EMILI

Upskilling for Digital Agriculture
Insights Report for Palette Skills Pilot Project

Prepared for Palette Skills
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EMILI

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About EMILI

The Enterprise Machine Intelligence and Learning Initiative (EMILI) is an industry-led non-profit created to prepare and empower the Manitoba economy to leverage digital disruption for success. EMILI works with industry and academia to accelerate the adoption of intelligent technologies in Manitoba's digital agriculture ecosystem and to ensure that people have the skills and talent required for the digital economy.

What is Digital Agriculture?

The Manitoba Digital Agriculture Table defines digital agriculture as the application of intelligent technologies to any or all the components of the agri-food chain before, during, and after on-farm production.



Images from EMILI's Machine Learning to Grow the Digital Agriculture Industry Project, 2021.

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About This Report

EMILI partnered with Palette Skills in early 2021 to form this project and secure funding from Protein Industries Canada. We are pleased to release this report focusing on upskilling opportunities for the digital agriculture project. Skills gaps created by the evolving requirements in the agri-food sector are a result of the integration of intelligent technologies. This has resulted in a lack of productivity and economic opportunity in the prairies. We support Palette's industry-led, rapid upskilling model that works directly with employers to understand their skills needs, and designs rapid training programs to fill talent gaps.

Palette Skills, the University of Saskatchewan, the Enterprise Machine Intelligence and Learning Initiative (EMILI) and Economic Development Regina are working to design and deliver an upskilling program for Canada's agri-food sector. The goal of this project is to leverage employment opportunities while addressing the labour shortage. The pilot will be launched in Saskatchewan with the goal to train 50 workers who will be placed in technology-enabled jobs in the agri-food industry.

EMILI reviewed recent academic articles and relevant industry reports to determine the most in-demand skills that would address the digital agriculture skills gaps. We had the opportunity to participate in a number of interviews with industry stakeholders across the prairies to hear directly from them about current challenges and opportunities within their organizations from a talent perspective. A survey was disseminated within our digital agriculture ecosystem as an additional tool to collect as much information on what skills were most in demand and how talent can take advantage of these opportunities. As co-chair of the Manitoba Digital Agriculture Table, EMILI is in a unique position to provide valuable insights into the skills needed in this sector and the dynamic pathways for current and future talent development. We have identified that agri-food skills gaps exist in the areas of agriculture and agronomic expertise, technology expertise, including data analysis and human skills such as problem solving and communication. Rapid upskilling will help address the skills gap in digital agriculture. For Canada to stay competitive regionally and as a country, developing programs that can provide post-pandemic economic recovery will be essential.

Key Findings

- Exceptional human skills are a desired competency for candidates wishing to transition into the digital agriculture ecosystem. Specifically, communication, collaboration, relationship building and teamwork skills.
- Collaboration between stakeholders, industry, and academia will provide opportunities to address talent shortages. Focusing on career readiness and development will prepare workers for the jobs of the future.
- Those with transferable skill sets will have a competitive advantage and will be able to adapt to new positions within the industry. Rapid upskilling can address talent shortages by providing opportunities for lifelong learning and the development of transferable competencies within the digital agriculture industry.
- Agricultural knowledge and experience is an asset for those who want to take advantage of the labour market in digital agriculture. However, it is not a limiting factor for those who do not have this background. Employers are willing to provide training and on-the-job experience for those with a desire to apply their skills to this sector.
- An important skill in digital agriculture, regardless of educational background is the ability to explain the application and opportunities that technologies enable in digital agriculture.

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Palette Project Survey Results

This survey was conducted to determine the most desirable skill sets and to identify the current skills gaps in the agri-food industry. Over a two week period this survey was disseminated throughout the partner networks via social media, direct email requests, and various network connections. Specifically, businesses, organizations, and academia within the agri-food sector were asked to complete a survey. In total, 30 surveys were completed. Based on these results we have highlighted several significant findings. These findings will help inform the pilot project launching in early summer 2022.

