title Extension Directors or Associate Dean of Extension.

Cooperative Extension Section is situated within the Board of Agricultural Assembly, located within APLU's Commission on Food, Environment, and Renewable Resources (CFERR).

As noted above, the Cooperative Extension Section at APLU is self-governed by the Extension Committee on Organization and Policy (ECOP) (https://www.aplu.org/members/commissions/food-environment-and-renewable-resources/board-on-agriculture-assembly/cooperative-extension-section/). ECOP consists of representatives of LGUs that voluntarily contribute financially (based on a pre-World War II funding formula) and work within the general policies and organizations established by ECOP.

Three separate Acts of the US Congress (1862, 1890, and 1994) created three types of LGU universities and colleges. Today there are 112 Land Grant institutions, of which 19 are historically black universities and 33 are tribal colleges and universities. These 112 higher education institutions are a remarkable historical legacy of US commitments to higher education and to the struggle for inclusiveness of minority populations. This is a single system of LGUs.

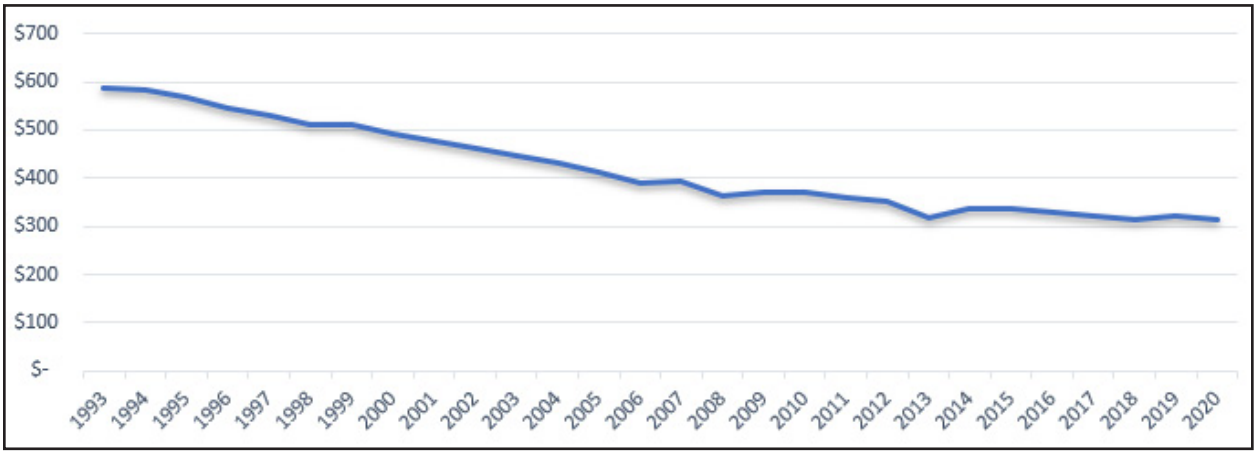
As noted above, the first Morrill Act of 1862 provided some federal funding for state-based colleges dedicated to the agricultural, mechanical, and military arts to establish a broader liberal education. These LGUs are unsurprisingly referred to as 1862 LGUs. In 1890, the second Morrill Act was established to provide Land Grant Universities for African American populations in the States that legally separated African and Anglo Americans (and prohibited African American attendance at the 1862 LGUs) via state-based segregation laws after the Civil War. This Act of Congress is one of the most visible examples of the failures of the post-Civil War period of Reconstruction to address the cultural, social, and political legacies of slavery, but also is an example of the resiliency and excellence of 1890 LGUs. This legislation led to 19 universities, primarily located in the former Confederacy and Border States. These LGUs are referred to as 1890 LGUs (Our History, n.d.) (https://www.1890foundation.org/history-of-land-grant-universities).

To create more equitable educational opportunities for underrepresented groups, Native American colleges were developed (Kowalkowski, et. al). In 1994, Congress established funding for Native American tribally controlled Land Grant colleges. This legislation belatedly recognized the sovereignty of Native American tribal governments and the importance of their tribal colleges. These LGUs are referred to as 1994 LGUs (1994 Tribal Land-Grant Colleges and Universities Program, n.d.). (https://www.usda.gov/partnerships/1994-program). In 2008, the Food, Conservation, and Energy Act authorized the establishment of a group of Hispanic-serving agricultural colleges and universities (HSACUs—not formally LGUs) to be eligible for NIFA Integrated Research, Education, and Extension Competitive Grants Programs (Hispanic-Serving Agricultural Colleges and Universities (HSACU) | National Institute of Food and Agriculture, n.d.). (https://nifa.usda.gov/hispanic-serving-agricultural-colleges-and-universities-hsacu)

3.0 Sources of funding for public agricultural extension

Federal, state, and county appropriations are critical elements sources of funding for Cooperative Extension—they are supplemented by a variety of other sources, including grants, service contracts, service fees, and gifts. For most states, funding from the federal level represents a relatively small part of the financing envelope for public agricultural extension. Federal funding for agricultural extension has steadily declined over time—see the figure below:

Figure 2
Federal support for US agricultural extension (millions of 2020 dollars under Smith-Lever 3 b&c)



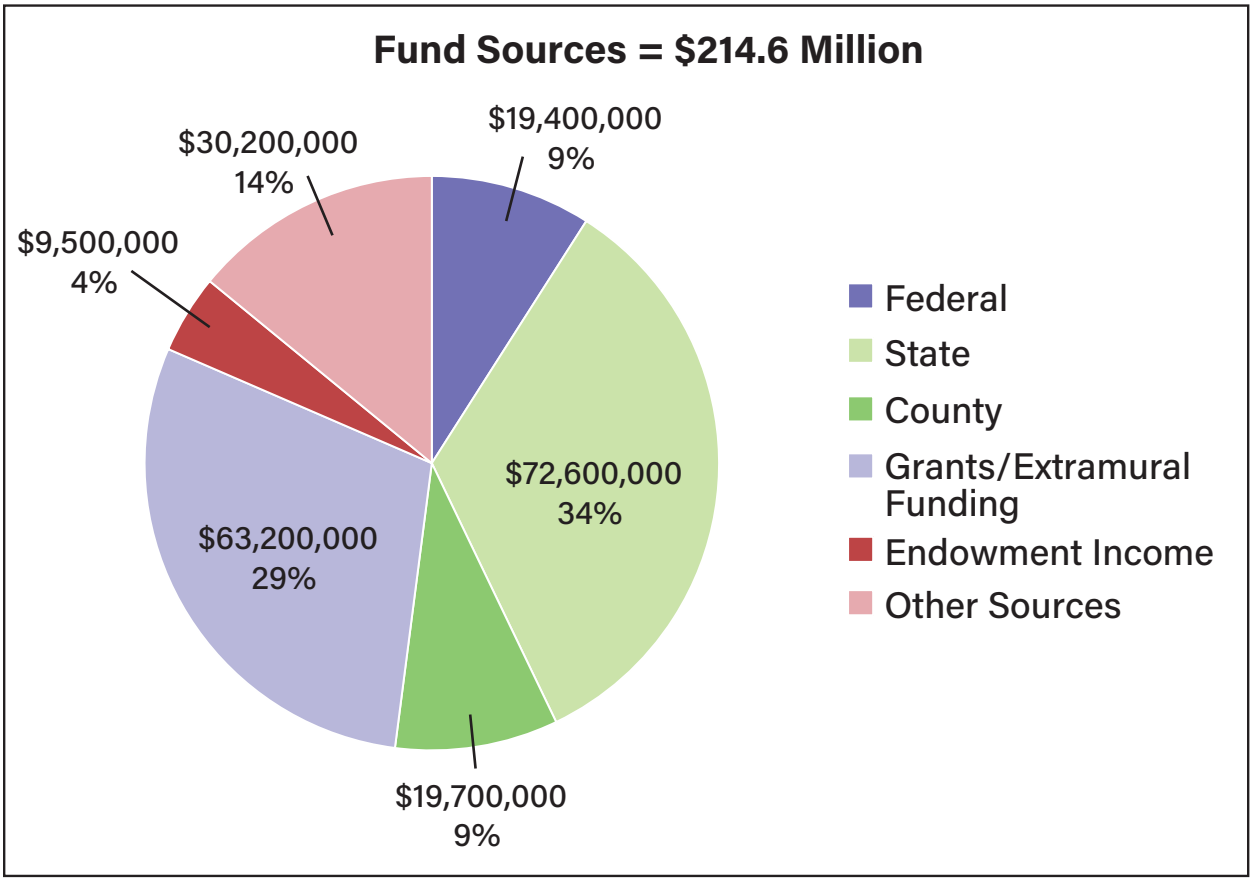
Source: APLU

Experienced observers suggest that federal support most frequently constitutes 5% to 15% of the financing available to state extension services for most state extension systems. Although comprehensive data about levels of state-level funding for public extension is not readily available, it is thought by system leaders that there has been a several-decades decline in such state-level funding. Instead of comprehensive data, several examples of how state public extension programs are financed are provided below:

3.1 Example: funding sources for public agricultural extension—the case of California

The University of California's Agriculture and Natural Resources Division's (UC ANR) mandate is to implement Cooperative Extension and related programs in California. UC ANR receives funding from several sources, including federal, state, and local governments (which account for roughly half of overall financing) and various other sources (see figure below).[11]

Figure 3
UC ANR Fund Sources FY 2018–19



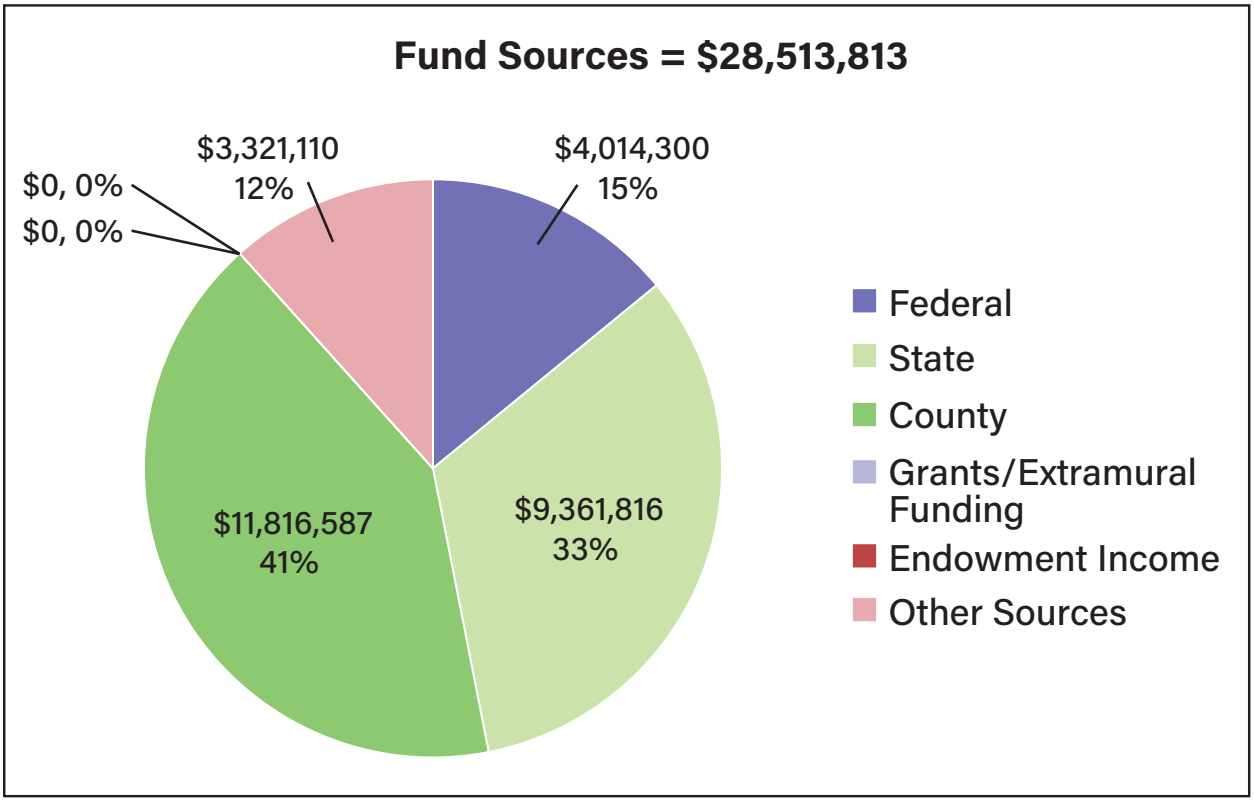
Source: UC ANR Annual Report (2019).

[11] As reported in a May 15, 2019 memo from the President of the University of California to the members of the University's Board of Regents.

3.2 Example: funding sources for public agricultural extension—the case of Colorado

The Colorado State University (CSU) Extension mandate is to implement Cooperative Extension and related programs in Colorado. CSU receives funding from several sources, including federal, state, and county funds governments and various other sources (see figure below).

Figure 4
Colorado State University Fund Sources FY 2018

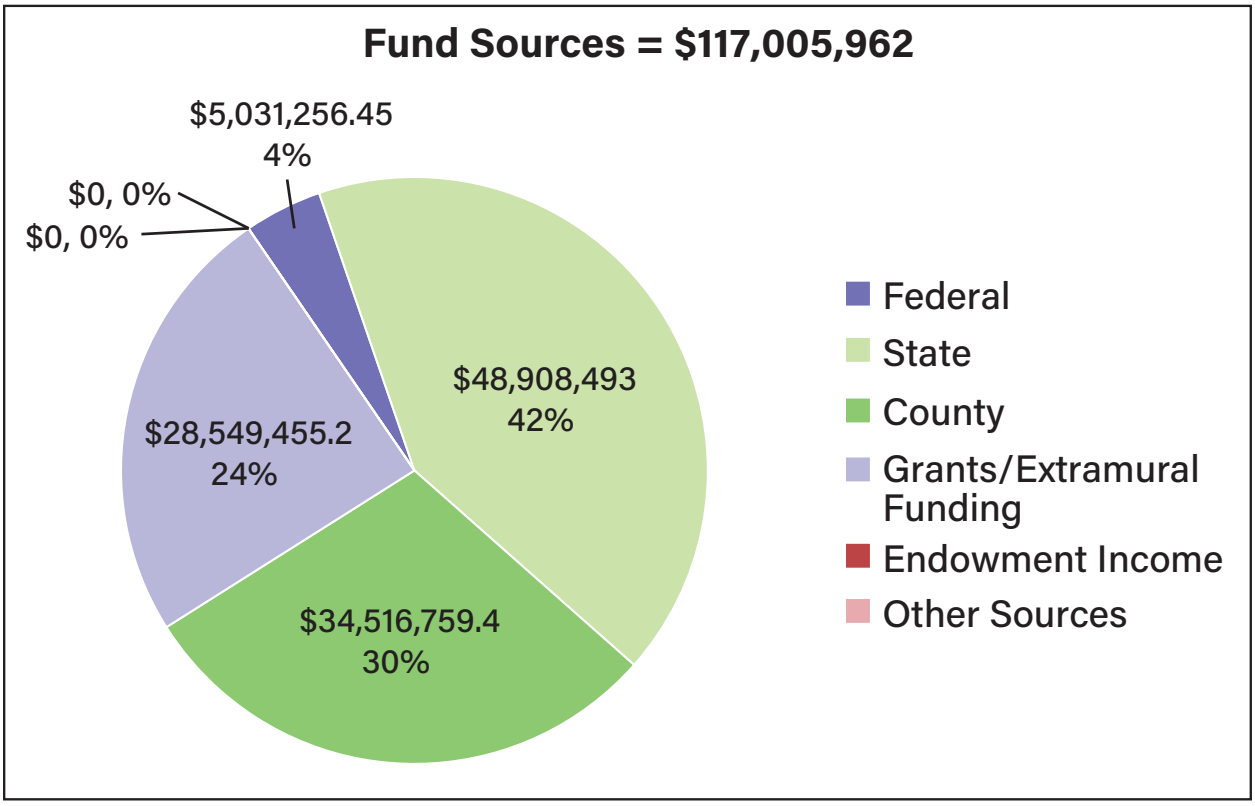


Source: Colorado State University Extension Annual Report (2018).

3.3 Example: funding sources for public agricultural extension—the case of Florida

The University of Florida (UF) Extension mandate is to implement Cooperative Extension and related programs in Florida. UF receives funding from several sources, including federal, state, county funds and grants, and extramural funding (see figure below).

Figure 5
University of Florida Fund Sources FY 2020

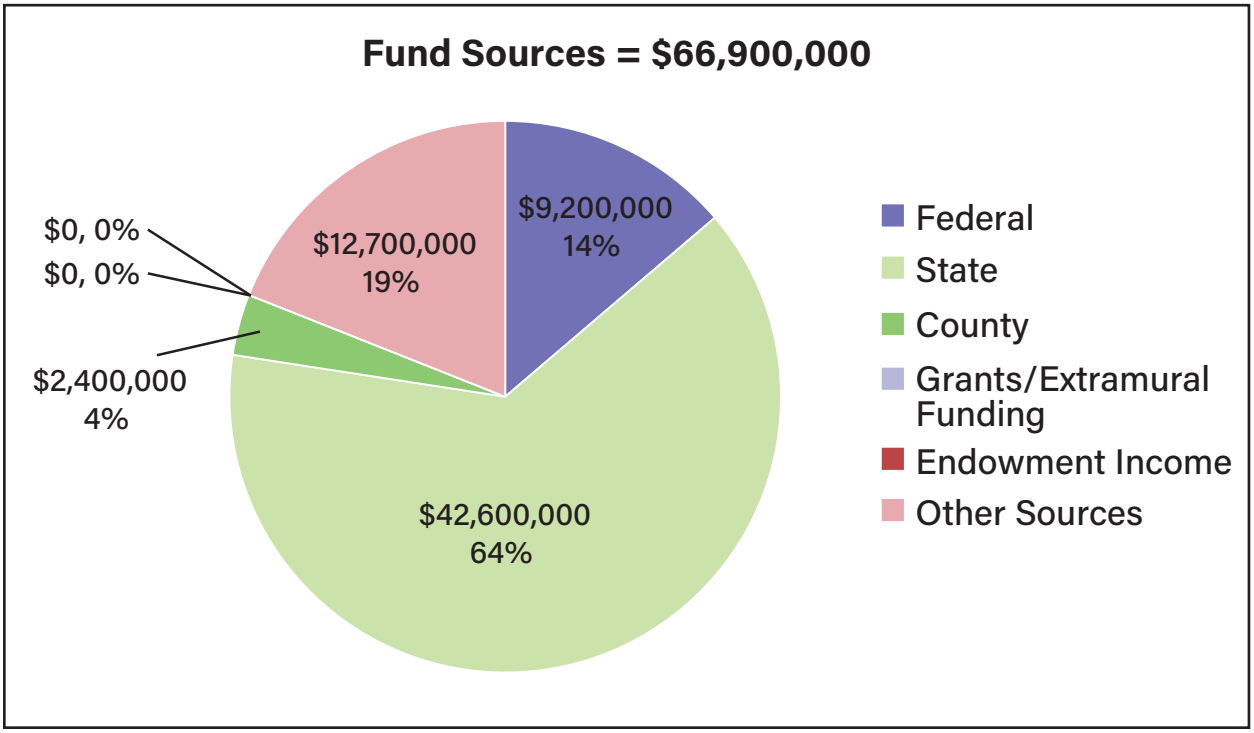


Source: UF/IFAS Extension Impacts and Budget Annual Report (2020).

3.4 Example: funding sources for public agricultural extension—the case of Alabama

The Alabama Cooperative Extension System mandate is to implement Cooperative Extension and related programs in Alabama. ACES receives funding from several sources, including federal, county, state, and other sources. More than half of ACES' budget comes from the state (see figure below).