Summary of Findings

- Agricultural related technical skills were identified as most important by participants with a 43 percent response rate.
- Business skills including entrepreneurship, supply chain management and human resources were ranked the next most important skill set at 27 percent.
- Both agricultural and technology related skills were ranked as most challenging to find when hiring for a position.
- Respondents are employing all available education and training tools to address skills shortages both for existing staff and new hires including internal and external training opportunities.
- 50 percent of respondents indicated that agricultural related skills are most lacking by entry-level technical new hires while entry-level non-technical hires were lacking in human skills. Communication, decision making, and problem solving were identified as the most lacking human skills.
- Mid- or senior -level hires were most lacking in human skills when joining an organization. These included problem solving, decision making, communication and social awareness.
- When asked to consider what qualities made recent hires most successful, three characteristics stood out to respondents. Multiple responses were allowed per respondent, which is why the percentages sum to more than 100.
    - Attitude and willingness to learn- 69%
    - Exceptional human skills - 65%
    - Cultural workplace fit - 62%

- Three potential programs were proposed that could rapidly upskill workers and prepare them for a transition to the agri-food industry. In order of most valuable programs were ranked as follows:
    - Introduction to Agriculture
    - Technology Integration
    - Human and Business Skills

- When asked if they consider hiring directly from a upskilling program:
    - 33 percent indicated they would hire from a program
    - 63 percent were open to the possibility

Conclusion

This survey will help inform Palette Skills in the development and implementation of their pilot program to rapidly upskill a cohort of individuals in the digital agriculture sector. The participants in this survey highlighted a need for workers who are willing to learn agriculture competencies on-the-job but that non-technical skills with a specific focus on exceptional human skills are most valuable for those looking to transition careers. Moreover, communication skills were consistently identified as well as directly stated as very important by organizations as a desired competency. Another important finding from this survey was that organizations are using internal and external training opportunities to fill current skills gaps. This suggests that new hires could benefit from these opportunities once they transition into the sector. Conversely, organizations are struggling to find individuals to fill current positions.

Palette Skills has the expertise to offer rapid upskilling programming to a cohort of skilled workers that will prepare them for a transition to the digital agriculture ecosystem. This survey highlighted the interest in hiring from an upskilling program that leverages transferable skill sets. Specifically, those with a willingness to learn and have exceptional human skills. Agriculture knowledge and experience would be an asset but is not a limiting factor for attracting those to fill the skills gap within this sector.

Implications for future program development and research

There is an opportunity within the digital agriculture sector to address skills gap shortages with workers who have transferable skills and those who are willing to learn about the agri-food industry. Those hoping to take advantage of these positions should focus on developing non-technical skills with a focus on exceptional human skills. A foundational familiarity with key elements of the agri-food sector and agronomic practices will ensure that workers are competitive in the hiring market. People with these skills can apply them directly to the digital agriculture ecosystem while targeted training and experiential opportunities can benefit those wishing to transition to this diverse field.

Rapid upskilling for current employees may benefit organizations who are struggling to fill vacant positions. One area of future study could focus on understanding the adaptability of employees who take skills training to determine best practices or programming recommendations for successful participation in such programs. A second study could focus on the specific talent pools, whether academic or within the labour market, where transferable skills exist. Targeted recruitment would be beneficial for upskilling opportunities and programs. Moreover, there is an opportunity for the promotion of interdisciplinary approaches for cultivating skills needed for the digital agriculture ecosystem and future labour market needs. Messaging that emphasizes the opportunity to transition sectors and learn agricultural competencies through job experiences, short courses, or microcredentials will become even more important. Organizations, academic institutions, and industry can leverage interdisciplinary skills in the context of the agri-food industry to address the skills shortages and prepare people for the future of work in this sector.

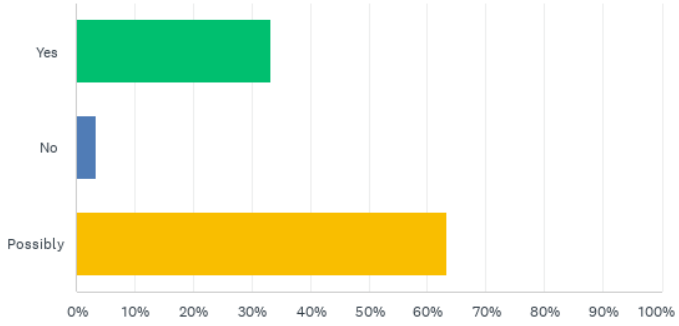
Relevant quotes on skill requirements

Question 3: What skill sets or positions are most difficult to find?
Question 4: Within your top-rated categories, what is the most important characteristic? Please explain your reasoning.

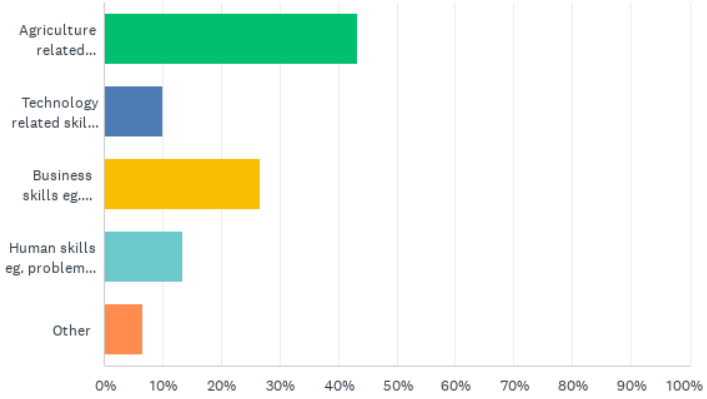
- *"Lifelong learning-as we continue to grow as a company we face new challenges daily and weekly. Without the attitude to learn, the necessity of change and adaptation creates high levels of frustration that will lead to efficiency issues and mistakes. That then leads to turnover and higher costs."*
- *"Communication- primary producers develop interpersonal relationships, not SnapChat buddies."*
- *"People with technology skills and the ability to apply those to agriculture or communicate their importance and application are very difficult to find. They are also highly valuable in the market and it is difficult to be competitive from a salary perspective."*
- *"Communication and problem solving skills / critical thinking are the most needed. This underpins the success of the individual and the organization and keeps them both nimble and adaptive."*
- *"Farming background, understanding of the ag sector in general."*

Infographics from the survey

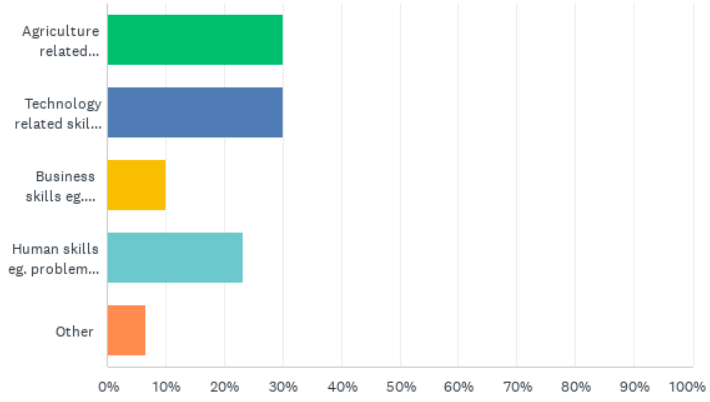
Q17 Assuming that a program is able to deliver well-trained talent with these skills, would you hire directly from it?



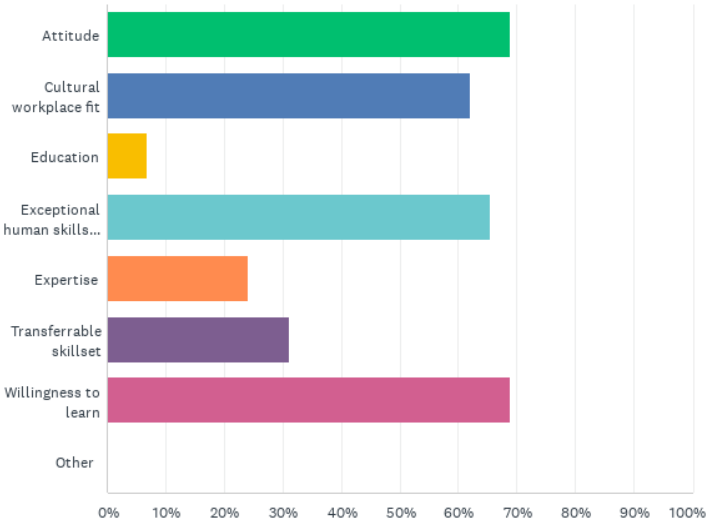
Q1 Within your organization, what skillsets are of greatest importance?



Q3 What skillsets or positions are most difficult to find?



Q14 Thinking back to your most critical hiring needs, what is the differentiating factor of the successful candidates in your hiring decision? Select all that apply.



Virtual Interviews with Agri-food Organizations

Palette Skills and EMILI staff undertook virtual interviews with representatives from key agri-food companies over a 4-month period in 2021-2022. In total nineteen organizations from Saskatchewan were interviewed. Meetings took place with senior executive and/or human resource management depending on availability and the current scale of the organization and their hiring needs. Organizations were considering their current needs as well as future gaps that will need to be addressed. The interviews gave an overview of the Palette Skills model, along with providing awareness of the upcoming pilot project and the value of participating in a program that upskills employees. The objective of the interviews was to determine what current and future challenges businesses were facing related to hiring, retention of employees and challenges and opportunities for those wishing to transition into the agri-food industry. Three key themes emerged that will be discussed in detail.