Figure 6
Alabama Cooperative Extension System Fund Sources FY 2020

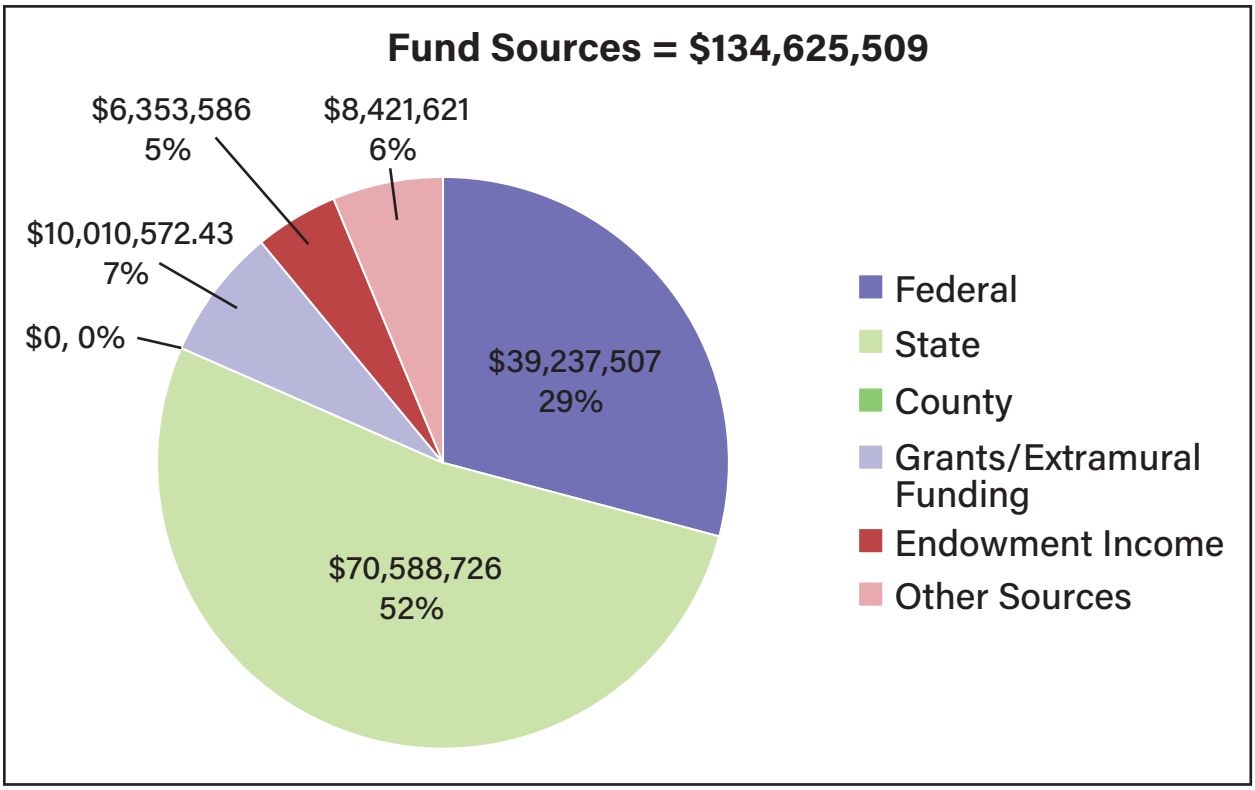


Source: Alabama Cooperative Extension System Budget (2020).

3.5 Example: funding sources for public agricultural extension—the case of Texas

Texas A&M AgriLife implements Cooperative Extension and related programs in Texas. This program receives funding from several sources, including federal, county, state, grants/extramural funds, endowment income, and other sources. More than half of this budget comes from the state and more than a quarter of funds come from federal funds (see figure below).

Figure 7
Texas A&M AgriLife Fund Sources FY 2020

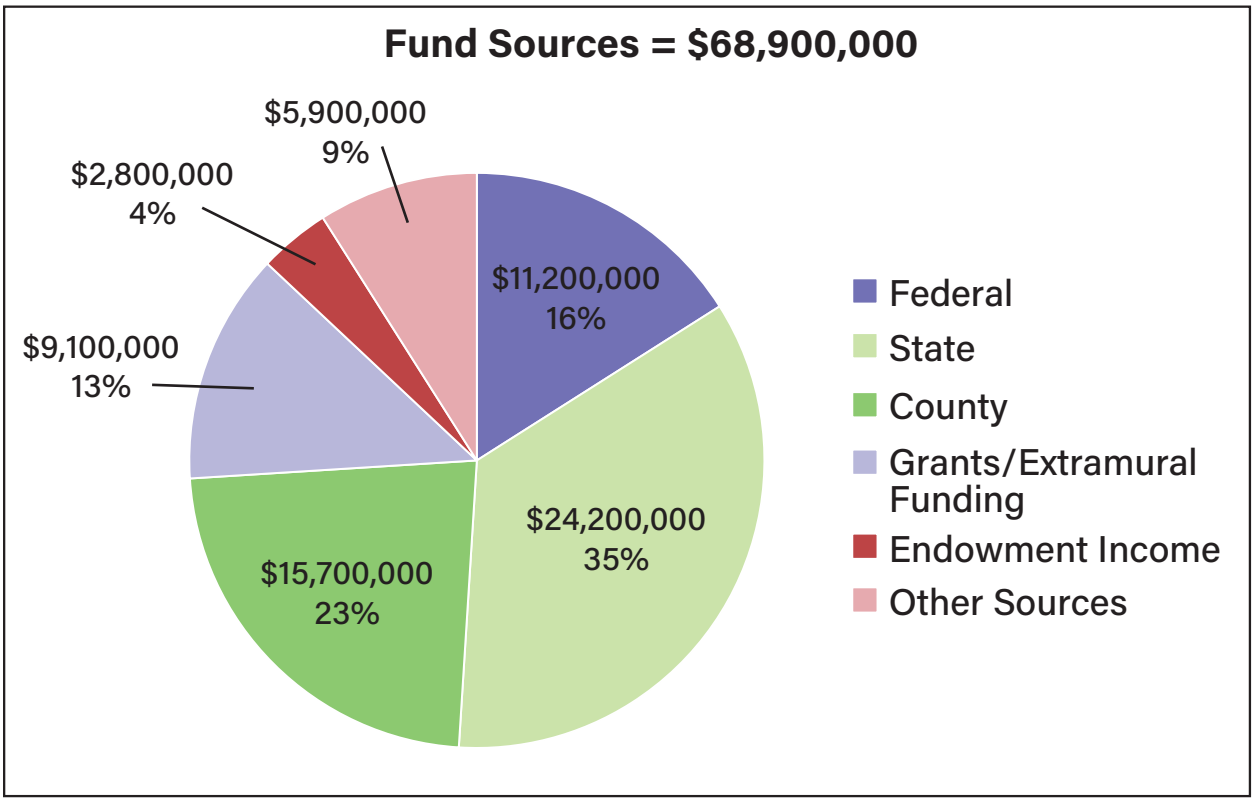


Source: Texas A&M AgriLife Extension Service Annual Financial Report (2020).

3.6 Example: funding sources for public agricultural extension—the case of Ohio

The Ohio State University Extension goal is to implement Cooperative Extension and related programs in Ohio. OSU receives funding from several sources, including federal, state, county, grants/extramural funds, endowment income, etc. 35% of OSU's budget comes from the state (see figure below).

Figure 8
Ohio State University Fund Sources FY 2016

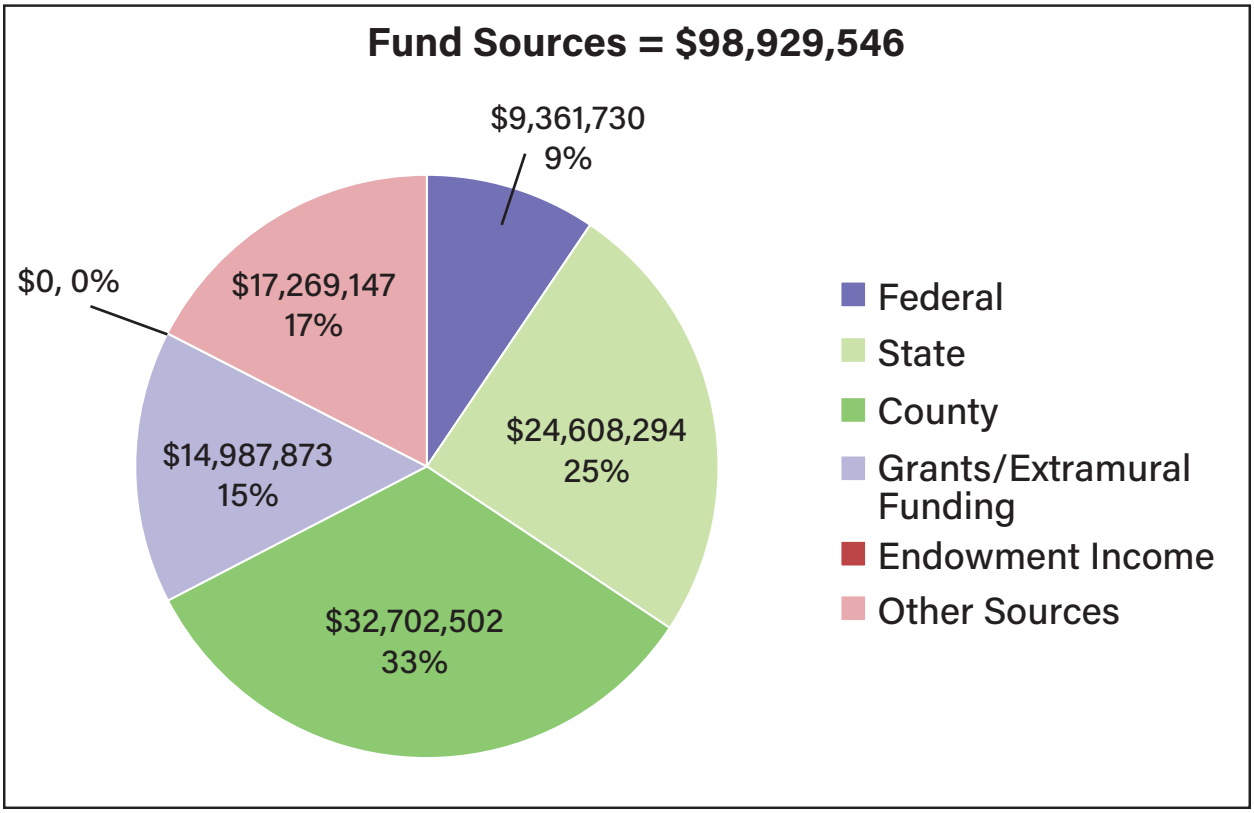


Source: Ohio State University Extension Annual Report (2016).

3.7 Example: funding sources for public agricultural extension—the case of Iowa

The Iowa State University program goal is to implement Cooperative Extension and related programs in Iowa. ISU receives funding from several sources, including federal, state, county, grants/extramural funds, and other sources. Thirty-three percent of OSU's budget comes from the counties (see figure below).

Figure 9
Iowa State University Fund Sources FY 2014



Source: Iowa State University Extension and Outreach Annual Report (2014).

4.0 The Organization of Extension Services within Land Grant Universities

The national LGU system is very decentralized. Land Grant Universities and colleges have as many administrative structures as there are LGU universities and colleges. As a result, there are many different internal university and college organizational structures and cultures—there is no single template for LGU administration.

Among 1862 and 1890 LGUs, Extension services are most often located with Colleges of Agriculture and Colleges of Human Development (many of the latter were once Colleges of Home Economics which have morphed into professionally-oriented colleges). Among these, Extension is administratively located in the College of Agriculture. There are twelve LGUs where extension is not found in a College of Agriculture. These extension services report directly to the university's Provost or President and have campus-wide program portfolios. So far, these 12 LGUs are not setting the trend, but they do offer examples of how Extension services located in a single college may develop broader, university-wide engagement among the other colleges and for the university as a whole.

As emphasized above, university-based Extension is locally embedded. Most state Extension services have university 'educators' or 'agents' living in or assigned to every county or parish. This is the most visible and essential feature of US university-based Extension services.

Again, Extension is primarily state and locally funded. From their earliest decades, LGU Extension has worked collaboratively with state and local government officials and with state and local advisory councils to determine program priorities and design individual program goals, strategies, and delivery platforms. These councils historically in rural areas have been composed of local farmers and ranchers, elected local officials, and a broad range of community leaders representing program areas such as youth development/4-H, environmental interests, and private sector supporters. Metropolitan Extension offices also include elected officials and community leaders supporting youth development and 4-H and community interests reflecting urban/metropolitan priorities.

There are as many variations in how agricultural extension is situated within their respective universities' organizational structure as there are LGUs. This website provides a diagram of how the University of Nebraska's agricultural extension program is positioned relative to USDA, Nebraska state government, and Nebraska's counties (Organizational Structure | Nebraska Extension, n.d.) (https://extension.unl.edu/organizational-structure/). While each LGUs has its unique structure, there are enough similarities among the LGUs that the University of Nebraska's example is illustrative of how extension services are typically situated within a college of agriculture. All US state extension services work closely with non-government organizations (not-for-profit), agricultural producer and consumer organizations, private for-profit agricultural advisory services, and federal government agencies.

As noted above, ECOP is organized into five regions (including a 'region' for 1890 LGUs). Within these regions, USDA/NIFA works with LGU AES and extension services to promote collaboration among the states' AES and extension services. This collaboration expands program capacity and impacts through interstate LGU sharing of talent and resources. Every region has a combined AES and Extension committee that oversees research and Extension program collaboration jointly funded by the states and USDA/NIFA. USDA/NIFA's oversight of Smith-Lever funding requires that at least 20 percent of these funds be dedicated to collaboration with other LGU Extension and AES services. This requirement both encourages and rewards multi-state LGU collaboration.

While Extension services in states with metropolitan areas historically have urban-focused programs, the 'urbanization' of Extension has accelerated during the past two decades. Urban Extension programming tends to be multi-disciplinary and often adds value to existing urban government and NGO programs. The

Western Center for Metropolitan Extension and Research is an example of LGU Extension services creating collaboration on metropolitan Extension programming and education (About Us | Western Center for Metropolitan Extension & Research | Washington State University, n.d.) (https://metroextension.wsu.edu/about-us/).

LGU youth development and education programs were established simultaneously and in concert with the creation of county Extension offices. US Extension services offer youth development their flagship youth development 4-H programs. These are county-based programs with state and national level collaboration. Youth development is a signature characteristic of all US Extension programs (National 4-H Council, n.d.) (https://4-h.org/about/leadership/national-4-h-council/).

Complementing and supporting U.S. Extension programs is NIFA's Regional Rural Development Centers (RRDCs). It was established in the Rural Development Act of 1972, the RRDCs support LGUs in building the scientific knowledge base needed to underpin education and extension programs in rural and community development. RRDCs also support agricultural advisors' professional development opportunities and educational programs to ensure high-quality, relevant, and timely technical assistance capacity and outreach for rural and community development. RRDCs have a long record of working partnerships with public and private entities toward common goals. In recent years, work with partners has expanded, promising sustainable rural and community development programs despite a period of fiscal austerity and scarce resources (https://nifa.usda.gov/regional-rural-development-centers/).

During the past two decades, ECOP has facilitated and supported the development of a highly sophisticated online platform by the Extension Foundation. This online institution is partially fee-based but also receives federal funding. While the Extension Foundation's programs are generally available to the public and all extension services, there are considerable additional benefits for universities that financially subscribe. During the past decade, the Extension Foundation has emerged as an online portal for rapid dissemination of information and as a platform for training agents/educators with just-in-time information (Regional Rural Development Centers | National Institute of Food and Agriculture, n.d.).

Additionally, the role of ECOP and the Extension Foundation has been strengthened in recent years through a new national level "Program Action Teams" (PATs). ECOP's standing program committee now includes PATs which uniquely enable engagement across all professionals in Extension aligned with ECOP's priorities for national funding with USDA-NIFA and beyond.

5.0 Looking forward: the continued utility and influence of university-based Extension in the US

The US Extension System is a reliable collaborator with agricultural producers in creating new knowledge, applying existing knowledge, working with producers and private sector companies, and in international collaboration. The basis of Extension's long-term utility for producers as well as environmental and consumer interests is at least three-fold. First, US university-based Extension services are grounded in the vast talent and educational depth of LGUs. Second, LGU Extension services are present in most US counties and have the capacity to both represent local interests to their campus colleagues and to adapt programs to local conditions. Third, US Extension services have access to and partner with yet another vast talent pool situated at USDA. Locally based and focused services of US Extension do not exist independent of their universities and function best when collaborating with USDA and the widely diverse interests of their communities and states.

US Extension services are direct representatives of and enablers of their universities in their collaboration with state and local governments. They have been a source of and the facilitator of technological and organiza-

tional innovations since their inception in the opening years of the 20th century. Yet, US Extension services are experiencing diminished funding over recent decades, and their access to the talent within their university continues to be narrow. Like all US higher education institutions at this time, they are struggling to sustain their fiscal resiliency and to broaden their programs to include cross-campus non-agricultural colleges. These are complex institutional challenges that Extension likely cannot manage internally alone. US Extension will benefit from renewed fiscal partnerships with USDA, their state governments, and most importantly, the sustaining fiscal commitments of their communities. These are not insurmountable challenges.

Extension's institutional configuration of being simultaneously state-owned, locally funded, and university-based and in direct collaboration at the national level with other LGUs (APLU and ECOP) and USDA makes the US's Extension services unique in comparison to other public extension programs across the world. As agricultural, food, and rural sectors evolve, the need for Extension will expand in both scale and scope. LGUs can develop and extend their Extension services' engagement and outreach capacities. Where Extension services are administered by a single college, LGUs can facilitate their becoming university-wide without harming existing programs and constituencies (Reed and Swanson, 2022). Extension can be a university-wide platform for regional and local engagement, including leadership in developing applied transdisciplinary educational, research and engagement programs (JCES special issue, 2022).

Correspondingly, the US Extension system's collective core institutional mandates can expand in focus and in the pragmatic modalities employed. For example, state and national programs can include more attention to the relationship between agriculture and nutrition, climate change, management of biohazards, and youth development, among other global and local challenges (Martin and Steele, 2022). An increasing imperative for universities and the diffusion of knowledge is expanding open science and open data to broaden the evidence base available to Extension educators (Woteki, 2022).

Figuring out the myriad paths for the US Extension system toward these goals once again will benefit from their collective discourse and sharing of best practices—something ECOP and APLU have done well over the past two decades. Importantly, their home institutions, including their own LGU, can incorporate county offices' local and regional implementation platforms into their interdisciplinary and transdisciplinary teaching and research portfolios. Orchestrating the development of Extension services requires innovative and creative reflection—and associated investment and capacity building. Rather than fumbling with the rigidities of strategic planning, LGUs can take advantage of their Extension services application of 'strategic doing.' And finally, and importantly for NAAAN, US Extension can profoundly benefit by directly and collaboratively working with their Canadian and Mexican counterparts. There are infinite possibilities in both this North American collaboration and globally with other Extension and rural advisory services.

It is to these challenges that follow-up discussions and reports will very usefully turn. Among the most interesting aspects of the reflection that will be required will be an examination of how the university-based structure of the US Extension system might facilitate the design and implementation of the evolution that is to come—ttempting to be more proactive than reactive. This process will be watched with great interest by the community of practice on extension (and beyond) across the world.

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FALL 2021

NORTH AMERICAN AGRICULTURAL ADVISORY NETWORK

SURVEY REPORT

Commissioned by the NAAAN Secretariat with the Institute for Research in the Social Sciences, Colorado State University, CSU System Office

NAAAN

NORTH AMERICAN AGRICULTURAL ADVISORY NETWORK

Survey Invitation Letter

Dear colleagues,

The North American Agricultural Advisory Network (NAAAN) was established late last year as the newest member of the Global Forum for Rural Advisory Services (GFRAS) https://www.g-fras.org/en/. GFRAS is a global network of agricultural advisory service organizations that connects and supports networking, learning, knowledge sharing, and advocacy for agricultural extension programs and service providers. As the newest member of the GFRAS network, the NAAAN is a North American platform promoting and supporting innovation, knowledge utilization, and information sharing among agricultural advisory service/extension organizations (both public and private) in Canada, Mexico, and the United States.

As one of its first activities, the NAAAN is conducting a survey to better understand the agricultural advisory/extension landscape within Canada, Mexico, and the United States. You have been identified as an expert of agricultural advisory/extension services for the United States by the NAAAN Steering Committee (which includes, inter alia: the Honourable Marie-Claude Bibeau, Canada's Minister of Agriculture and Agri-Food; Secretary Victor Villalobos; Mexico's Secretary of Agriculture and Rural Development; and Secretary Tom Vilsack, Secretary of Agriculture, USDA).

Your participation in this survey is crucial to understanding agricultural training, agricultural education, and agricultural advisory/extension services in the United States. The information you provide will inform the future support and focus areas of NAAAN and the work we do collectively across the three countries.