Questions that were most commonly asked included:

1. What are the top challenges you face in growing your company?
2. How have your talent needs changed over time? What's different about the challenges you're facing today?
3. What roles are most often hiring for and struggling to fill? When you think of an ideal candidate for one of those roles, what comes to mind?
4. How has COVID impacted your business and recruitment/talent acquisition priorities?
5. Where do you usually recruit from? How often do you deviate from your job post requirements (ie. hiring workers with different credentials, certifications or work experience than you define as required)? Do you have any non-negotiables for hiring this position?
6. How do you decide to hire someone? What do you do to ensure new hires are successful?
7. How important is a foundational understanding of agriculture to your organization when hiring?

Themes

Agricultural Knowledge

We found that when asked about the importance of agricultural knowledge in hiring decisions for both entry-level applicants or those transitioning to roles within the agri-food sector, management thought it was an asset but not a requirement. A foundational understanding or background in agriculture would benefit the applicant in a better understanding of the sector as well as for positions that had direct contact with farmers. Agricultural knowledge would also help those who are in relationship-building capacities within the organization. Companies specifically were interested in attracting those with agribusiness or agronomy degrees. However, organizations emphasized that agricultural knowledge can be taught on the job through training, direct experience, or mentorship opportunities. A common sentiment was that agricultural knowledge can be taught and hiring for a corporate culture fit or those with exceptional human skills was the priority.

Beyond this report, a further study into what skills and attributes make up this desired corporate culture fit could be beneficial. Greater inquiry is required to understand what employers mean by corporate culture fit and what this means in this context and the barriers to transitioning experience in this sector. Program design and stakeholder relationships could focus on addressing questions around cultural fit in the workplace and the need to identify them in a further study or survey.

Hiring Needs and Challenges

From a talent attraction perspective, organizations have relied on international recruitment, LinkedIn, and recruitment firms. The companies interviewed highlighted the importance of a post-secondary degree in the application process but that job specific skills can be learned once hired. Most desired degrees and positions included business agronomists, supply chain management professionals, sales, relationship managers, and software developers. Challenges for attraction and retention included competition for desired talent from other industries, community/geographical location, and a deficit in human skills for relationship development within agriculture. Companies were struggling

with communicating the diverse range of opportunities available to potential hires within this sector. They were excited to emphasize that job security in the sector was relatively insulated throughout the COVID-19 shutdowns that impacted many workplaces. The promotion of the quality of employment and availability of opportunities in this sector will help attract and retain new talent. Additionally, presenting the benefits of living in the geographical area, for this case Saskatchewan, was mentioned as a barrier for attraction.

Most Desired Skill Sets

Companies continued to echo the need for workers with exceptional human skills. This included those with critical thinking, problem solving, communication, and attitude. Hiring for "fit" once the credential aspect was established was most important in the hiring process. Companies felt that employees struggle when transitioning from a post-secondary institution to a work environment. They were open to developing transferable skills from other sectors to the agricultural industry. Talent that is able to adapt to new technologies and use these skills in digital agriculture would be an asset.

Conclusion

Companies are looking for individuals who have a relevant degree or experience that can be applied to the agri-food sector. Human skills such as project management, business development, collaboration, relationship building and problem solving are the most desired non-technical skills. Through providing opportunities for upskilling in the agricultural sector, workers can transition to well-paying, disruption-proof jobs in a digital agriculture pathway. Digital agriculture would benefit from increased promotion of these opportunities as well as training that targets the knowledge and skills needed to transition into the industry. The experiences of the cohort of individuals who participate in the program developed will provide additional insights to verify the results of the survey responses. Cohort participants will be able to provide valuable first-hand accounts to better understand their experience and potential barriers they may have experienced. Continued dialogue between stakeholders, employers, and individuals in this program will provide valuable insights.

Digital Agriculture Table Insights

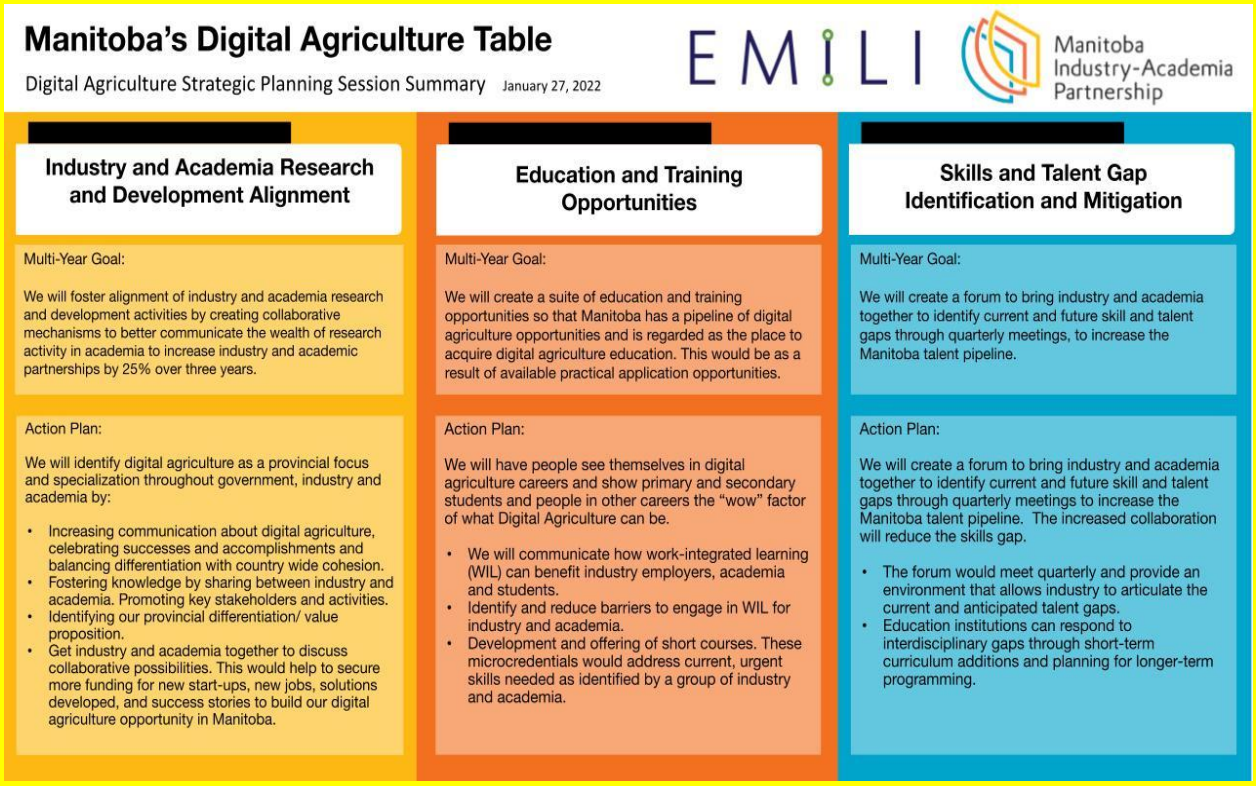
The Manitoba Digital Agriculture Table was established in 2020 and is co-chaired by the Manitoba Industry-Academia Partnership (MI-AP) and the Enterprise Machine Intelligence and Learning Initiative (EMILI). Both MI-AP and EMILI are non-profits established in Manitoba to increase collaboration and productive activity of industry-academia relationships. EMILI does so with a specific focus on the digital agriculture industry. The co-chairs of this group work to convene meetings, engage stakeholders, and act on findings and directions. The strength of this group comes from the collaborative nature of the participants and their expertise throughout the digital agriculture industry. This group brings together industry leaders and academic professionals to work towards the goal of enhancing the competitive advantage and the growing collective agriculture capacity of Manitoba. The three priorities of this table are to foster industry and academic alignment to increase research and development partnerships, increase education and training to advance career opportunities, and skills and talent gap identification and mitigation. There is an opportunity for Palette Skills to address skills gaps and talent shortages in the digital agriculture sector. By utilizing the current platforms for collaboration and relationships within the Manitoba digital agriculture industry, valuable insights can be gained and built upon moving forward.

Palette Skills was invited to attend one of Manitoba's Digital Agriculture Table's strategic planning sessions in March 2022 to promote the rapid upskilling pilot project. The benefit of the Digital Agriculture Table is the diverse cross-section of experts within industry and academia. There were twenty-two participants at this meeting. Palette's Pilot Project was presented along with the survey that was created in partnership with EMILI. By sharing this project and opportunity with this group, valuable insights were captured that would benefit the goals of the project and foster future connections regarding upskilling workers in the digital agriculture ecosystem. Along with project promotion, Palette Skills was able to join stakeholders in the discussions about the future skills needed, current industry challenges and pose questions to further their understanding of the digital agriculture ecosystem in the Prairie Provinces.