We have selected the Institute for Research in the Social Sciences (IRISS) at Colorado State University, to manage this survey research titled "North American Agricultural Advisory Network Survey." Allison Cantwell is the Principal Investigator and researcher from IRISS. The NAAAN Secretariat is hosted by the Colorado State University System. This project is funded by the NAAAN Secretariat. For more information on the NAAAN, please visit our website: https://www.csuspur.org/naaan/

This online survey will take approximately 20 - 30 minutes of your time. To continue to the survey, click here: (LINK)

Thank you for your time and valuable input. We are deeply grateful for your participation.

The NAAAN Steering Committee

Canada

- The Honourable Marie-Claude Bibeau (ex officio), Minister of Agriculture and Agri-Food
- David Gray, Ph.D., Professor, Dalhousie University
- Mary Robinson, President, Canadian Federation of Agriculture

Mexico

- Secretary Victor Villalobos (ex officio), Secretary of Agriculture and Rural Development
- Carlos Vazquez Ochoa, Minister Counselor, Agricultural Office, Embassy of Mexico to the United States
- Lourdes Cruz Trinidad, General Coordinator of International Affairs, Secretariat of Agriculture and Rural Development

United States

- Secretary Tom Vilsack (ex officio), Secretary of Agriculture, USDA
- Douglas Steele, Ph.D., Vice President, Food, Agriculture & Natural Resources, Association of Public and Land-Grant Universities
- Cathie Woteki, Ph.D., Professor of Food Science and Human Nutrition, Iowa State University; Visiting Distinguished Institute Professor, Biocomplexity Institute, University of Virginia; President, Charles Valentine Riley Memorial Foundation

Introduction

The North American Agricultural Advisory Network (NAAAN) is the newest member of the Global Forum for Rural Advisory Services (GFRAS). The NAAAN Steering Committee and country teams identified experts on agricultural advisory/extension services in Canada, Mexico, and the United States of America. Individuals were asked to participate in a survey to assist the NAAAN in understanding how agricultural training, agricultural education, and agricultural advisory/extension services are structured and are operating in their respective countries. The information respondents provided will inform the future support and focus areas of the NAAAN and the collective work of the NAAAN across the three countries.

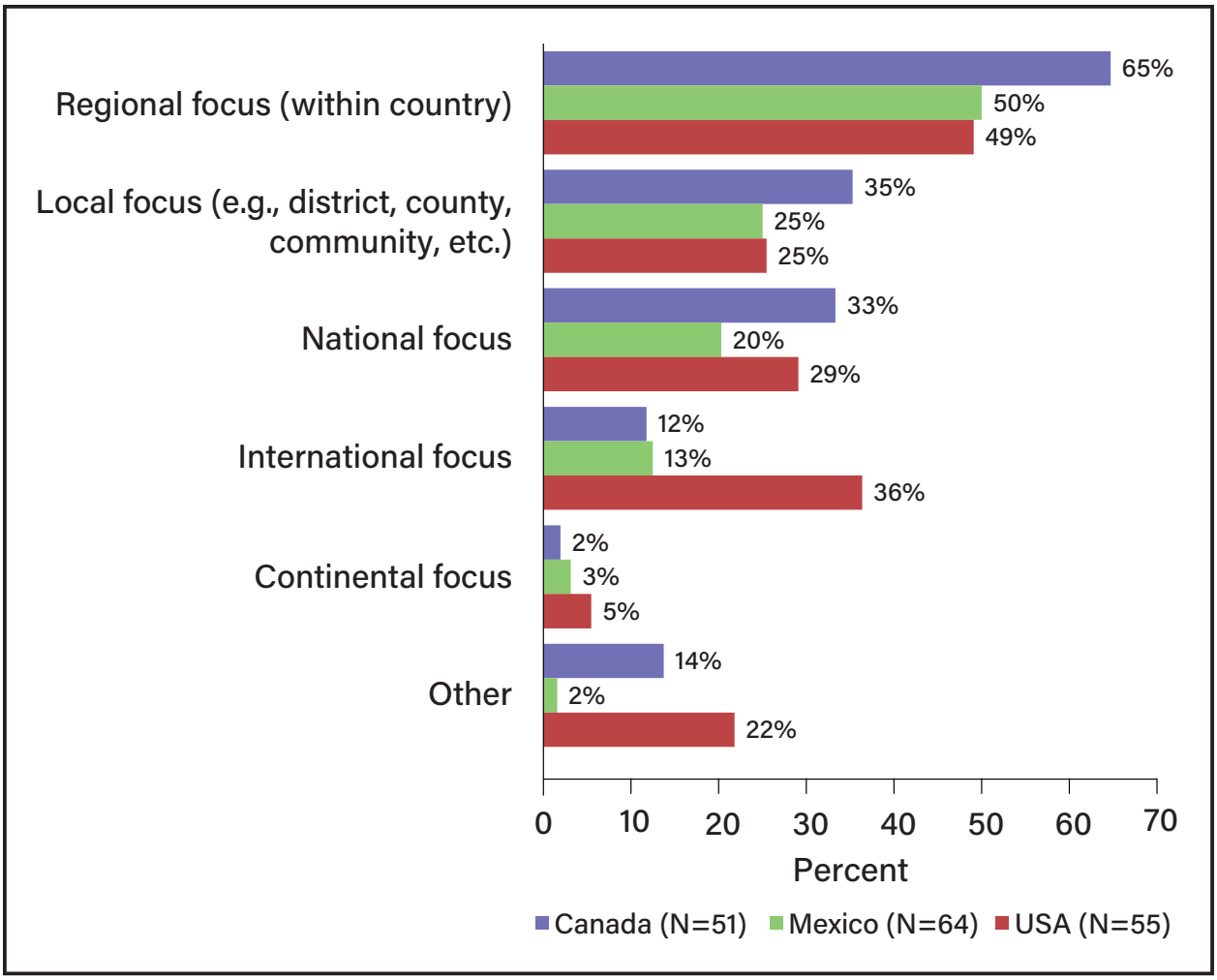
Characteristics of Respondents

The survey was sent to over 500 agricultural advisory/extension experts across Canada, Mexico, and the United States. The survey received 170 responses, 51 from Canada, 64 from Mexico, and 55 from the United States. Respondents varied in their level and type of experience with agricultural advisory and extension services. Over one-third of respondents (38%) have over 20 years of experience in agricultural advisory/extension services, another 25% have 10-19 years of experience, and the remaining 20% have been involved less than 10 years.

Geographic Scope of Work

In all three countries, the most frequently selected geographic scope of work for respondents is regional focus, meaning working within a region of their home country. The second most frequently chosen scope of work in both Canada and Mexico is local focus, meaning within their district, county, or community. In the United States, the most frequently chosen scope of work is an international focus. All three countries identified national focus as the third most frequently selected geographic scope of work.

Figure 1
Geographic scope of work

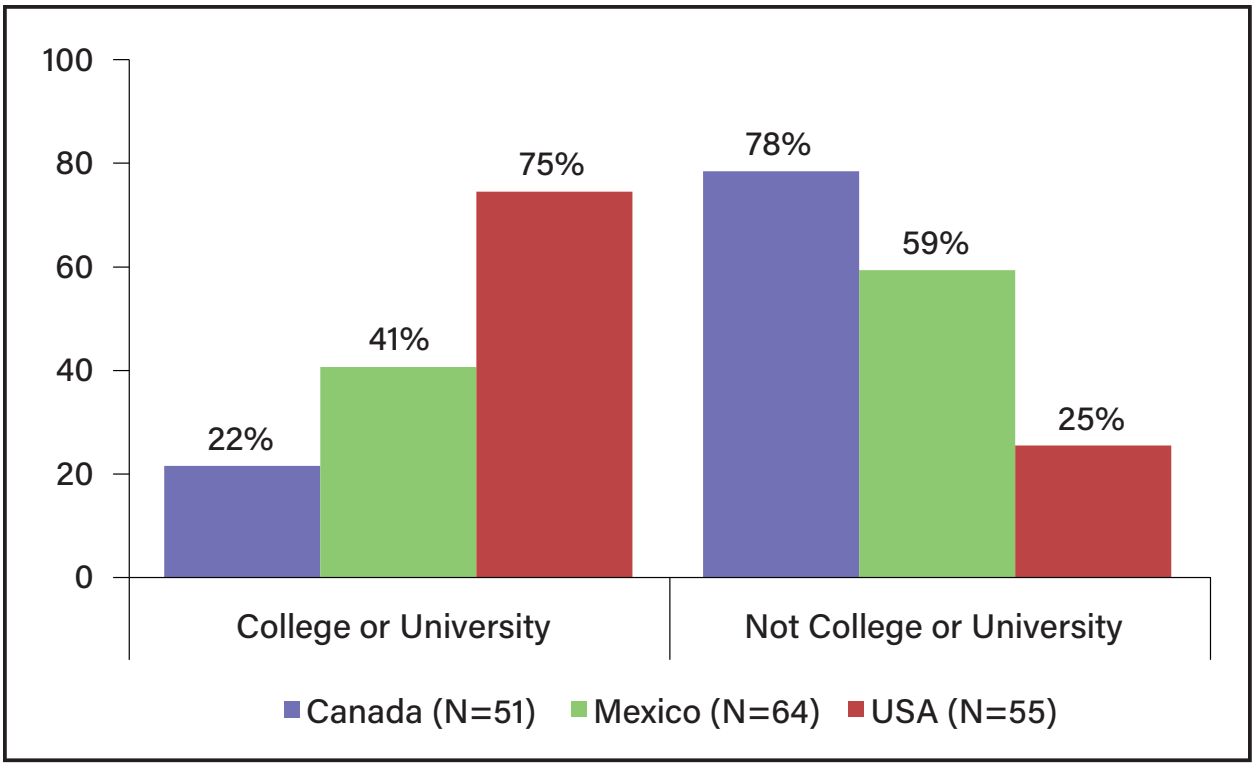


Source: NAAAN survey report (2021).

Organization Type

Respondents were asked to identify what type of organization they represent in their work for agricultural advisory/extension services. In the United States, most respondents represent a college or university (75%), while in Canada and Mexico, the majority of respondents represent other types of organizations. This suggests that agricultural advisory/extension services, while closely tied to land- grant universities in the United States, are more closely tied to other organizations in Canada and Mexico.

Figure 2
College/University vs. Other Organization



Source: NAAAN survey report (2021).

NAAAN Thematic Areas

The NAAAN has three initial thematic areas of focus:

- Biodefense/Biosecurity and Management of Natural Disaster: Diseases, climate change, and natural disasters threaten agricultural systems and economies. Agricultural advisory/extension services can coordinate responses and help mitigate risk.
- Improving Soil and Water Management: Soil and water management are fundamental aspects of productive agricultural activities. They are also critical elements in the mitigation of, and resilience to, climate change. These are important and traditional thematic areas of focus for agricultural advisory/extension services.
- Building Skills & Career Development for Youth: NAAAN is building on the existing work of groups to prepare the next generation of leaders in global agriculture, including work with Together We Grow and Young Professionals for Agricultural Development.

What are the main topics for which agricultural advisory/extension services are available to the public from your organization?

Respondents were asked to select the main topics for which agricultural advisory/extension services are available to the public from their organization within each of the three current NAAAN thematic areas.

Biodefense/Biosecurity and Management of Natural Disaster

In general, all topics identified are available from some organizations across each country. Over 50% of respondents selected all topics for the United States. Disaster mitigation and disaster management were not selected very often for Canada and Mexico. The graph below shows how availability for each topic varies across each country.

Main topics available to the public in Canada

- Climate Change (61%)
- Disease Management (61%)
- Pest Management (59%)
- Disease Surveillance (53%)

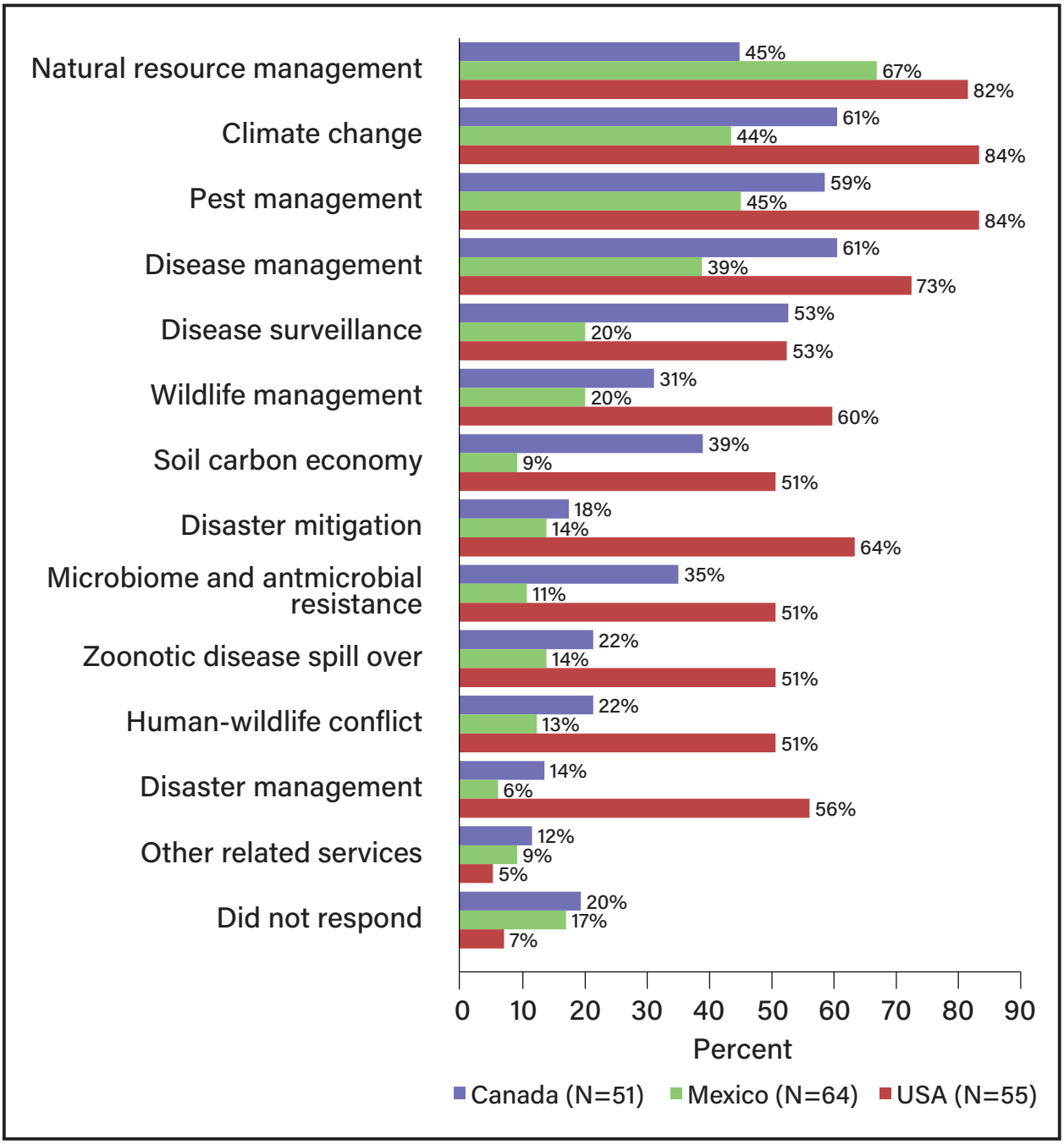
Main topics available to the public in Mexico

- Natural Resource Management (67%)
- Pest Management (45%)
- Climate Change (44%)
- Disease Management (39%)

Main topics available to the public in the United States

- Climate Change (84%)
- Pest Management (84%)
- Natural Resource Management (82%)
- Disease Management (73%)

Figure 3
Topics Available Related to Biodefense/Biosecurity and Management of Natural Disaster



Source: NAAAN survey report (2021).

Qualitative Findings

What additional programs or services should be available for biodefense/biosecurity and management of natural disaster through agricultural advisory/extension services?

In addition to selecting the main topics available to the public in Biodefense/Biosecurity and Management of Natural Disaster, survey respondents were asked to share additional programs or services that should be available for biodefense/biosecurity and management of natural disaster through agricultural advisory/extension services. Researchers used inductive coding to qualitatively analyze the open text responses. The following codes were created:

Coordination This theme includes coordination between local, regional, national, and international entities, as well as across different sectors (governmentt., private, non-profit, research, etc.). The goal is to integrate rather than duplicate efforts through coordination between programs. Coordinating programs reduces the number of programs available to streamline access for farmers to ensure they are not overwhelmed.

Resilience This theme focuses on the need for climate change adaptation and mitigation practices in addition to practices to adjust to other eco-system changes. Many discuss different practices such as flood mitigation and wildfire risk management, as well as more general risk analyses and prevention planning.

Data and Technology This theme focuses on the use of data management, data analysis, and new technologies to assist farmers in biodefense/biosecurity and management of natural disasters. For example, this includes, support tools to assist farmers in making decisions around pathogens and plant breeding in addition to training needs for the use of large and complex data analysis and interpretation.

Economic Concerns This theme focuses on keeping farmers on the farm. This includes funding that helps support adoption of new technologies or practices and adaption to weather and climate change because prevention practices are more cost effective than mitigation practices.

Alternative Production Practices This theme emerges in the responses from Mexico and focuses on alternative practices in food production, mainly around organic, sustainability, and agro-ecological concerns. Mexican respondents also mentioned concerns over farm size, pointing toward a need to support family farms.

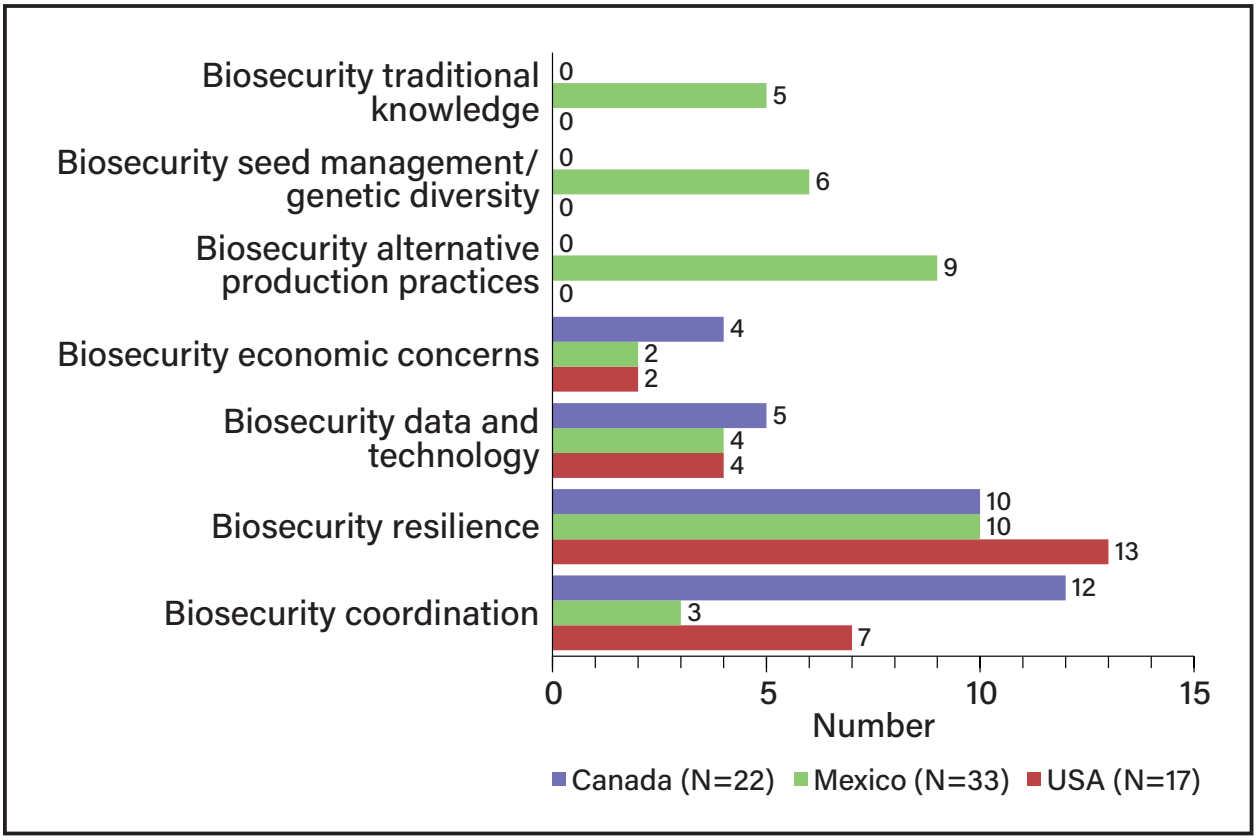
Seed Management/Genetic Diversity Mexican respondents discussed the conservation of native seeds and genetic diversity as resources for peasant agriculture.

Traditional Knowledge This theme emerges in responses from Mexico and focuses on the need for stronger linkages with rural communities and leveraging the traditional knowledge, which they have accumulated over their lands to mitigate disasters and have deeper knowledge of local resources.

Qualitative Results Summary

Resilience is the most frequent or second most frequent theme for all three countries. Coordination is another frequent theme for both Canada and the United States. Mexican respondents have three themes that were unique to that country: traditional knowledge, seed management, and alternative production practices. The chart below displays the frequency of each theme across the three countries.

Figure 4
Additional Topics Needed Related to Biodefense/Biosecurity and Management of Natural Disaster



Source: NAAAN survey report (2021).

Improving Soil and Water Management

In general, all topics identified are available from some organizations across each country. The top two topics offered to the public across all three countries are crop production and sustainable agriculture. The graph below shows how availability for each topic varies across each country.

Main topics available to the public in Canada

- Crop Production (67%)
- Sustainable Agriculture (65%)
- Intercropping and Crop Rotation (61%)
- Soil Analysis (59%)

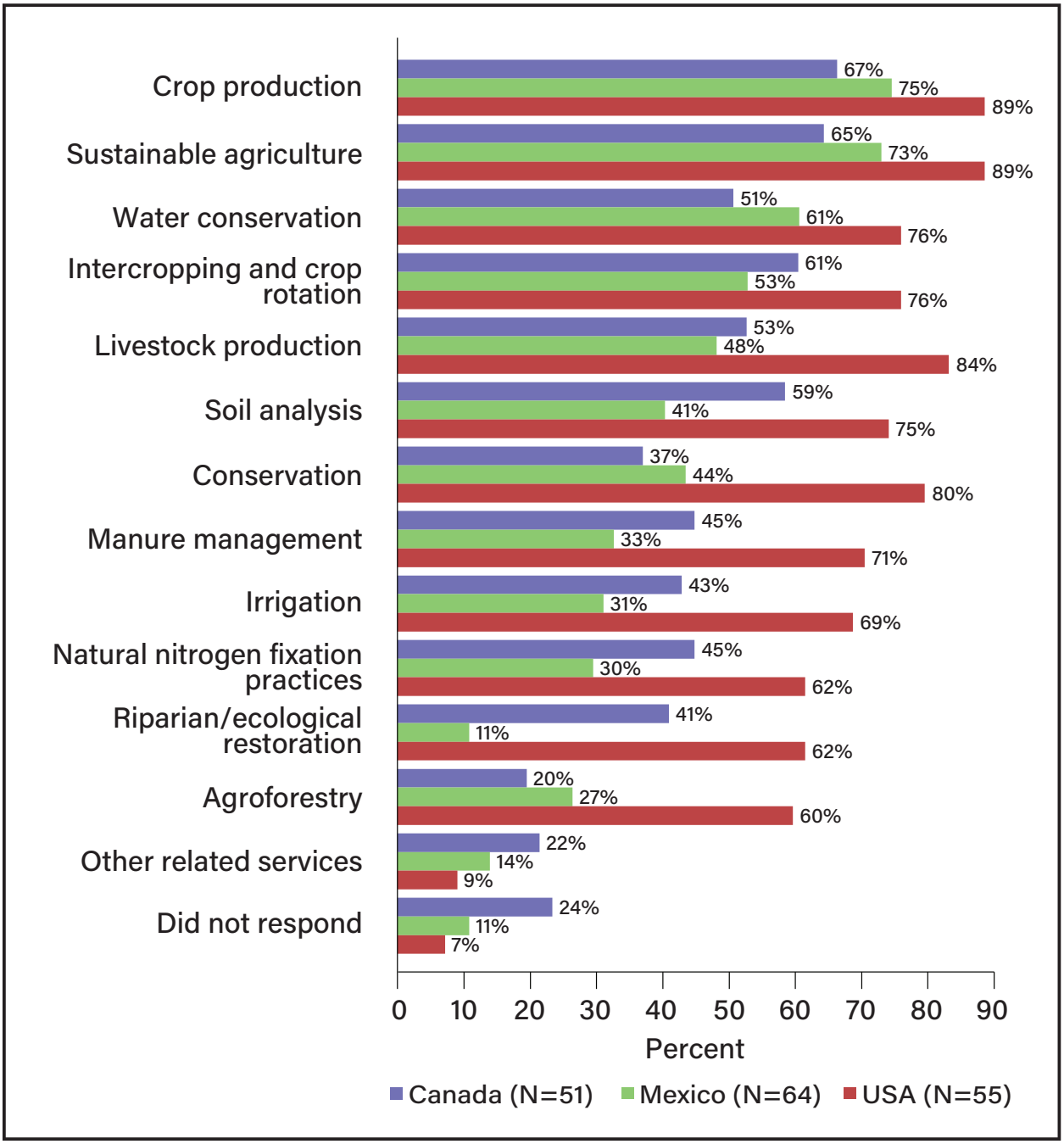
Main topics available to the public in Mexico

- Crop Production (75%)
- Sustainable Agriculture (73%)
- Water Conservation (61%)
- Intercropping and Crop Rotation (53%)

Main topics available to the public in the United States

- Crop Production (89%)
- Sustainable Agriculture (89%)
- Livestock Production (84%)
- Conservation (80%)

Figure 5
Availability of Topics Related to Improving Soil and Water Management



Source: NAAAN survey report (2021).

Qualitative Findings

What additional programs or services should be available for improving soil and water management through agricultural advisory/extension services?

Survey respondents were asked to share additional programs or services that should be available for improving soil and water management through agricultural advisory/extension services. Researchers used inductive coding to qualitatively analyze the open text responses. The following codes were created:

Best Practices Respondents discussed specific practices to improve soil and water management. No-till methods, carbon sequestration and carbon markets are some examples. This also includes ways to support adoption of best practices through incentives and investment in infrastructure. Specific to Mexico, respondents also discussed rainwater harvesting.

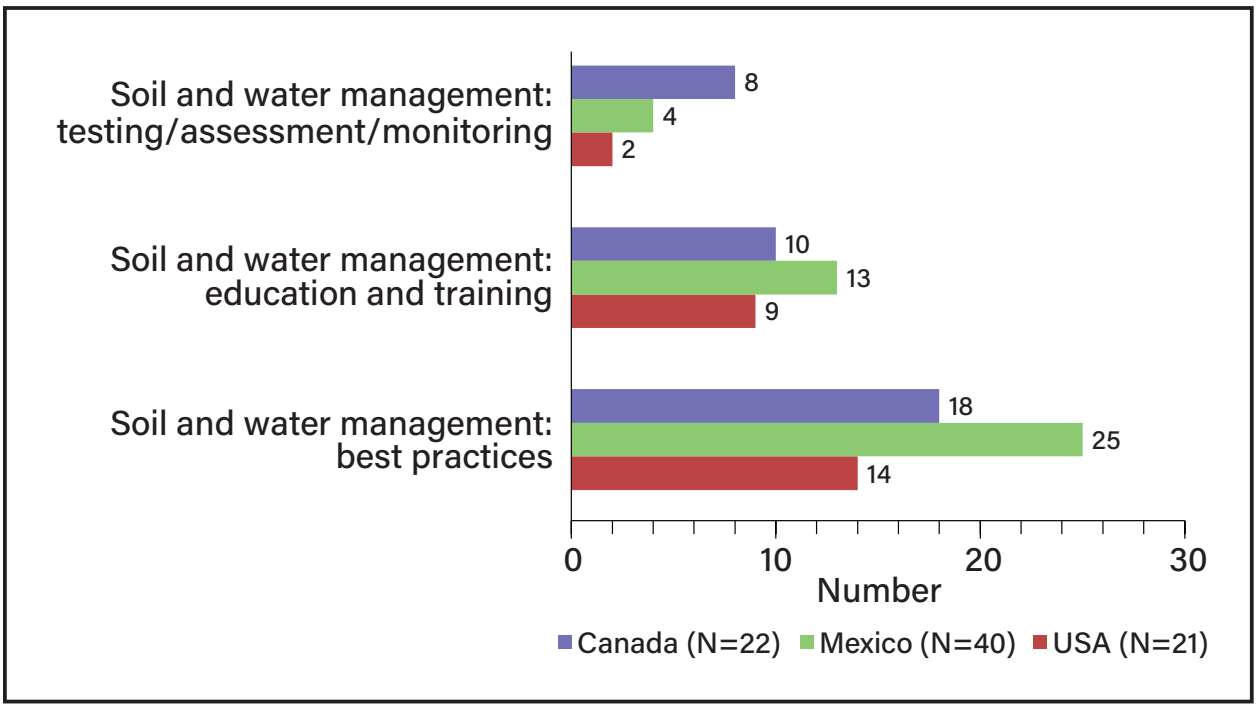
Education and Training This category includes training on the use of new technologies and data analysis related to soil and water management and a focus on knowledge translation. Specific to Mexico, respondents also mentioned traditional knowledge.

Testing/Assessment/Monitoring Respondents discussed the need to develop and strengthen soil testing labs and the use of soil health surveys. This includes employing easier methods for monitoring, and tools for assessing carbon sequestration.

Qualitative Results Summary

In each of the three countries, the most frequent theme regarding desired soil and water management services or programs is related to best practices, including specific methods for improving soil and water management, as well as infrastructure to support adoption of best practices. A subtheme that emerges in Mexico only was rainwater harvesting programs or services. The chart below displays the frequency of each theme across the three countries.

Figure 6
Soil and Water Management



Source: NAAAN survey report (2021).

Building Skills and Career Development for Youth

Youth Development opportunities are most prevalent in the United States but available in all three countries. The graph below shows how availability for each topic varies across each country.

Main topics available to the public in Canada

- Youth Agricultural Programs (41%)
- Partnerships with Secondary Schools (41%)
- Other Related Services (33%)
- Youth Development (31%)

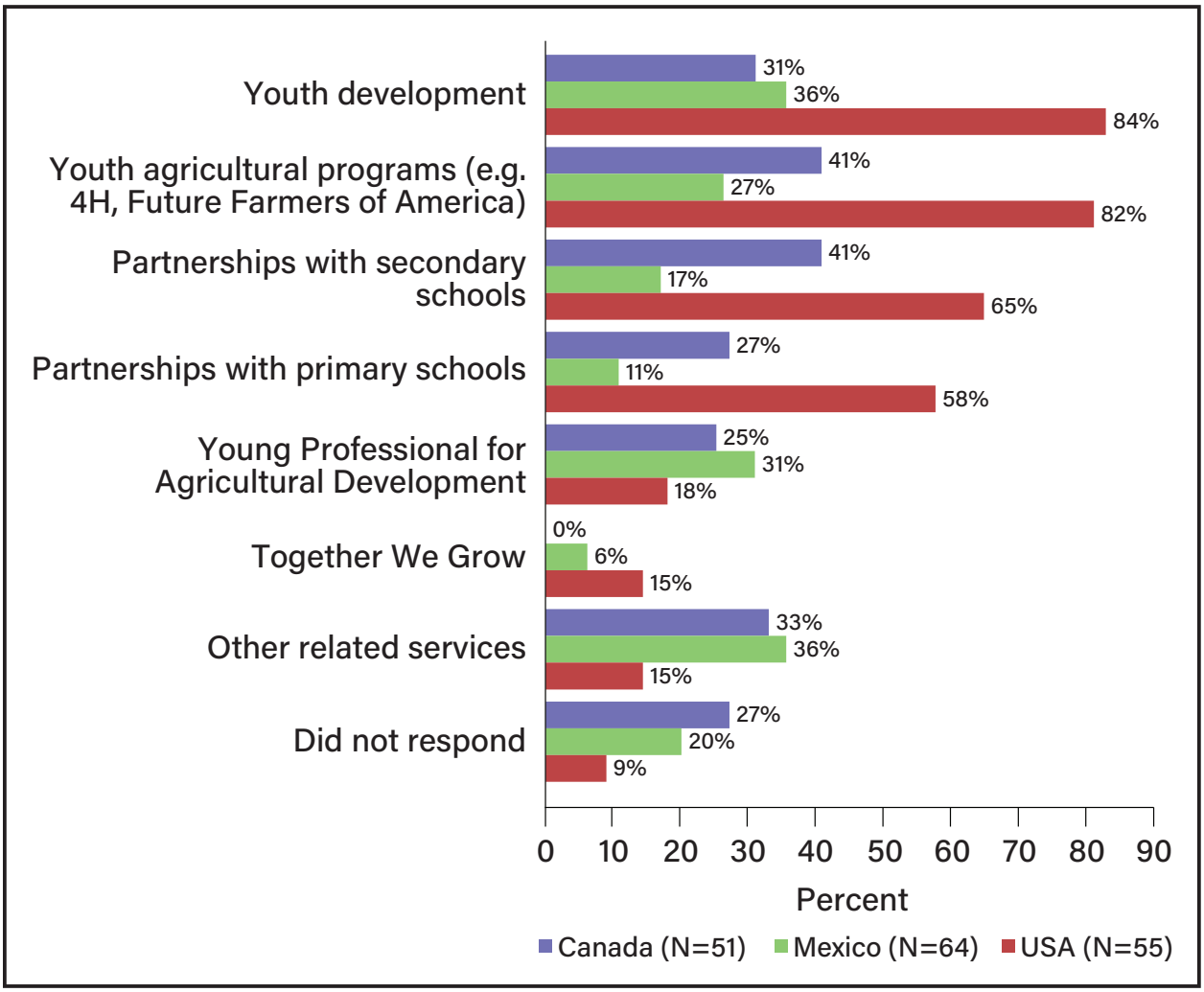
Main topics available to the public in Mexico

- Youth Development (36%)
- Other Related Services (36%)
- Young Professional for Agricultural Development (31%)

Main topics available to the public in the United States

- Youth Development (84%)
- Youth Agricultural Programs (82%)
- Partnerships with Secondary Schools (66%)
- Partnerships with Primary Schools (58%)

Figure 7
Availability of Topics Related to Building Skills and Career Development for Youth



Source: NAAAN survey report (2021).

Qualitative Findings

What additional programs or services should be available for building skills and career development for youth through agricultural advisory/extension services?

Respondents were asked to share additional programs or services for building skills and career development for youth that should be available through agricultural advisory/extension services. Researchers used inductive coding to qualitatively analysis the open text responses. The following codes were created:

Mentorship and Life Skills This theme includes a desire for mentoring youth interested in agriculture, through youth groups, colleges/universities, and other organizations.

Career Promotion and Outreach This theme focuses on educating youth about the types of careers involved in the agriculture sector, specific career development paths, and training programs to engage youth in agriculture.

Youth Programming Respondents identified specific types of youth-oriented programming to maintain youth engagement in the agriculture sector, in addition to identifying new groups of youth not yet engaged or repre-

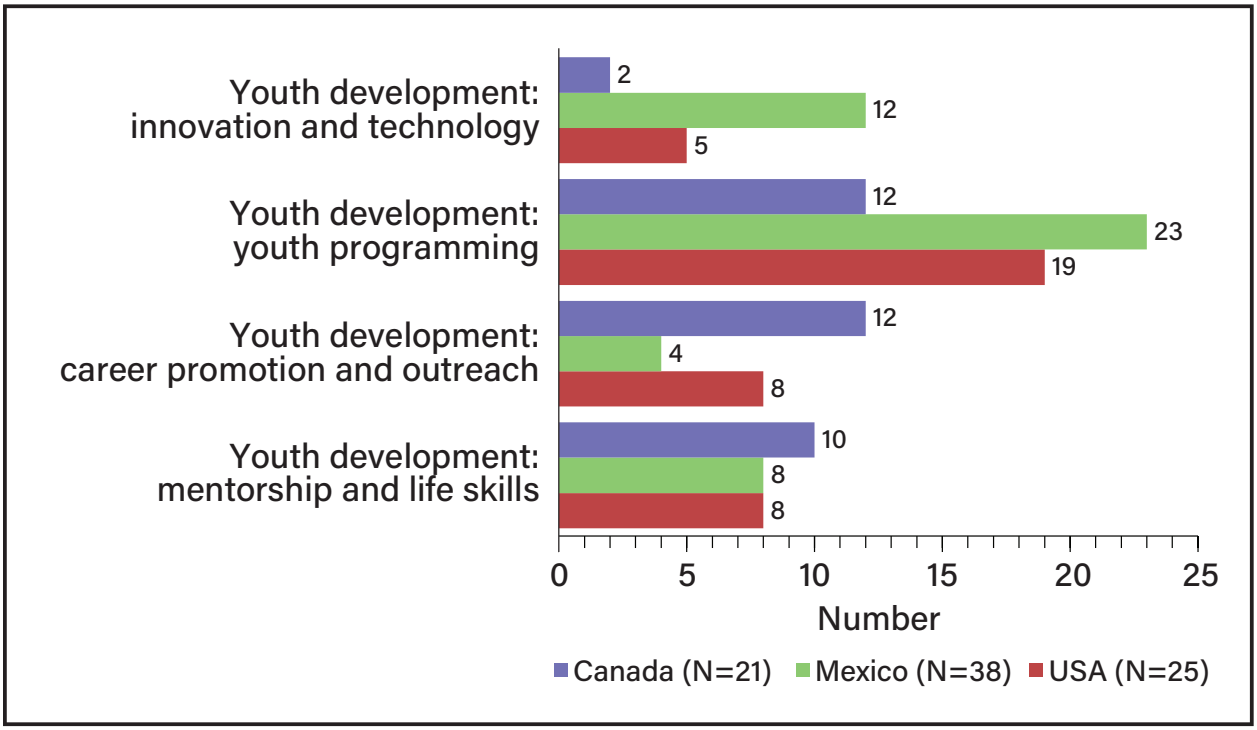
sented in agriculture. In responses from Mexico, the additional subtheme of acknowledgement of traditional and intercultural education also emerges.

Innovation and Technology Respondents focused on technology and agriculture innovation to attract youth to the industry.

Qualitative Results Summary

In each of the three countries, the most frequent theme regarding needed programs or services for building skills and career development for youth is related to specific types of youth programming aimed at maintaining youth engagement, as well as targeting segments of the youth population that are currently under or unrepresented in the agriculturale sector. In Mexico's responses, the second most frequent theme is innovation and technology, whereas this is the least frequent theme in both Canada and the United States. The chart below displays the frequency of each theme across the three countries.

Figure 8
Availability of Topics Related to Building Skills and Career Development for Youth



Source: NAAAN survey report (2021).

Other Services Offered to the Public

A series of other services typically offered through agricultural advisory/extension services were listed to respondents. Many of these topics are available in the United States and few are available in Mexico or Canada, however, the top offering across all three countries is rural/community development.