The Palette Pilot Project has the opportunity to contribute to one of the Table's three priorities - the identification and mitigation of skills and talent gaps. Future findings and

best practices from the pilot have the potential to shape understandings around upskilling workers in the Prairies to address skills gaps and talent shortages. Ongoing collaboration will help ensure that current and future talent are able to take advantage of the job opportunities in this sector and contribute to building a stronger economy.

Based on earlier sessions, the below summary was created and references the future direction of The Digital Agriculture Table. A full strategic plan will be available in September 2022.



Infographic created by MI-AP

Industry Reports

The following section outlines 11 recent industry reports from organizations that are doing current and future skills development and identification for the Canadian economy. These industry findings will strengthen the Palette Pilot Project by confirming that the skills gap in digital agriculture is a valuable and worthwhile opportunity for workers hoping to change careers or enter the workforce. Rapid upskilling will be able to address the gap in the digital agriculture industry by providing workers who have competencies that are valuable with the opportunity to develop their skills and transition into this industry. EMILI reviewed reports that were published no later than 2015 from stakeholders that were relevant to the digital agriculture sector. This included organizations in the agriculture industry, academic centers, and organizations focused on career development. The most relevant information from each report was identified and highlighted in this document. The source documents were linked and additional information can be referenced.

Agri-food Innovation Council (AIC)

Report Name: The Investment Environment for Agri-Food Research and Innovation
Date: February 2021
Author: AIC

Section: Recommendations, P.4

Recommendations on how to improve the adoption of automation in agriculture and agri-food industries:

- A barrier to implementing automation on farms is the high costs of operating and maintaining the automation and farmers' reluctance to adopt automation because they do not know how it works and how it will affect their businesses. Therefore, AIC recommends that the Government of Canada provide farmers with direct funding that will cover the initial cost of implementing automation on their farms.
- Government funding has been very effective in supporting clusters in the agri-food sector, especially in primary agriculture, improving research and innovation as well as bridging the gap between academia and industry. AIC recommends that the Government of Canada continue to provide incentives that would create new clusters from various sectors that will provide mentorship and capital enablement opportunities for agri-food entrepreneurs.
- The government as well as other agri-food stakeholders will benefit from implementing stronger mechanisms that lead to better strategic direction and allocation of resources in the agri-food sector. As such, AIC recommends that an independent and cross-sectoral body, which is inclusive of industry, academia, and non-profit, should be formed to coordinate the task-force on current and future issues and opportunities within the agri-food sector.

BioTalent Canada

Report Name: Close up on the bio-economy: Labour Market intelligence (LMI)
Date: October 2021
Author: BioTalent Canada

Section: Labour Market Outlook, P.28

- 65,000 more workers will be needed in the bio-economy sector by 2029.
- Employers rated the following technical, business, and soft skills as very important for employees to have by 2029;
    - Problem-solving
    - Collaboration
    - Communication
    - Interpersonal
    - Digital
    - Business development
    - Commercialization
    - Partnership/Networking
- Roles such as manufacturing and production, distribution and logistics, management, finance, and administration will be difficult to fill in 2029.
- Employers struggle to find and retain talent because of insufficient capital to pay competitive wages as well as an insufficient number of qualified candidates with specialized skills and experience.
- BioTalent indicated that work-integrated learning (WIL) is an effective way for students and recent graduates to develop their skills and gain exposure in the workforce.

Level of education required by employers in the following areas;

- College diploma or trade school
    - Distribution and logistics
    - Manufacturing and production
- University undergraduate degrees
    - Information technology
    - Management, finance, and administration

    - Legal and regulatory affairs
    - Marketing, business development and sales
    - Quality control and assurance
- University graduate degrees
    - Research and development

Canadian Agricultural Human Resource Council (CAHRC)

Report Name: How Labour Challenges Will Shape the Future of Agriculture: Agriculture Forecast to 2029
Date: August 2019
Author: CAHRC

The authors suggest some ways to address the critical labour shortages in the agricultural sector. These include;

- Agriculture and agri-food sectors need to increase the awareness of agriculture careers, job requirements, and career pathways available within the sector by developing an integrated and collective system. This will ensure that workers, students, and educators all have access to current and unified information.
- Agricultural employers, managers, and supervisors can benefit from using best-practices HR management tools for their recruitment, employment, and retention efforts.
- Agricultural training and educational programs need to be designed in such a way that it closely aligns with the current and future needs of agricultural industries so that it prepares students for on-the-job training.

Additional Points of Interest

- Critical labour shortages can be mitigated through closer alignment between training and educational program offerings. Knowledge of the agriculture industry's requirements for jobs and skills will improve attraction and retention.
- Awareness around the wages in the agriculture sector may be attractive to new graduates or those seeking to change careers.
- There are two factors that are driving the labour gap in agriculture: growth in labour demand and supply of Canadian workers.
- Skill shortcomings of new and existing workers will need to be addressed through training, providing better work conditions, or other incentives such as shorter hours.

CERIC

Report Name: National Business Survey: Career Development in the Canadian Workplace
Date: January 2022
Author: Environics research

Report Summary on Areas of Interest

- A shortage of skilled workers has been identified as a concern for many Canadian business executives.
- A gap in the skills organizations are looking for and what job seekers possess has presented a hiring challenge. Employers are unsure how to address it and have two considerations on how to deal with this challenge: employers need to better prepare to address these concerns and provide training or that workers need to address these challenges prior to job seeking.
- Soft skills have been identified as the more in demand skill set with employers willing to offer technical training for the position. Hiring for soft skills has been challenging.

Section: Soft skills, P.24 - 37

- Employers indicate experiencing increasing difficulty in recruiting talent with the soft skills they deem important.
- According to prospective employers, communication skills and having a positive attitude continue to be the most important soft skills. Other important soft skills include reliability, strong work ethic, teamwork, and interpersonal skills.
- Most employers favour hiring people with important soft skills and provide training rather than waiting to find people with the right technical skills.

Future Skills Centre

Report Name: Is the Future Micro? Unbundling learning for flexibility & access
Date: March 2021
Author: Mary Chaktsiris, Karen McCallum, Robert Luke, Wendy Cukier, Lena Patterson, Nirvana Garreffa, and Emma Gooch.

Section: Context, P.2 - 9.

- A micro-credential is described as a certification that is awarded for completing a short program that is focused on a specific and relevant set of skills or competencies.
- Provincial governments including Ontario, Saskatchewan, and British Columbia, have all moved to invest and expand the role of micro-credentials within existing education systems.
- Some of the ways micro-credentials can be used includes;
    - to rapidly reskill/upskill in times of work disruption.
    - to augment post-secondary programming and provide alternate access to higher education.
    - to attract, engage, and maintain talent in the workforce.

The Conference Board of Canada in partnership with The Future Skills Centre (FSC)

Report Name: Green Occupation Pathways: From Vulnerable Jobs to Rapid-Growth Careers
Date: February 2022
Author: The Conference Board of Canada and The Future Skills Centre

Section: Human Factor in Job Transitions, P.14 - 22.

- The authors suggest that one in five Canadian workers is working a job that is at considerable risk of automation and for those workers, there are few or no options to transition into lower-risk occupations without undergoing significant retraining.
- Some of the barriers that these workers face as they transition to lower risk occupations in the clean economy sector includes;
    - Workers may be reluctant to leave their jobs if they have no guarantee that the position they are transitioning to will have good benefits and long-term viability.
    - Workers also identified not having the necessary skills or experience to succeed in a new occupation. While workers are willing to devote their time to retraining and upskilling opportunities, they are not willing to spend more than six months doing so.
    - For other workers, the cost of retraining or upskilling and the cost they will incur in transporting themselves to and from the training locations is another limiting factor. Workers claim that there are time and financial constraints associated with engaging in retraining or upskilling opportunities.
- The authors suggest that transferable skills and social and emotional skills like communication, creativity, critical thinking, collaboration, and adaptability are the

least likely to be replaced by technology. This is because they allow workers to adapt to the dynamic nature of the labour market.

- Workers with a solid foundation of social and emotional skills will have a greater opportunity of acquiring the necessary technical skills on the job.

The Conference Board of Canada in partnership with The Future Skills Centre (FSC)

Report Name: Modelling Job Transitions in Canada
Date: March 2021
Author: Sheila Rao, Thomas Hindle, Nachum Gabler

Section: Identifying Potential Job Transitions, P.10 - 14.

- The authors defined two main criteria for potential job transition to be viability and desirability.
- Viable jobs are jobs that have similar skills, education and other job requirements as the current jobs of the workers. While desirable jobs are jobs that move the workers into an occupation that has a positive employment outlook.
- Job transitions need to be both viable and desirable for workers. As workers transition to new positions they do not want to start their careers from scratch or embark on a new career path with declining employment prospects. Workers are looking for stability and positive growth prospects as they transition to new positions.
- Potential earnings is also a significant factor that influences potential job transitions. Most workers do not want to and are not willing to take a large pay cut as they transition. They are looking for positions that will offer them similar or higher rates of compensation.