Main topics available to the public in Canada

- Rural/Community Development (35%)
- Financial Education (29%)
- Mental Health (29%)
- Nutrition (26%)
- Marketing Farm Products (26%)

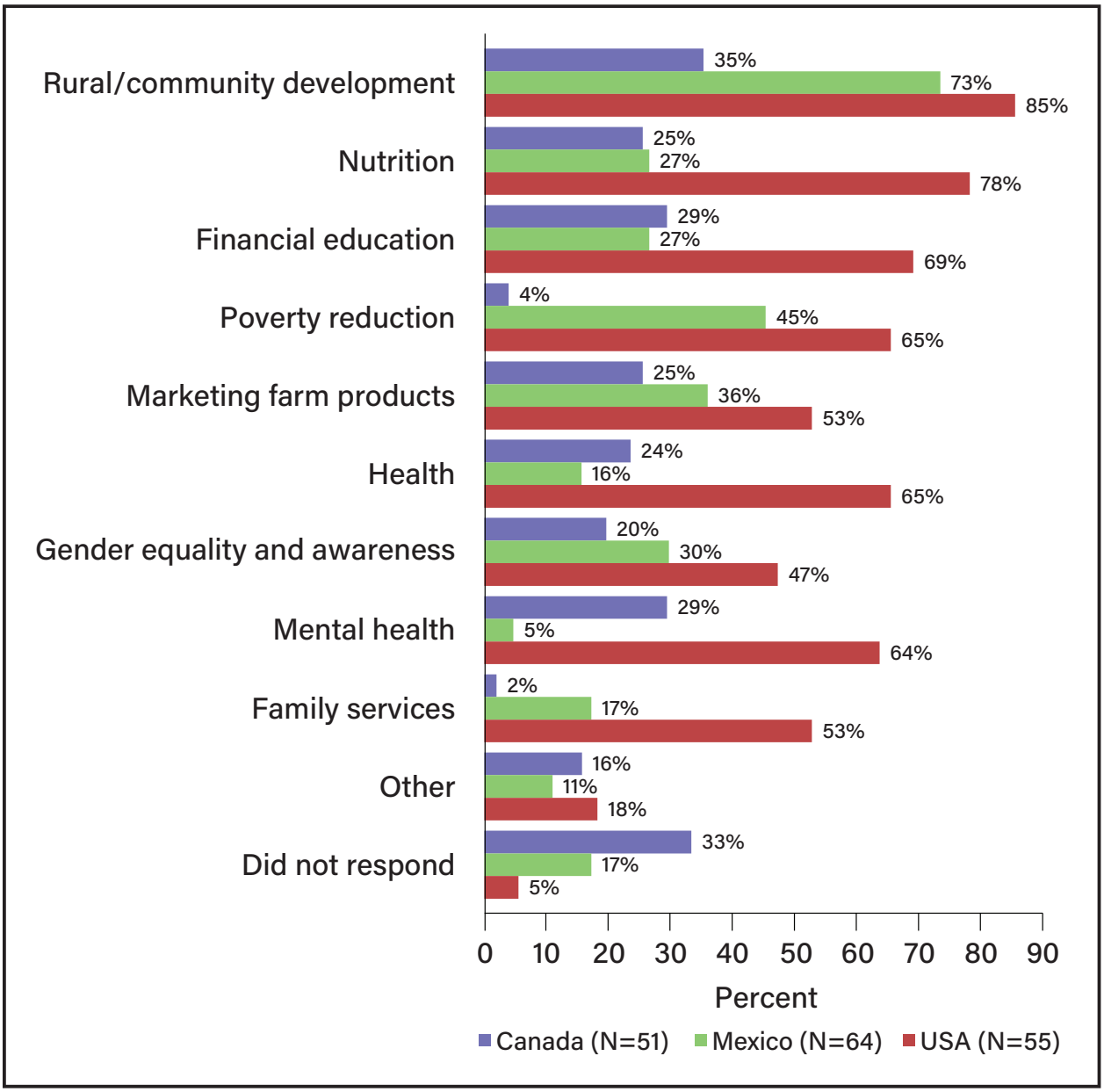
Main topics available to the public in Mexico

- Rural/Community Development (73%)
- Poverty Reduction (45%)
- Marketing Farm Products (36%)
- Gender Equality and Awareness (30%)

Main topics available to the public in the United States

- Rural/Community Development (86%)
- Nutrition (78%)
- Financial Education (69%)
- Poverty Reduction (66%)

Figure 9
Availability of Other Service Topics Offered to the Public



Source: NAAAN survey report (2021).

Service Modalities

How are agricultural advisory/extension programs and services offered by your organization?

Organizations offer programs and services in a variety of ways across the three countries; however, each country identified an in-person modality within their top three responses. Each of the countries listed in-person workshops or trainings within their top three modalities, and Mexico and the United States identified in-person interactions with farmers within their top three modalities. The United States also identified in-person interaction with non-farmer community members within their top three modalities. The graphs below show the main in-person modalities across the three countries and the main non-in-person modalities across the three countries.

Main Modalities in Canada

- In-person workshops or trainings (73%)
- Virtual meetings with farmers (71%)
- Website posts (69%)
- In-person interaction with farmers (67%)
- Printed educational materials (e.g. newsletters, mailed fliers) (67%)
- Social media posts (e.g. Facebook, Twitter) (67%)

Main Modalities in Mexico

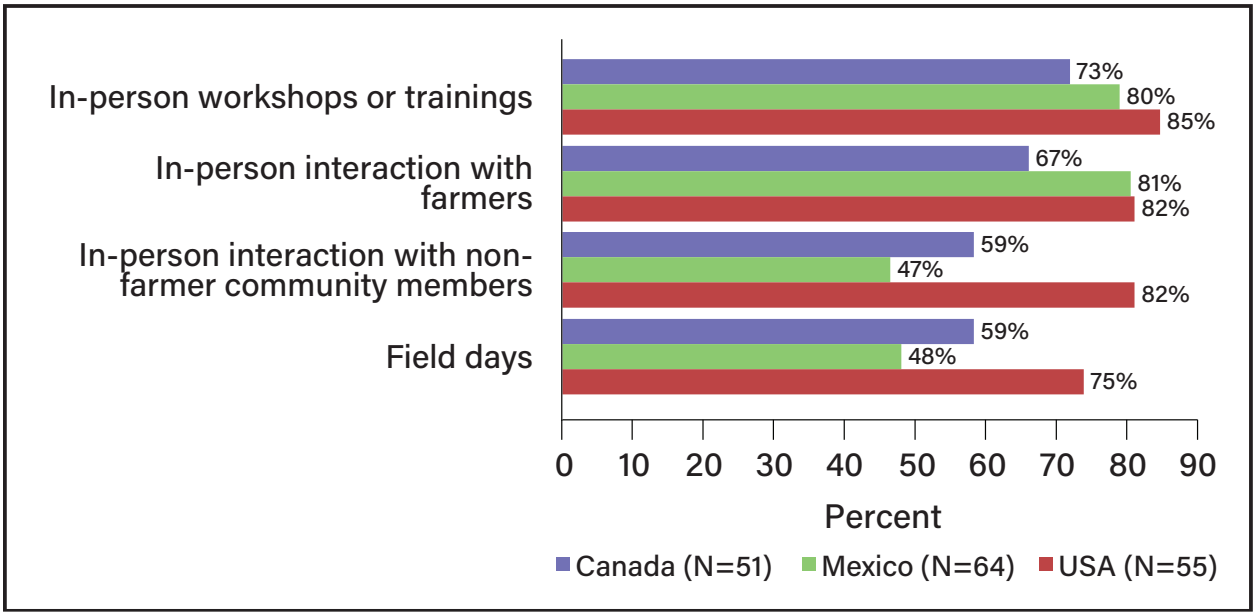
- In-person interaction with farmers (81%)
- In-person workshops or trainings (80%)

Main Modalities in the United States

- In-person workshops or trainings (86%)
- In-person interaction with farmers (82%)
- In-person interaction with non-farmer community members (82%)
- Printed educational materials (e.g. newsletters, mailed fliers) (80%)
- Virtual meetings with farmers (80%)

Figure 10

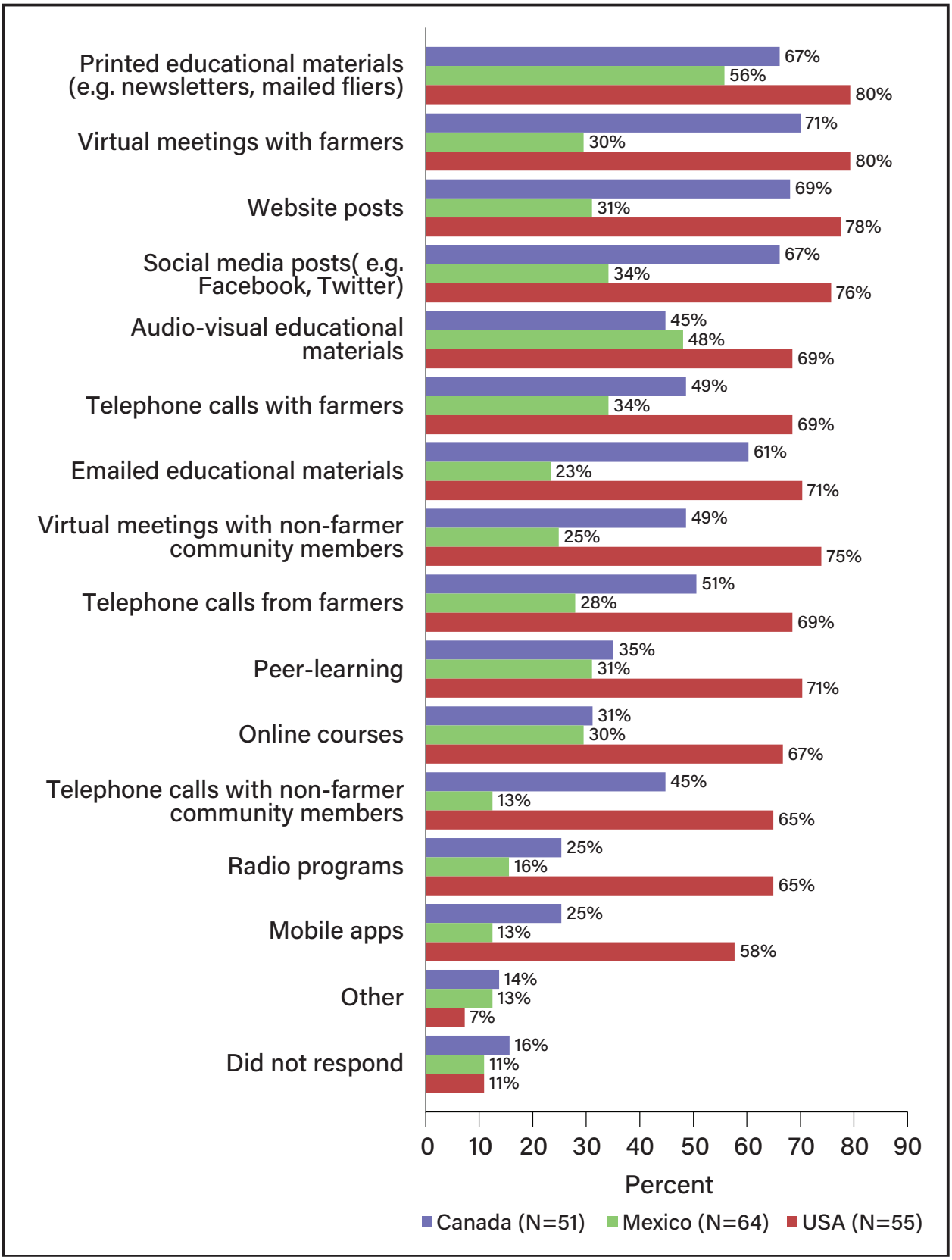
How are agricultural advisory/extension programs and services offered by your organization?
In-Person Service Modalities



Source: NAAAN survey report (2021).

Figure 11

How are agricultural advisory/extension programs and services offered by your organization? Non-In Person Service Modalities



Source: NAAAN survey report (2021).

Farmer Challenges Accessing Programs and Services

What challenges do farmers experience in accessing agricultural advisory/extension programs and services?

Respondents in all three countries reported similar challenges faced by farmers in accessing agricultural advisory/extension programs and services, with Canada and the United States sharing the top three challenges (awareness of programs and services, no or slow internet access, and perception of the value of agricultural advisory/extension services) and Mexico sharing two of three of those challenges (awareness of programs and services and perception of the value of agricultural advisory/extension services).

Challenges Faced by Canada's Farmers

- Awareness of programs and services (65%)
- No or slow internet access (61%)
- Perception of the value of agricultural advisory/extension services (59%)

Challenges Faced by Mexico's Farmers

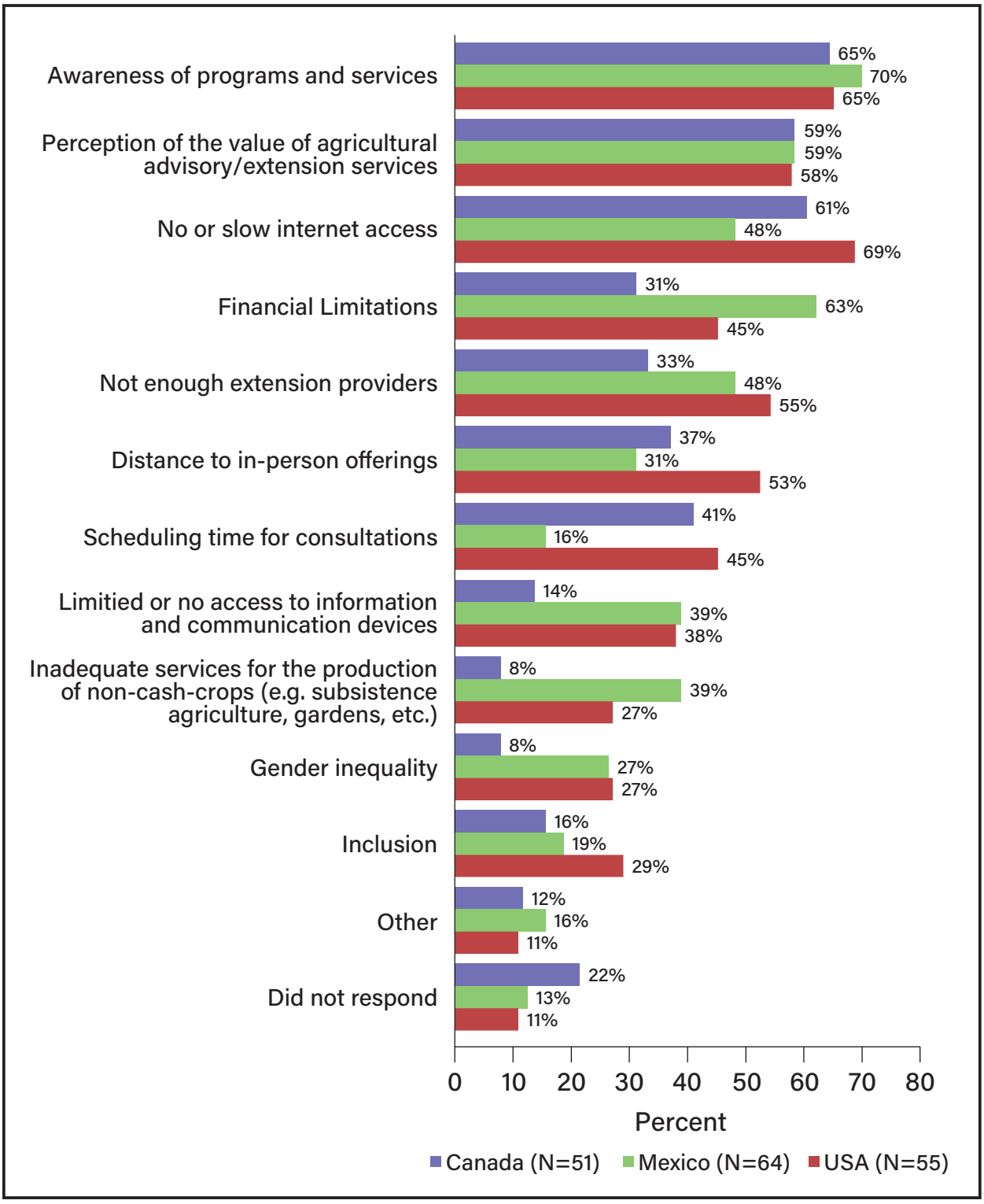
- Awareness of programs and services (70%)
- Financial Limitations (63%)
- Perception of the value of agricultural advisory/extension services (59%)

Challenges Faced by the United States' Farmers

- No or slow internet access (69%)
- Awareness of programs and services (66%)
- Perception of the value of agricultural advisory/extension services (58%)

Figure 12

What challenges do farmers experience in accessing agricultural advisory/extension programs and services?



Source: NAAAN survey report (2021).

Organizational Challenges in Providing Services

What challenges do staff from your organization face in providing programs and services to farmers and the community?

Organizations across the three countries share the same top three staff challenges in providing programs and services to farmers and the community: not enough financial resources, not enough staff, and no or slow internet access. Additionally, Mexico respondents ranked distance to reach community members who need services as a top priority, and United States. respondents ranked limited ability to support farmers from underrepresented groups as a top priority.

Main Organizational Challenges in Providing Services in Canada

- Not enough financial resources (69%)
- Not enough staff (59%)
- No or slow internet access (33%)

Main Organizational Challenges in Providing Services in Mexico

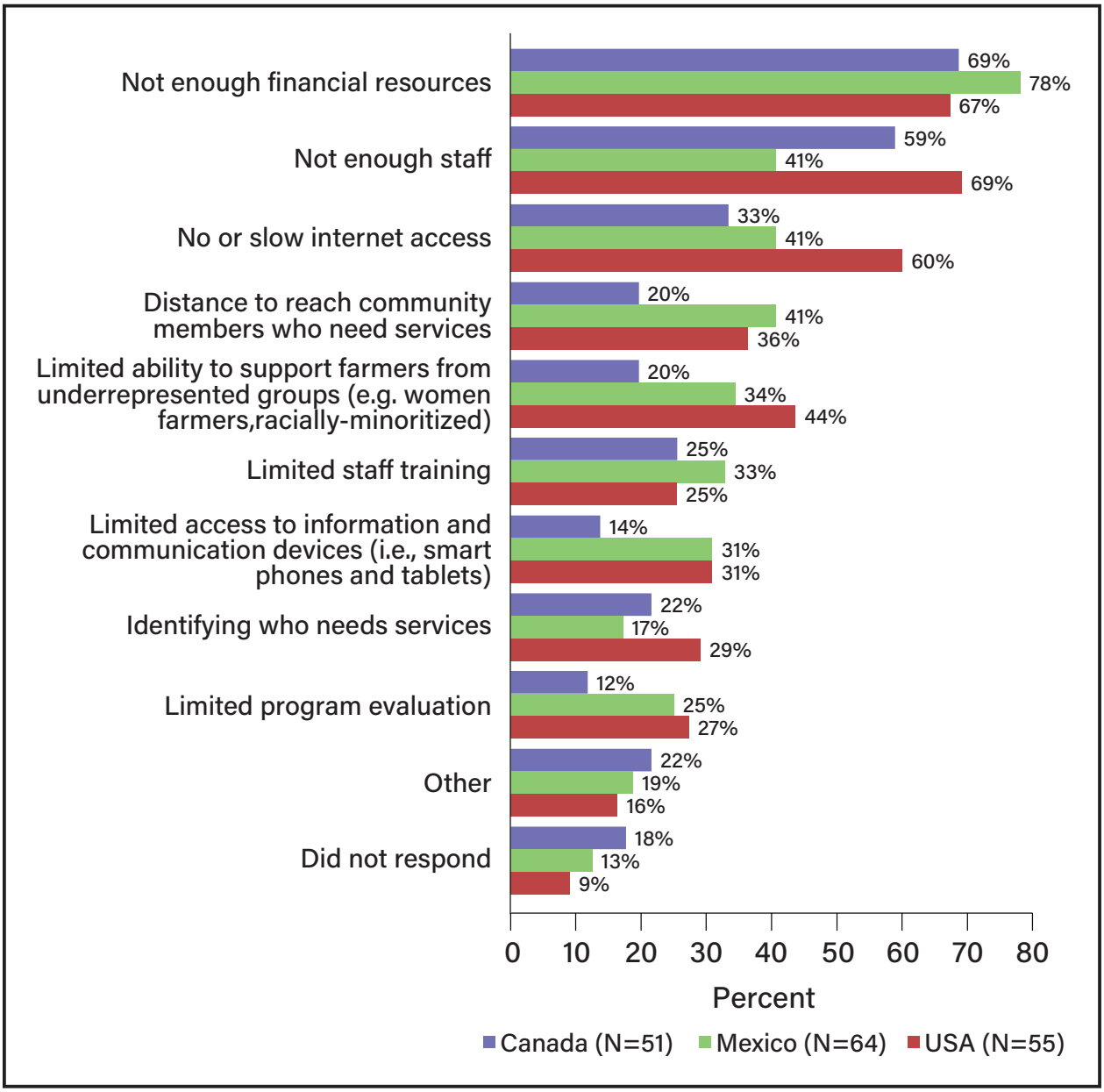
- Not enough financial resources (78%)
- Not enough staff (41%)
- No or slow internet access (41%)
- Distance to reach community members who need services (41%)

Main Organizational Challenges in Providing Services in the United States

- Not enough staff (69%)
- Not enough financial resources (67%)
- No or slow internet access (60%)
- Limited ability to support farmers from underrepresented groups (e.g. women farmers, racially minoritized farmers) (44%)

Figure 13

What challenges do staff from your organization face in providing programs and services to farmers and the community?



Source: NAAAN survey report (2021).

Collaboration Efforts

What types of organizations does your organization collaborate with for information and program offerings?

Organizations in all three countries collaborate with other types of organizations for information and program offerings. The most frequent type of collaboration in all three countries is between respondent organizations and universities, colleges, and other academic institutions. The graph below shows how types of collaborations varied between respondent organizations and other types of organizations across the three countries.

Most frequent organizations for collaboration in Canada

- Universities/Colleges/Academic Institutions (82%)
- Agricultural research programs and institutions (80%)
- Agricultural advisory/extension organizations in my country (75%)
- Federal/National Government agencies (75%)
- State/Provincial Government agencies (75%)
- Private industry (75%)

Most frequent organizations for collaboration in Mexico

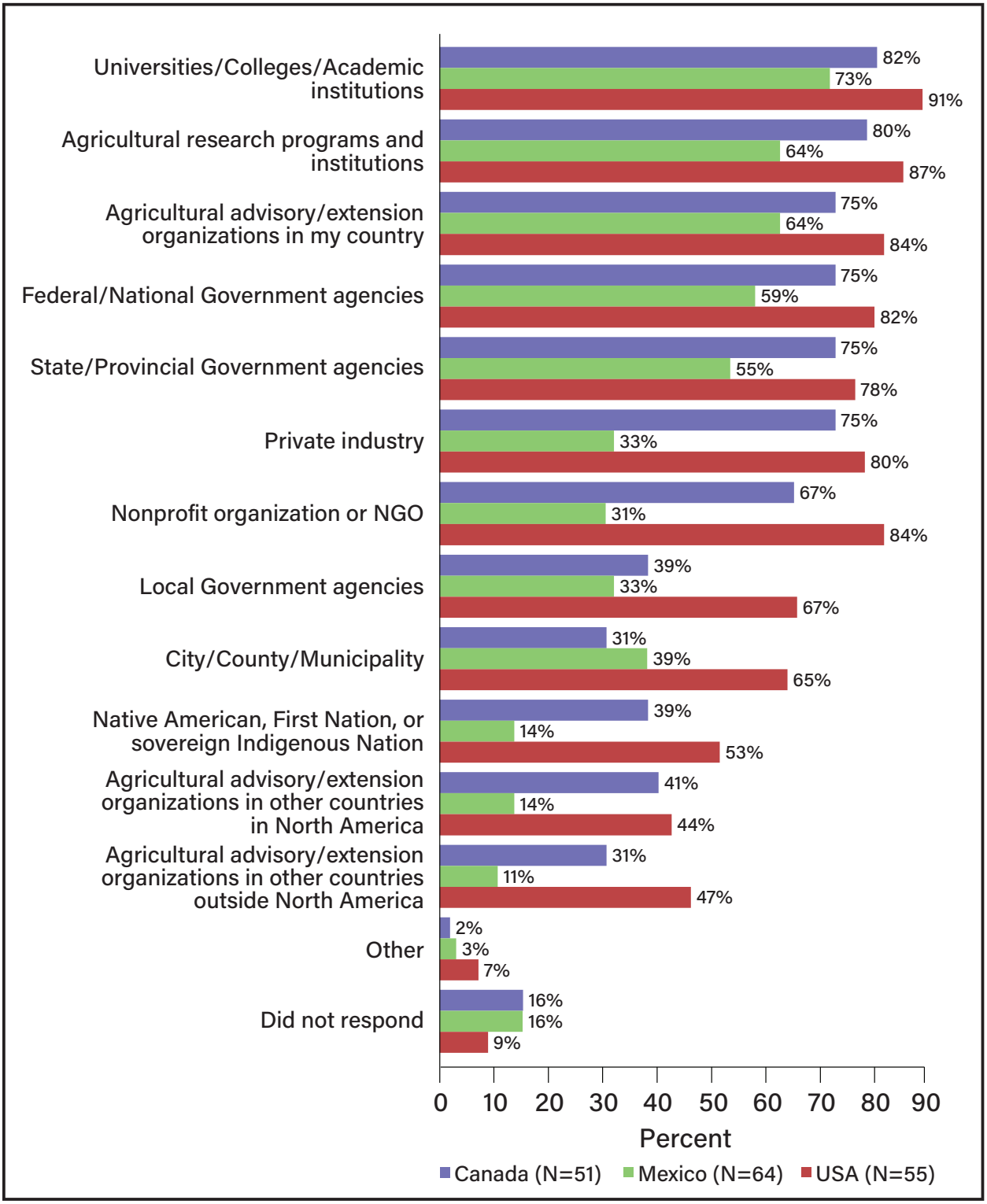
- Universities/Colleges/Academic Institutions (73%)
- Agricultural research programs and institutions (64%)
- Agricultural advisory/extension organizations in my country (64%)
- Federal/National Government agencies (59%)

Most frequent organizations for collaboration in the United States

- Universities/Colleges/Academic Institutions (91%)
- Agricultural research programs and institutions (87%)
- Agricultural advisory/extension organizations in my country (84%)
- Nonprofit organization or NGO (84%)
- Federal/National Government agencies (82%)

Figure 14

What types of organizations does your organization collaborate with for information and program offerings?



Source: NAAAN survey report (2021).

Ways of Collaborating Across Organization Types

Universities and College Collaborations

How do agricultural advisory/extension services in your organization collaborate with universities and colleges?

Respondents in all three countries share two common ways of collaborating with universities and colleges: sharing knowledge with them and collaborating directly with their researchers. Canada and United States respondents identified an additional two shared ways of collaborating with universities and colleges: learning from them and consulting researchers for advice.

Most frequent ways of collaborating with universities and colleges for Canada

- We learn from them (73%)
- We collaborate directly with researchers (69%)
- We share our knowledge with them (63%)
- We consult researchers for advice (63%)

Most frequent ways of collaborating with universities and colleges for Mexico

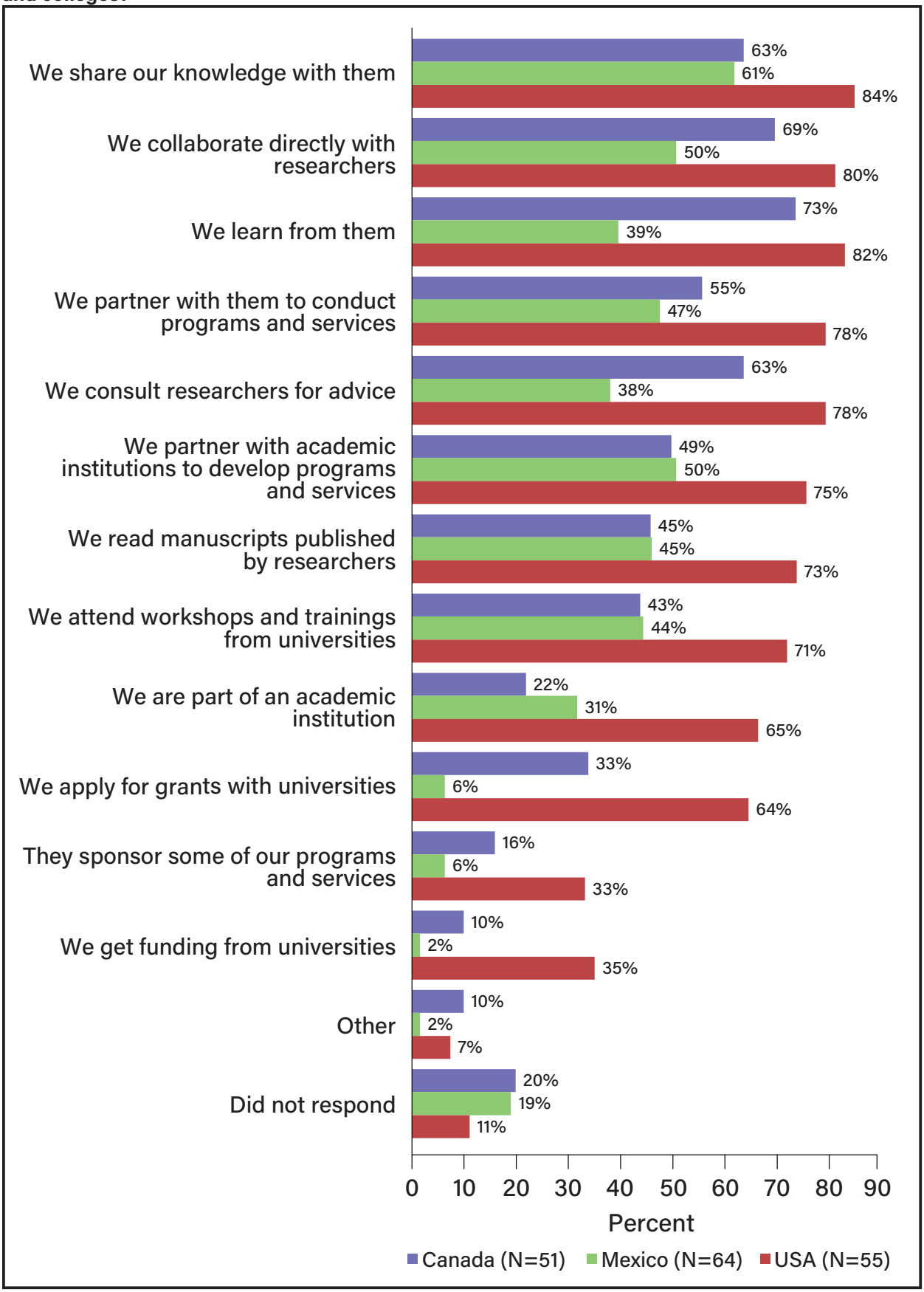
- We share our knowledge with them (61%)
- We collaborate directly with researchers (50%)
- We partner with academic institutions to develop programs and services (50%)

Most frequent ways of collaborating with universities and colleges for the United States

- We share our knowledge with them (84%)
- We learn from them (82%)
- We collaborate directly with researchers (80%)
- We partner with them to conduct programs and services (78%)
- We consult researchers for advice (78%)

Figure 15

How do agricultural advisory/extension services in your organization collaborate with universities and colleges?



Source: NAAAN survey report (2021).

Agricultural Research Programs and Institutions

How do agricultural advisory/extension services in your organization collaborate with agricultural research programs and institutions?

Respondents that said they collaborate with agricultural research programs and institutions were asked to identify how they do so. Canadian and United States respondents shared their top three ways of collaborating with agricultural research programs and institutions, and Mexican residents shared two of their top three: we share knowledge with them (all countries), we learn from them (Canada, United States), and we partner with them to conduct programs and services (Canada, United States). Mexican respondents also said that they partner with agricultural research programs and institutions to develop programs and services.

Most frequent ways of collaborating with agricultural research programs & institutions for Canada

- We learn from them (85%)
- We share knowledge with them (80%)
- We partner with them to conduct programs and services (61%)

Most frequent ways of collaborating with agricultural research programs & institutions for Mexico

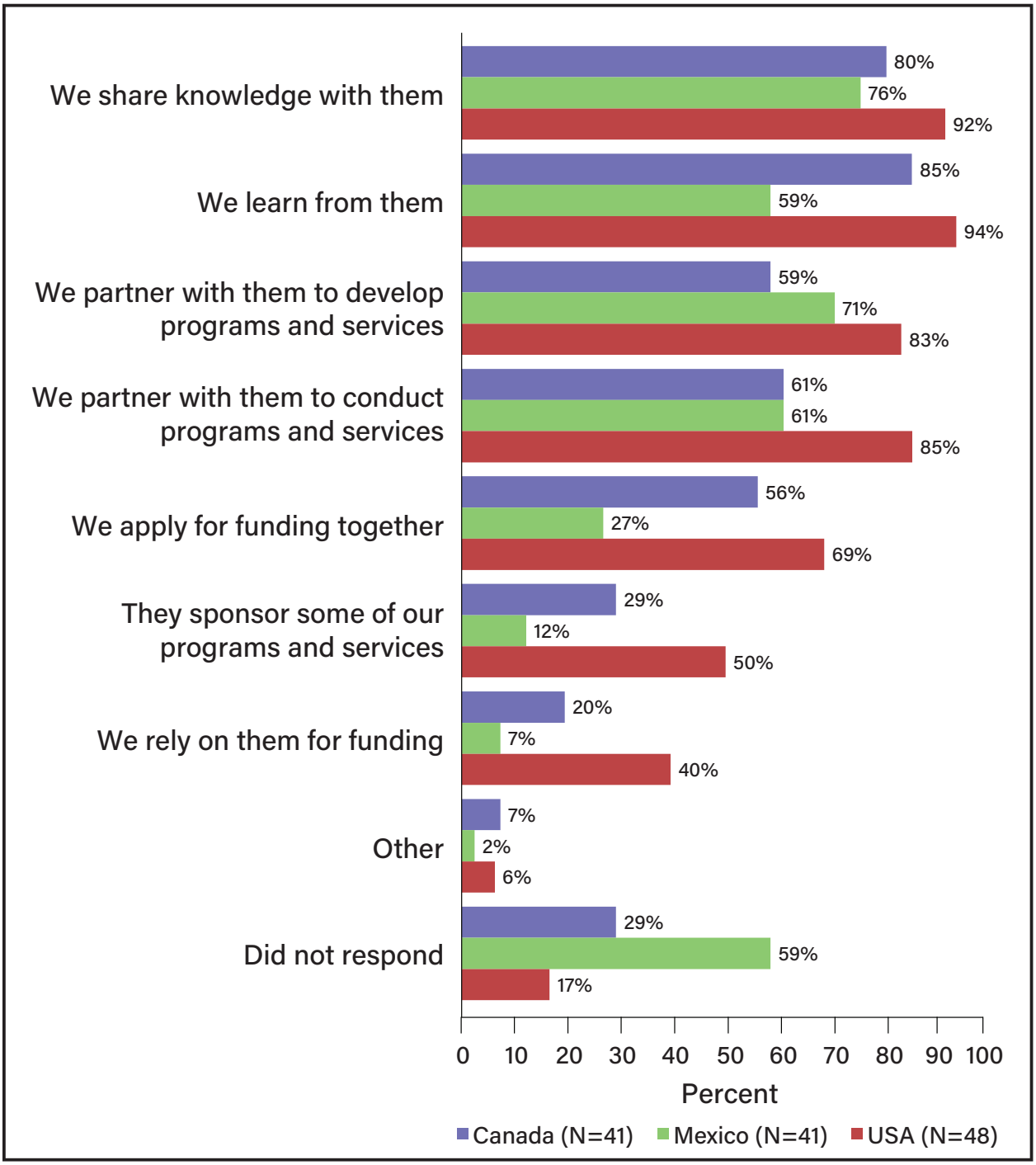
- We share knowledge with them (76%)
- We partner with them to develop programs and services (71%)
- We partner with them to conduct programs and services (61%)

Most frequent ways of collaborating with agricultural research programs & institutions for the United States

- We learn from them (94%)
- We share knowledge with them (92%)
- We partner with them to conduct programs and services (85%)

Figure 16

How do agricultural advisory/extension services in your organization collaborate with agricultural research programs and institutions?



Source: NAAAN survey report (2021).

Agricultural Advisory/Extension Organizations in My Country

How do agricultural advisory/extension services in your organization collaborate with other agricultural advisory/extension organizations?

Of the respondents that said they collaborate with agricultural advisory/extension organizations in their countries, respondents in all three countries listed sharing knowledge with other organizations and partnering with them to develop programs and services in their top three responses. Canada and the United States also said that they learn from them in their top three responses.

Most frequent ways of collaborating with other agricultural advisory/extension organizations for Canada

- We share knowledge with them (95%)
- We learn from them (84%)
- We partner with them to develop programs and services (82%)

Most frequent ways of collaborating with other agricultural advisory/extension organizations for Mexico

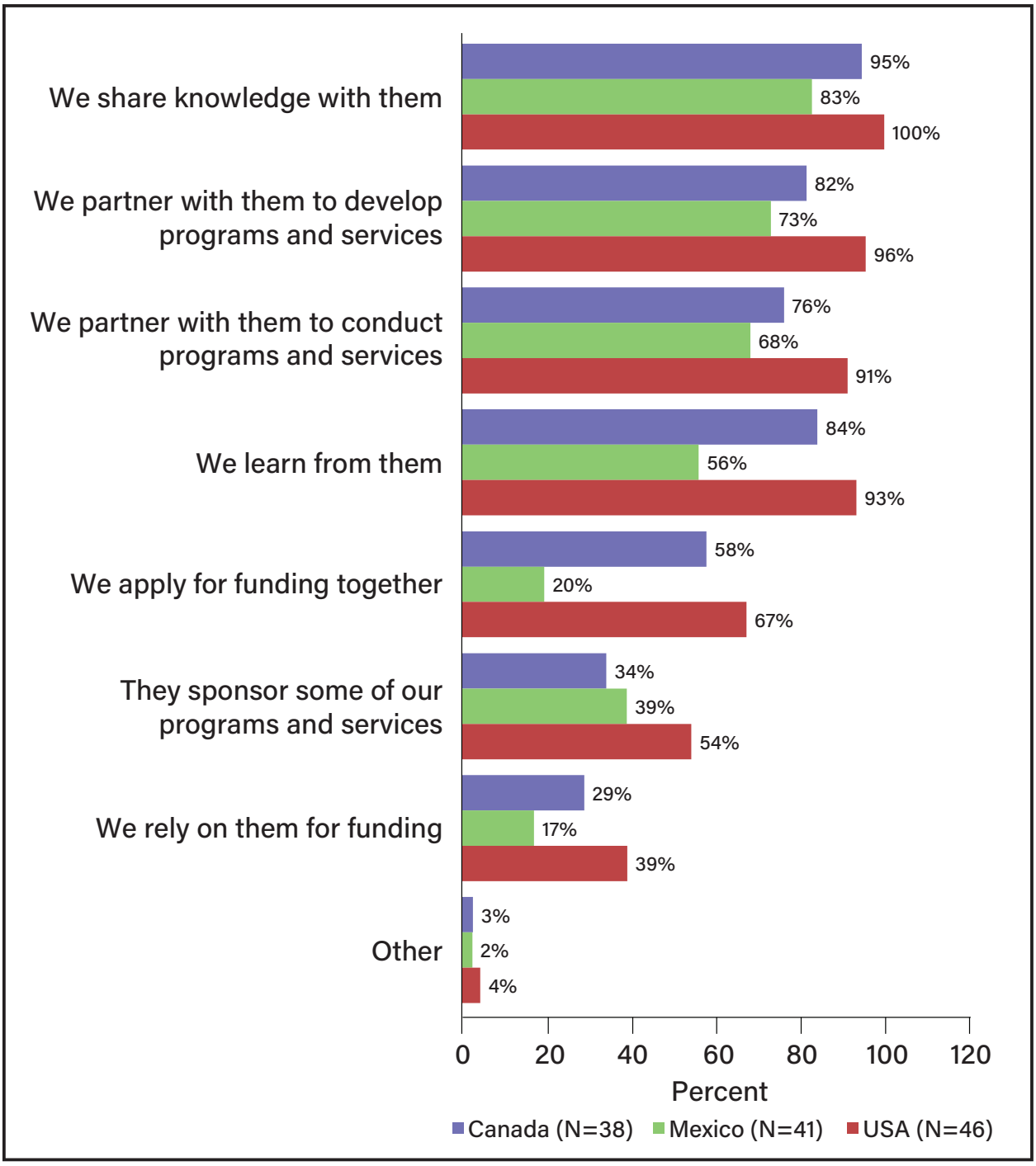
- We share knowledge with them (83%)
- We partner with them to develop programs and services (73%)
- We partner with them to conduct programs and services (68%)

Most frequent ways of collaborating with other agricultural advisory/extension organizations for the United States

- We share knowledge with them (100%)
- We partner with them to develop programs and services (96%)
- We learn from them (94%)

Figure 17

How do agricultural advisory/extension services in your organization collaborate with other agricultural advisory/extension organizations?



Source: NAAAN survey report (2021).

Government Agencies (Federal/National, State/Provincial, and Local Levels)

How do agricultural advisory/extension services in your organization collaborate with government agencies?

Of the respondents that said they collaborate with government agencies, respondents in all three countries listed relying on them for funding and partnering with them to conduct programs and services within their top three responses. Mexican respondents also said that they sponsor some of their programs and services in their top three most frequently chosen responses.

Most frequent ways of collaborating with government agencies for Canada

- We share knowledge with them (71%)
- We rely on them for funding (67%)
- We partner with them to conduct programs and services (59%)
- We partner with them to develop programs and services (59%)

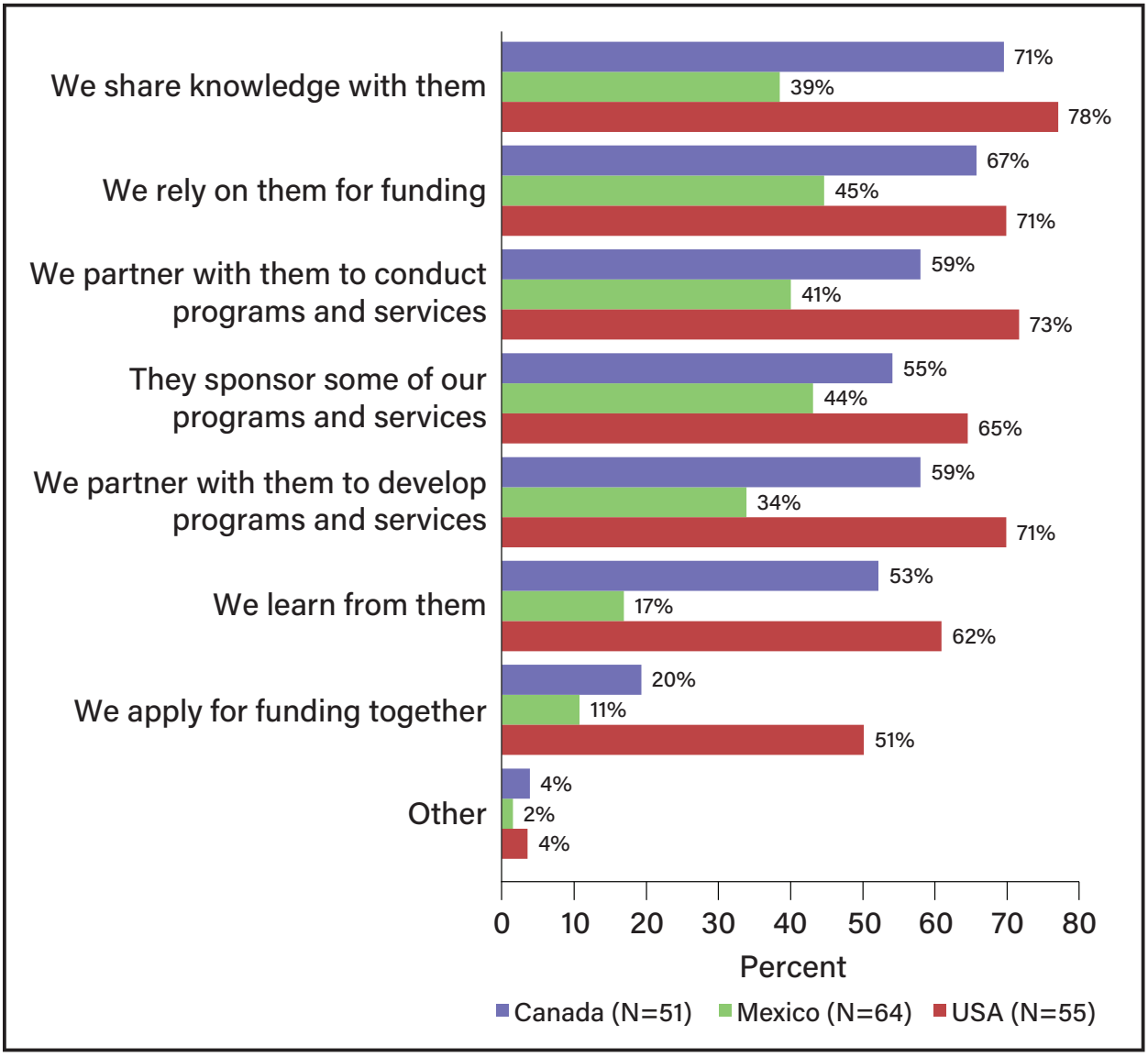
Most frequent ways of collaborating with government agencies for Mexico

- We rely on them for funding (45%)
- They sponsor some of our programs and services (44%)
- We partner with them to conduct programs and services (41%)

Most frequent ways of collaborating with government agencies for the United States

- We share knowledge with them (78%)
- We partner with them to conduct programs and services (73%)
- We rely on them for funding (71%)
- We partner with them to develop programs and services (71%)

Figure 18
How do agricultural advisory/extension services in your organization collaborate with with government agencies?



Source: NAAAN survey report (2021).

Impact Metrics

What types of metrics does your organization use to measure its impact?

Respondents were asked to select the metrics they use to show their organization's impact. Each of the three countries identified number of people served by programs (educational impact) and number of publications produced annually (knowledge creation) in their top three. Respondents from Mexico and the United States identified agricultural productivity (agricultural impact) as one of the top three metrics for measuring impact while Canada focused on money leveraged for additional programming.

Main Metrics Used by Canada

- Number of people served by programs (educational impact) (63%)
- Money leveraged for additional programming (47%)
- Number of publications produced annually (knowledge creation) (39%)

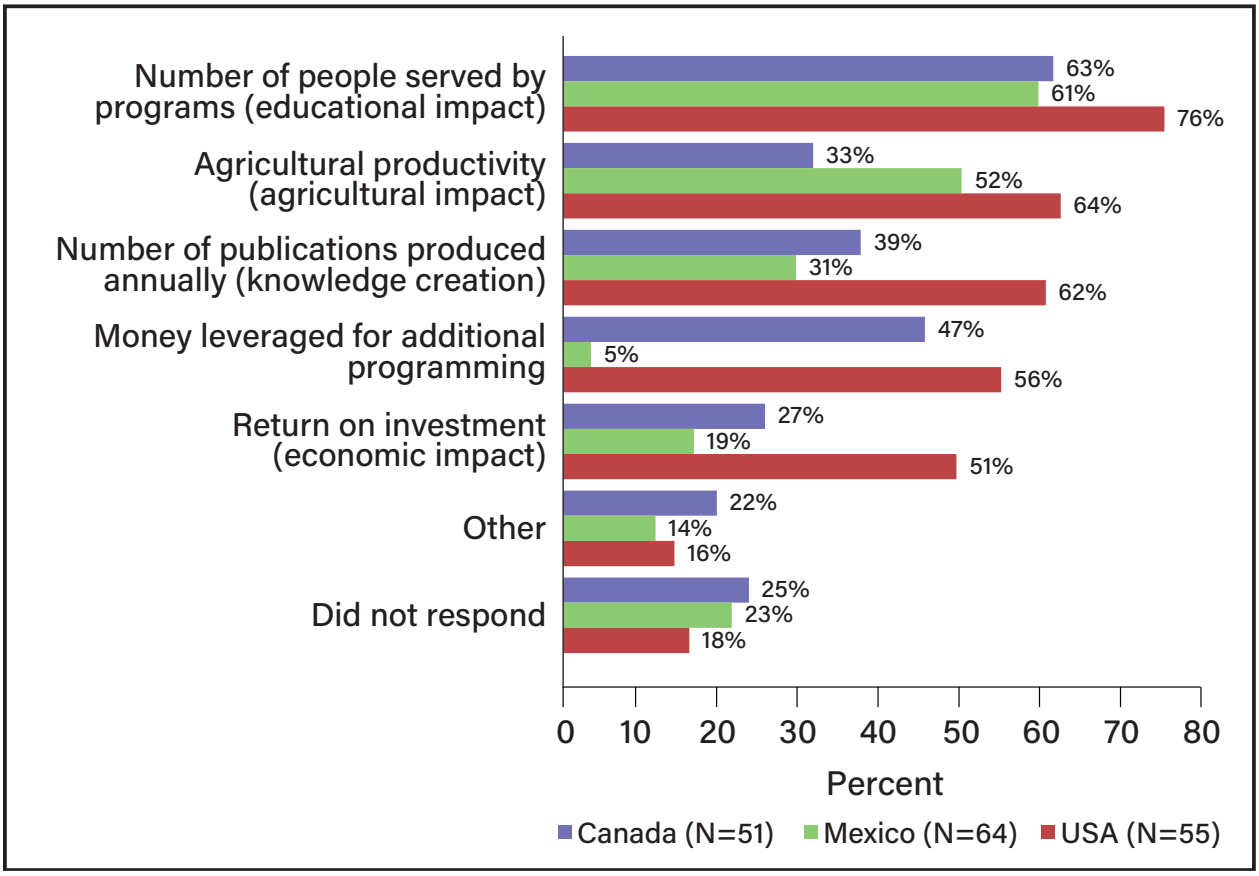
Main Metrics Used by Mexico

- Number of people served by programs (educational impact) (61%)
- Agricultural productivity (agricultural impact) (52%)
- Number of publications produced annually (knowledge creation) (31%)

Main Metrics Used by United States

- Number of people served by programs (educational impact) (76%)
- Agricultural productivity (agricultural impact) (64%)
- Number of publications produced annually (knowledge creation) (62%)

Figure 19
What types of metrics does your organization use to measure its impact?



Source: NAAAN survey report (2021).

Budget and Service Changes

How has the annual budget for your organization changed over the last 20 years? If your organization is not at least 20 years old, please answer in reference to its inception.

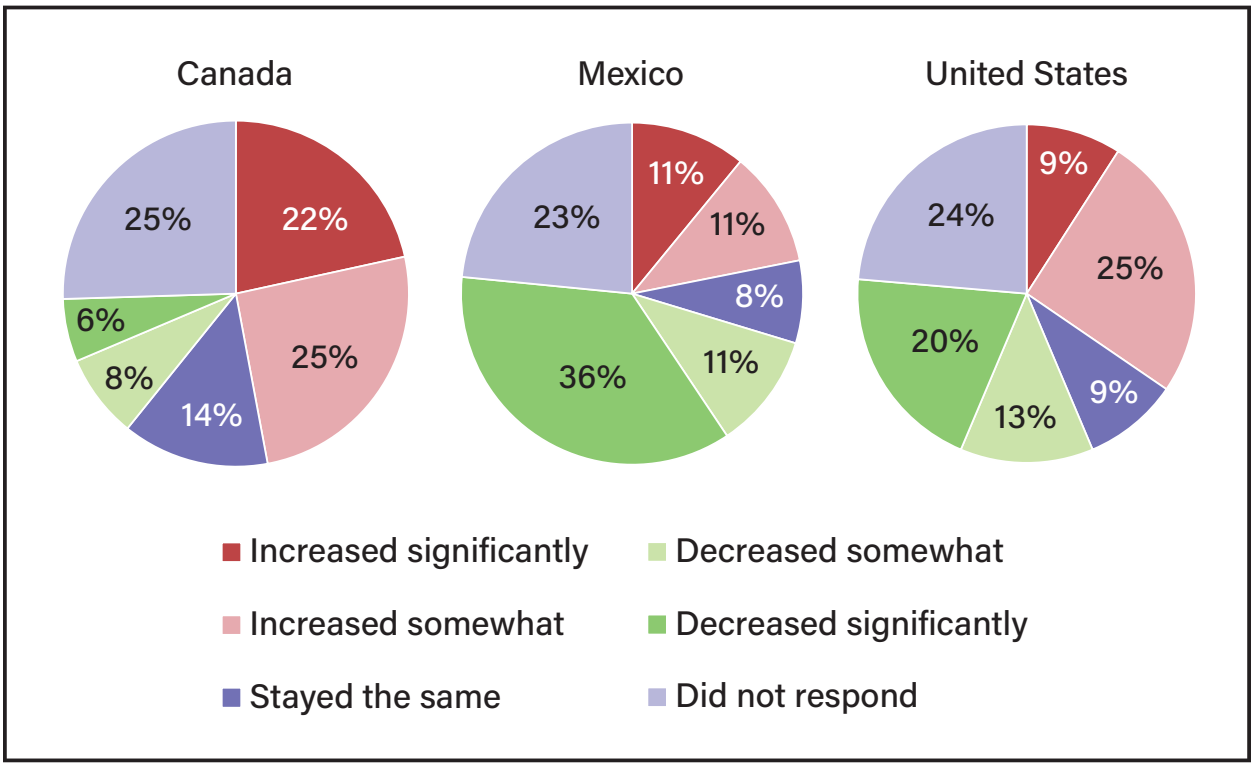
Respondents were asked to report how their budget changed over the last 20 years. The trends vary across by country. Almost 60% of respondents in Mexico reported budgets that have decreased somewhat or significantly. About 33% of respondents in the United States reported that budgets have decreased somewhat or significantly, but another 34% reported that budgets have increased somewhat or significantly. Almost 50% of respondents in Canada reported their budgets have increased somewhat or significantly.

Changes in Number of Farmer Relationships

How has the annual budget for your organization changed over the last 20 years? If your organization is not at least 20 years old, please answer in reference to its inception.

Respondents were asked to report how their budget changed over the last 20 years. The trends vary across by country. Almost 60% of respondents in Mexico reported budgets that have decreased somewhat or significantly. About 33% of respondents in the United States reported that budgets have decreased somewhat or significantly, but another 34% reported that budgets have increased somewhat or significantly. Almost 50% of respondents in Canada reported their budgets have increased somewhat or significantly.

Figure 20
Changes in Number of Farmer Relationships

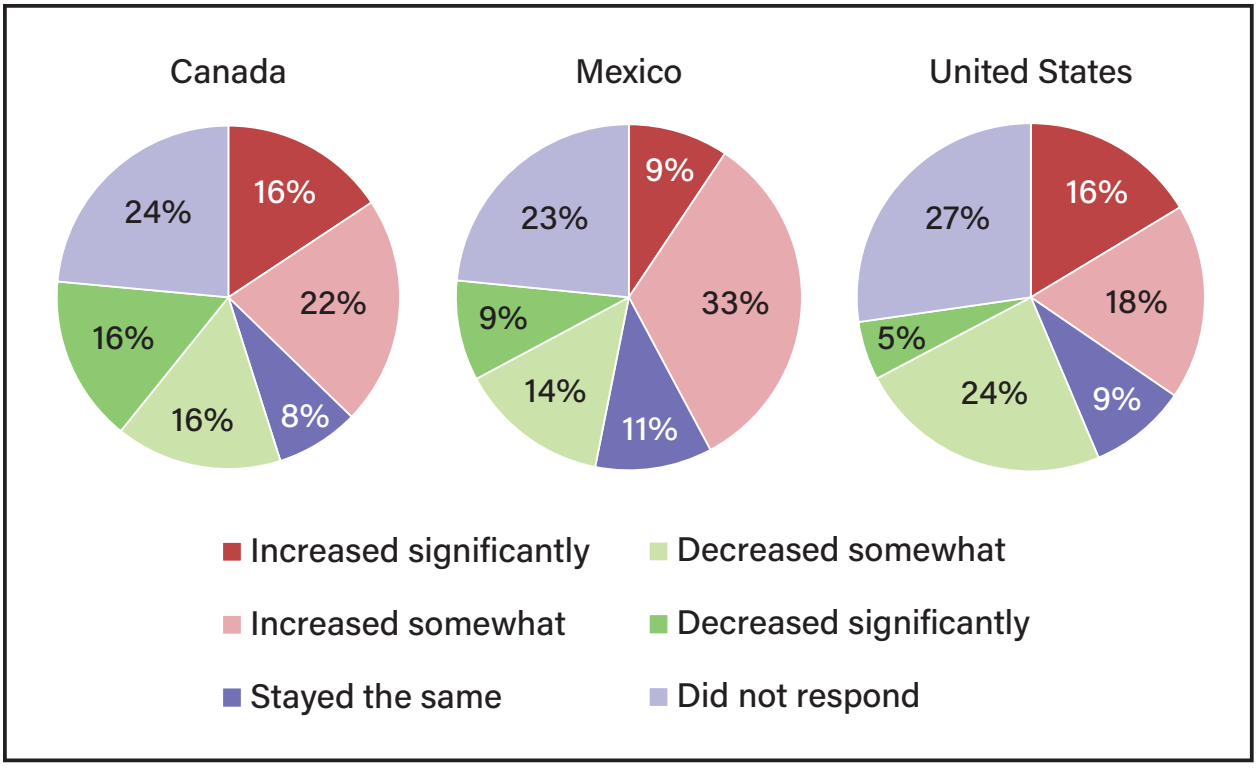


Source: NAAAN survey report (2021).

How has the number of farms and agribusinesses that your organization works with changed over the last 20 years? If your organization is not at least 20 years old, please answer in reference to its inception.

Respondents were also asked how the number of farmers they worked with has changed over the last 20 years. While budget changes have been mixed, demand for services from farmers has also been mixed. In Canada, 37% of respondents reported that demand from farmers has increased somewhat or significantly while 32% reported demand has decreased somewhat or significantly. In Mexico, 42% of respondents reported that demand has increased somewhat or significantly while 23% reported it has decreased somewhat or significantly. In the United States, 34% of respondents reported that demand has increased somewhat or significantly while 29% reported that demand from farmers has decreased somewhat or significantly.

Figure 21
Demand for Services From Farmers



Source: NAAAN survey report (2021).

Appendix A: Survey Demographic Characteristics

Respondent Age

How old are you?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
25-34	1	2.0%	6	9.4%	2	3.6%	9	5.3%
35-44	5	9.8%	6	9.4%	7	12.7%	18	10.6%
45-54	13	25.5%	13	20.3%	11	20.0%	37	21.8%
55-64	19	37.3%	21	32.8%	18	32.7%	58	34.1%
65-74	2	3.9%	6	9.4%	6	10.9%	14	8.2%
75+	0	0.0%	2	3.1%	1	1.8%	3	1.8%
Did not respond	11	21.6%	10	15.6%	10	18.2%	31	18.2%
Total	51		64		55		170	

Source: NAAAN survey report (2021).

Length of Involvement in Agricultural Advisory/Extension

How long have you been involved in ag advisory/extension?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
0-4 years	2	3.9%	4	6.3%	3	5.5%	9	5.3%
5-9 years	7	13.7%	11	17.2%	6	10.9%	24	14.1%
10-14 years	6	11.8%	11	17.2%	6	10.9%	23	13.5%
15-19 years	4	7.8%	8	12.5%	7	12.7%	19	11.2%
20+ years	21	41.2%	19	29.7%	24	43.6%	64	37.6%
Did not respond	11	21.6%	11	17.2%	9	16.4%	31	18.2%
Total	51		64		55		170	

Source: NAAAN survey report (2021).

Gender identity

What is your gender identity?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
Woman	19	37.3%	13	20.3%	23	41.8%	55	32.4%
Man	21	41.2%	39	60.9%	20	36.4%	80	47.1%
Non-binary/non-conforming	0	0.0%	0	0.0%	1	1.8%	1	0.6%
Prefer not to respond	0	0.0%	1	1.6%	3	5.5%	4	2.4%
Did not respond	11	21.6%	11	17.2%	8	14.5%	30	17.6%
Total	51		64		55		170	

Source: NAAAN survey report (2021).

Ethnicity

What is your ethnicity?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
Native American, First Nations	0	0.0%	2	3.1%	1	1.8%	3	1.8%
Black, African American	0	0.0%	0	0.0%	3	5.5%	3	1.8%
Hispanic/Latino	0	0.0%	50	78.1%	0	0.0%	50	29.4%
White	37	72.5%	2	3.1%	38	69.1%	77	45.3%
Other	1	2.0%	0	0.0%	0	0.0%	1	0.6%
Multi-racial	1	2.0%	0	0.0%	1	1.8%	2	1.2%
No Response	12	23.5%	10	15.6%	12	21.8%	34	20.0%
Total	51		64		55		170	

Source: NAAAN survey report (2021).

Appendix B: In-Country Geographic Location of Respondents

If Canada, what province	N	Percent
Alberta	3	5.9%
British Columbia	6	11.8%
Manitoba	5	9.8%
New Brunswick	5	9.8%
Newfoundland and Labrador	3	5.9%
Nova Scotia	4	7.8%
Ontario	9	17.6%
Prince Edward Island	6	11.8%
Quebec	4	7.8%
Saskatchewan	6	11.8%
Total	51	100.0%

Source: NAAAN survey report (2021).

If Mexico, what state	N	Percent
Baja California Sur	7	10.9%
Campeche	1	1.6%
Chiapas	1	1.6%
Chihuahua	21	32.8%
Coahuila	2	3.1%
Guanajuato	1	1.6%
Hidalgo	1	1.6%
Mexico	7	10.9%
Mexico City	9	14.1%
Nuevo Leon	1	1.6%
Oaxaca	1	1.6%
Puebla	2	3.1%
San Luis Potosi	1	1.6%
Tabasco	4	6.3%
Veracruz	4	6.3%
Yucatan	1	1.6%
Total	64	100.0%

Source: NAAAN survey report (2021).

If USA, what state	N	Percent
Alabama	1	1.8%
California	1	1.8%
Colorado	6	10.9%
Florida	1	1.8%
Georgia	1	1.8%
Hawaii	1	1.8%
Illinois	1	1.8%
Indiana	2	3.6%
Iowa	1	1.8%
Kansas	1	1.8%
Kentucky	1	1.8%
Louisiana	1	1.8%
Maine	1	1.8%
Maryland	2	3.6%
Michigan	1	1.8%
Mississippi	1	1.8%
Missouri	3	5.5%
Montana	1	1.8%
Nebraska	1	1.8%
New Mexico	1	1.8%
North Carolina	1	1.8%
Ohio	1	1.8%
Oklahoma	2	3.6%
Oregon	2	3.6%
Pennsylvania	2	3.6%
South Dakota	1	1.8%
Tennessee	1	1.8%
U.S. Virgin Islands	1	1.8%
Utah	1	1.8%
Virginia	3	5.5%
Washington	1	1.8%
West Virginia	1	1.8%
Wisconsin	2	3.6%
Wyoming	2	3.6%
Sovereign Nation	1	1.8%
Washington D.C.	4	7.3%
Total	55	100.0%

Source: NAAAN survey report (2021).

Appendix C: Other Organizational Collaboration Efforts

City/County/Municipality

How does your organization collaborate with the City/County/Municipality?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
We share knowledge with them	11	68.8%	18	72.0%	35	97.2%	64	83.1%
We partner with them to conduct programs and services	8	50.0%	15	60.0%	32	88.9%	55	71.4%
We partner with them to develop programs and services	5	31.3%	17	68.0%	26	72.2%	48	62.3%
We learn from them	8	50.0%	4	16.0%	29	80.6%	41	53.2%
They sponsor some of our programs and services	2	12.5%	9	36.0%	29	80.6%	40	51.9%
We rely on them for funding	3	18.8%	4	16.0%	26	72.2%	33	42.9%
We apply for funding together	3	18.8%	5	20.0%	21	58.3%	29	37.7%
Other	3	18.8%	1	4.0%	0	0.0%	4	5.2%
Total	16		25		36		77	

Source: NAAAN survey report (2021).

Private Industry

How does your organization collaborate with private industry?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
We share knowledge with them	35	92.1%	16	76.2%	41	93.2%	92	54.1%
We learn from them	30	78.9%	8	38.1%	37	84.1%	75	44.1%
We partner with them to conduct programs and services	22	57.9%	11	52.4%	37	84.1%	70	41.2%
They sponsor some of our programs and services	27	71.1%	11	52.4%	31	70.5%	69	40.6%
We partner with them to develop programs and services	18	47.4%	12	57.1%	31	70.5%	61	35.9%
We rely on them for funding	20	52.6%	3	14.3%	28	63.6%	51	30.0%
We apply for funding together	14	36.8%	6	28.6%	21	47.7%	41	24.1%
Other	2	5.3%	1	4.8%	1	2.3%	4	2.4%
Total	38		21		44		170	

Source: NAAAN survey report (2021).

Non-profits

How does your organization collaborate with Nonprofit organizations or NGOs?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
We share knowledge with them	32	94.1%	18	90.0%	43	93.5%	93	93.0%
We partner with them to conduct programs and services	29	85.3%	15	75.0%	40	87.0%	84	84.0%
We partner with them to develop programs and services	29	85.3%	14	70.0%	33	71.7%	76	76.0%
We learn from them	25	73.5%	7	35.0%	36	78.3%	68	68.0%
We apply for funding together	23	67.6%	2	10.0%	27	58.7%	52	52.0%
They sponsor some of our programs and services	10	29.4%	6	30.0%	23	50.0%	39	39.0%
We rely on them for funding	7	20.6%	3	15.0%	15	32.6%	25	25.0%
Other	1	2.9%	0	0.0%	1	2.2%	2	2.0%
Total	34		20		46		100	

Source: NAAAN survey report (2021).

Native Americans, First Nations, or sovereign Indigenous Nations

How does your organization collaborate with Native Americans, First Nations, or sovereign Indigenous Nations?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
We share knowledge with them	18	90.0%	9	100.0%	27	93.1%	54	93.1%
We learn from them	17	85.0%	8	88.9%	25	86.2%	50	86.2%
We partner with them to conduct programs and services	11	55.0%	6	66.7%	26	89.7%	43	74.1%
We partner with them to develop programs and services	12	60.0%	4	44.4%	23	79.3%	39	67.2%
We apply for funding together	4	20.0%	4	44.4%	18	62.1%	26	44.8%
They sponsor some of our programs and services	2	10.0%	0	0.0%	7	24.1%	9	15.5%
We rely on them for funding	1	5.0%	0	0.0%	3	10.3%	4	6.9%
Other	2	10.0%	0	0.0%	3	10.3%	5	8.6%
Total	20		9		29		58	

Source: NAAAN survey report (2021).

Other Organizations

How does your organization collaborate with other?	Country							
	Canada		Mexico		USA			
	N	Percent	N	Percent	N	Percent	Total	Percent total
We learn from them	1	100.0%	2	100.0%	3	75.0%	6	85.7%
We share knowledge with them	1	100.0%	1	50.0%	3	75.0%	5	71.4%
We partner with them to develop programs and services	1	100.0%	2	100.0%	2	50.0%	5	71.4%
We partner with them to conduct programs and services	1	100.0%	1	50.0%	3	75.0%	5	71.4%
We rely on them for funding	0	0.0%	0	0.0%	2	50.0%	2	28.6%
They sponsor some of our programs and services	0	0.0%	0	0.0%	2	50.0%	2	28.6%
We apply for funding together	0	0.0%	0	0.0%	2	50.0%	2	28.6%

Source: NAAAN survey report (2021).

Survey Questions in English

NAAAN Mapping Survey

The North American Agricultural Advisory Network (NAAAN) is the newest member of the Global Forum for Rural Advisory Services (GFRAS) https://www.g-fras.org/en/. You have been identified as an expert on agricultural advisory/extension services by the NAAAN Steering Committee. Your participation is crucial to understanding agricultural training, agricultural education, and agricultural advisory/extension services in Canada, Mexico, and/or the United States of America. The information you provide will inform the future support and focus areas of the NAAAN and the work we do collectively across the three countries. For more information on the NAAAN, please visit our website: https://www.csuspur.org/naaan/

We have selected the Institute for Research in the Social Sciences (IRISS) at Colorado State University to manage this survey research titled '"North American Agricultural Advisory Network Survey."'. Allison Cantwell is the Principal Investigator and researcher from IRISS.

This online survey will take approximately 20–30 minutes of your time. Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participation at any time. The Institute for Research in the Social Sciences will retain your name, email address, organization, and role to track participation and send reminders to you and will not be distributed for future research. The data from this study will be released publicly after the study to include each country but without any personally identifying information. When we report the data to others, we will combine the data from all participants from each country.

If you have any questions about the research, please contact Allison Cantwell: Allison.cantwell@colostate.edu or the Institute for Research in the Social Sciences, cla_iriss@colostate.edu. If you have any questions about your rights as a volunteer in this research, contact the CSU IRB at: 1-970-491-1553.

Thank you for your time and valuable input.

Please click the arrow to affirm your consent to participate in this survey

1. Where are you located?
   - Canada: Which province? _____
   - Mexico: Which state? _____
   - United States: Which state? _____
     or Sovereign Nation (please specify) _____

2. Please identify the agricultural advisory/extension-related organization you are a part of (or affiliated with). _____

3. What aspect of agricultural advisory/extension services do you focus on?
   _____

4. What is the geographic scope of your work?
   - Local focus (e.g., district, county, community, etc.)
   - Regional focus (within country)
   - National focus
   - Continental focus
   - International focus
   - Other (fill in) _____

We are interested in learning about the agricultural advisory/extension services available through your organization and how the NAAAN can support those services now and in the future. Within its broader role in expanding networking and shared learning among the agricultural advisory/extension communities of practice in the three countries, the NAAAN will have a particular focus over the next several years on three thematic areas:

(1) Biodefense/Biosecurity and Management of Natural Disaster: Diseases, climate change, and natural disasters threaten agricultural systems and economies. Advisory services can coordinate responses and help mitigate risk.

(2) Improving Soil and Water Management: Soil and water management are fundamental aspects of productive agricultural activities. They are also critical elements in the mitigation of, and resilience to, climate change.

(3) Building Skills and Career Development for Youth: NAAAN is building on the existing work of groups to prepare the next generation of leaders in global agriculture, including work with Together We Grow and Young Professionals for Agricultural Development.

5. What are the main topics for which agricultural advisory/extension services are available to the public from your organization? (select all that apply)

Biodefense/Biosecurity and Management of Natural Disaster

- ◦ Natural resource management
- ◦ Soil carbon economy
- ◦ Disaster management
- ◦ Disaster mitigation
- ◦ Climate change
- ◦ Disease management
- ◦ Microbiome and antimicrobial resistance
- ◦ Disease surveillance
- ◦ Zoonotic disease spill over
- ◦ Pest management
- ◦ Wildlife management
- ◦ Human-wildlife conflict
- ◦ Other services related to Biodefense/Biosecurity and Management of Natural Disaster (please specify) _____

Improving Soil and Water Management

- ◦ Crop production
- ◦ Livestock production
- ◦ Water conservation
- ◦ Irrigation
- ◦ Riparian/ecological restoration
- ◦ Conservation
- ◦ Sustainable agriculture
- ◦ Agroforestry
- ◦ Soil analysis
- ◦ Manure management
- ◦ Natural nitrogen fixation practices
- ◦ Intercropping and crop rotation
- ◦ Other services related to Improving Soil and Water Management (please specify) _____

Improving Soil and Water Management

- ◦ Crop production
- ◦ Livestock production
- ◦ Water conservation
- ◦ Irrigation
- ◦ Riparian/ecological restoration
- ◦ Conservation
- ◦ Sustainable agriculture
- ◦ Agroforestry
- ◦ Soil analysis
- ◦ Manure management
- ◦ Natural nitrogen fixation practices
- ◦ Intercropping and crop rotation
- ◦ Other services related to Improving Soil and Water Management (please specify)

  _____

Building Skills and Career Development for Youth

- ◦ Youth development
- ◦ Youth agricultural programs (e.g. 4H, Future Farmers of America)
- ◦ Together We Grow
- ◦ Young Professional for Agricultural Development
- ◦ Partnerships with primary schools
- ◦ Partnerships with secondary schools
- ◦ Other services related to Building skills and Career Development for Youth (please specify)

  _____

Other Services

- ◦ Marketing farm products
- ◦ Nutrition
- ◦ Health
- ◦ Poverty reduction
- ◦ Family services
- ◦ Mental health

- Financial education
- Gender equality and awareness
- Rural/community development
- Other services (Please specify) _____

6. What additional programs or services should be available for biodefense/biosecurity and management of natural disaster through agricultural advisory/extension services?
   _____

7. What additional programs or services should be available for improving soil and water management through agricultural advisory/extension services?
   _____

8. What additional programs or services should be available for building skills and career development for youth through agricultural advisory/extension services?
   _____

9. How are agricultural advisory/extension programs and services offered by your organization? (select all that apply)
   - In-person interaction with farmers
   - In-person interaction with non-farmer community members
   - Field days
   - Virtual meetings with farmers
   - Virtual meetings with non-farmer community members
   - Telephone calls with farmers
   - Telephone calls from farmers
   - Telephone calls with non-farmer community members
   - Printed educational materials (e.g., newsletters, mailed fliers)
   - Emailed educational materials
   - Audio-visual educational materials
   - Radio programs
   - Website posts
   - Social media posts (e.g., Facebook, Twitter)
   - Online courses
   - In-person workshops or training

- Peer-learning
- Mobile apps
- Other (please specify) _____

10. What challenges do staff from your organization face in providing programs and services to farmers and the community? (select all that apply)
    - Not enough staff
    - Not enough financial resources
    - No or slow internet access
    - Distance to reach community members who need services
    - Identifying who needs services
    - Limited access to information and communication devices (i.e., smart phones and tablets)
    - Limited staff training
    - Limited ability to support farmers from underrepresented groups (e.g., women farmers, racially-minoritized farmers)
    - Limited program evaluation
    - Other (please specify) _____

11. What challenges do farmers experience in accessing agricultural advisory/extension programs and services? (select all that apply)
    - Awareness of programs and services
    - Perception of the value of agricultural advisory/extension services
    - Distance to in-person offerings
    - No or slow internet access
    - Scheduling time for consultations
    - Gender inequality
    - Financial limitations
    - Inclusion
    - Limited or no access to information and communication devices
    - Not enough extension providers
    - Inadequate services for the production of non-cash-crops (e.g., subsistence agriculture, gardens, etc.)
    - Other (please specify) _____

12. How well do you feel the needs and concerns of farmers are considered for programs and services offered by your organization?

_____

The next series of questions focus on understanding the role of research, education, and academic institutions in agricultural advisory/extension services.

13. What types of organizations does your organization collaborate with for information and program offerings? (select all that apply)

- ◦ Agricultural advisory/extension organizations in my country
- ◦ Agricultural advisory/extension organizations in other countries in North America
- ◦ Agricultural advisory/extension organizations in other countries outside of North America
- ◦ Agricultural research programs and institutions
- ◦ Universities/Colleges/Academic Institutions
- ◦ City/County/Municipality
- ◦ Local Government agencies
- ◦ State/Provincial Government agencies
- ◦ Federal/National Government agencies
- ◦ Private industry
- ◦ Nonprofit organization or NGO
- ◦ Native American, First Nation, or sovereign Indigenous Nation
- ◦ Other (please specify) _____

14. How does your organization collaborate with other agricultural advisory/extension organizations?

- ◦ We learn from them
- ◦ We share our knowledge with them
- ◦ We rely on them for funding
- ◦ We partner with them to develop programs and services
- ◦ We partner with them to conduct programs and services
- ◦ They sponsor some of our programs and services
- ◦ We apply for funding together
- ◦ Other (please specify) _____

15. How does your organization collaborate with agricultural research programs and institutions?

- We learn from them
- We share our knowledge with them
- We rely on them for funding
- We partner with them to develop programs and services
- We partner with them to conduct programs and services
- They sponsor some of our programs and services
- We apply for funding together
- Other (please specify) _____

16. How do agricultural advisory/extension services in your organization collaborate with universities and colleges? (select all that apply)

- We learn from them
- We share our knowledge with them
- We collaborate directly with researchers
- We read manuscripts published by researchers
- We consult researchers for advice
- We partner with academic institutions to develop programs and services
- We partner with them to conduct programs and services
- They sponsor some of our programs and services
- We are part of an academic institution
- We attend workshops and trainings from universities
- We apply for grants with universities
- We get funding from universities
- Other (please specify) _____

17. How does your organization collaborate with the City/County/Municipality?

- We learn from them
- We share our knowledge with them
- We rely on them for funding
- We partner with them to develop programs and services
- We partner with them to conduct programs and services

- ◦ They sponsor some of our programs and services
- ◦ We apply for funding together
- ◦ Other (please specify) _____

18. How does your organization collaborate with government agencies?

- ◦ We learn from them
- ◦ We share our knowledge with them
- ◦ We rely on them for funding
- ◦ We partner with them to develop programs and services
- ◦ We partner with them to conduct programs and services
- ◦ They sponsor some of our programs and services
- ◦ We apply for funding together
- ◦ Other (please specify) _____

19. How does your organization collaborate with private industry?

- ◦ We learn from them
- ◦ We share our knowledge with them
- ◦ We rely on them for funding
- ◦ We partner with them to develop programs and services
- ◦ We partner with them to conduct programs and services
- ◦ They sponsor some of our programs and services
- ◦ We apply for funding together
- ◦ Other (please specify) _____

20. How does your organization collaborate with Nonprofit organizations or NGOs?

- ◦ We learn from them
- ◦ We share our knowledge with them
- ◦ We rely on them for funding
- ◦ We partner with them to develop programs and services
- ◦ We partner with them to conduct programs and services
- ◦ They sponsor some of our programs and services
- ◦ We apply for funding together
- ◦ Other (please specify) _____

21. How does your organization collaborate with Native Americans, First Nations, or sovereign Indigenous Nations?

- We learn from them
- We share our knowledge with them
- We rely on them for funding
- We partner with them to develop programs and services
- We partner with them to conduct programs and services
- They sponsor some of our programs and services
- We apply for funding together
- Other (please specify) _____

22. How does your organization collaborate with (other, specified)?

- We learn from them
- We share our knowledge with them
- We rely on them for funding
- We partner with them to develop programs and services
- We partner with them to conduct programs and services
- They sponsor some of our programs and services
- We apply for funding together
- Other (please specify) _____

The next series of questions focus on the way agricultural advisory/extension services are structured, funded and how monitoring of impact is reported for your country/state/province.

23. Your organization is operated by (select all that apply):

- National government
- State/provincial government
- Local government
- Farmers' organization
- Nonprofit organization or NGO
- Native American, First Nation, or sovereign Indigenous Nation
- Private sector
- Universities/Colleges/Academic Institutions

- Agricultural research organization
- Other (please specify) _____

24. What is the approximate annual budget for your organization in USD? Please leave blank if you do not know the budget.

_____

25. How has the annual budget for your organization changed over the last 20 years? If your organization is not at least 20 years old, please answer in reference to its inception.

- The budget has increased significantly
- The budget has increased somewhat
- The budget has stayed the same
- The budget has decreased somewhat
- The budget has decreased significantly

26. Please estimate what share of the budget is financed by each of the following sectors (round to the nearest whole number)

- National government : _____
- State/provincial government : _____
- Local government : _____
- Nonprofit organization or NGO : _____
- Native American, First Nation, or sovereign Indigenous Nation : _____
- Private Sector : _____
- Farmers and other clients of the services : _____
- Other : _____
- Total : _____

27. What percentage of your institutions' funding comes from appropriated funds vs. competitive funds (fee for service)?

- Appropriated from government funding : _____
- Competitive funding (fees for service) : _____
- Other : _____
- Total : _____

28. What types of metrics does your organization use to measure its impact? (select all that apply):

- Return on investment (economic impact)
- Agricultural productivity (agricultural impact)
- Number of publications produced annually (knowledge creation)
- Number of people served by programs (educational impact)
- Money leveraged for additional programming
- Other (please specify) _____

29. How has the number of farms and agribusinesses that your organization works with changed over the last 20 years? If your organization is not at least 20 years old, please answer in reference to its inception.

- The number has increased significantly
- The number has increased somewhat
- The number has stayed the same
- The number has decreased somewhat
- The number has decreased significantly

The remaining questions are collected to inform the demographic characteristics of respondents from each country.

30. How long have you been involved in agricultural advisory/extension services?

- 0–4 years
- 5–9 years
- 10–14 years
- 15–19 years
- Over 20 years

31. What is your gender identity?

- Woman
- Man
- Transgender woman
- Transgender man
- Non-binary/non-conforming
- Prefer to describe (Please specify) _____
- Prefer not to respond

32. Which of the following best describes your ethnicity? (select all that apply)

- ◦ Arabic, Central Asian, etc.
- ◦ Black, African, Caribbean, etc.
- ◦ East Asian, Chinese, Japanese, Korean, etc.
- ◦ Hispanic, Mexican, Latin American, Central American, Spanish
- ◦ Native American, First Nations, Indigenous
- ◦ South Asian, Indian, Pakistani, etc.
- ◦ White, Northern European, North American, etc.
- ◦ Other (please specify) _____
- ◦ Prefer not to respond

33. How old are you?

- ◦ 18–24
- ◦ 25–34
- ◦ 35–44
- ◦ 45–54
- ◦ 55–64
- ◦ 65–74
- ◦ 75 or older