The Conference Board of Canada in partnership with The Future Skills Centre (FSC)

Report Name: Bridging Generational Divides: Advancing Digital Skills in Canada's Apprenticeships and Skilled Trades Ecosystem
Date: September 2020
Author: The Conference Board of Canada and The Future Skills Centre

Relevant points:

- The seven core digital skills needed by tradespeople include;
    - Technical,
    - Information management,
    - Digital communication,
    - Virtual collaboration,
    - Creativity,
    - Critical thinking,
    - Problem-solving in digital environments.
- Generational differences, such as workplace and communication preferences, between younger and older workers are slowing the shift, as are challenges related to time, cost, geography, outdated training technologies and curricula, and Internet access.
- Additional barriers include limited breadth of on-the-job training, technology changes in industry outpacing training and curriculum standards, difficulty recruiting staff with relevant digital skills knowledge, and paper-based logbooks.

The Information and Communications Technology Council (ICTC)

Report Name: Canadian Agri-food Technology: Sowing the Seeds for Tomorrow
Date: September 2021
Authors: Maryna Ivus, Nathan Snider, Peter Taillon, Mairead Matthews, Maya Watson, Arun Sharvirala, and the ICTC Digital Think Tank team *Section:* Agri-Food Technology Talent, P. 31 - 44.

- In this report, advanced technology skills and education are required through three different business domains. These domains include farm robotics, agriculture and automation, and precision agriculture.
- Farm robotics is a combination of production technology and traditional agricultural skills. Top jobs in the sector include swine technician, farm worker/technician, manufacturing engineers, business development managers, etc. Employers in this industry require workers to have industry automation skills, sales recordkeeping, and agriculture skills to mention a few.
- The top jobs in the agriculture and automation industry involve more traditional technology experts like software developers, automation experts, and cloud-based technology experts. Employers in this industry demand workers with agriculture, application programming interface, and automation skills.
- Precision agriculture encompasses a broad range of business activities, technologies, and high-yield production. Some of the top jobs in this field include agronomists, heavy duty mechanics, branch/assistant managers, and production advisors. Employers in this industry demand workers with precision agriculture, agronomy, crop production, and customer relationship management skills.

Section III: Technology Adoption, P. 45 - 70

Barriers to technology adoption:

- High cost of operating and maintaining equipment
- No access to high-speed internet, especially in rural areas.
- Shortage of skilled labour
- Technical challenges related to using technology.

- Farmers do not understand the digital technologies or how it will affect their businesses.
- Drivers of technology adoption includes; climate crisis, population growth, food insecurity.

The Information and Communications Technology Council (ICTC)

Report Name: Onwards and Upwards - Digital Talent Outlook 2025
Date: August 2021
Author: Maryna Ivus, Akshay Kotak, Alexandra Cutean ，Rob Davidson, Ryan McLaughlin, and the Digital Think Tank team.

Section II: The Canadian Digital Economy, P.33 - 51.

- ICTC forecasts that by the end of 2025, there would be a demand for 250,000 jobs in the Canadian digital economy.
- The digital economy is composed of tech workers in all sectors and all workers in the tech sector.
- The top technical skills in demand include software engineering, web development, business analyst, project managers and digital engineers.
- The top soft skills in demand include communication, problem solving, teamwork and interpersonal skills.

Public Policy Forum

Report Name: Improving the Linkages between University and Work: Policy and practice recommendations
Date: June 2021
Author: Harvey P. Weingarten

Section: Policy Recommendations, P.12 - 23.

- In this article, the author offers some policy recommendations to better align educational institutions with the workplace and industry needs. These recommendations include;
    - Universities need to restructure their curriculums, which is currently more content-based, to focus more on developing important skills and competencies.
    - Universities should adopt a credential system that documents the skills and competencies students have acquired or possess rather than the current traditional transcript, that just lists the courses and grades of the students.
    - There should be a greater diversity of universities and other types of higher education institutions that deliver workforce readiness programs for students.
    - Update government regulations and bureaucratic constraints on universities, so that they can rapidly adopt innovation and diversity.
    - The Canadian government should continue to focus on closing the equity gap by creating and funding more programs that address the financial, social and cultural factors that hinder people from attending post-secondary institutions.

Annotated Bibliography

Introduction and Methodology

This annotated bibliography contains 12 recent article summaries on the current and future skills gaps in the digital agriculture sector. The information gathered will help inform the Palette Pilot Project on upskilling and preparing individuals who will join the workforce with the competencies they need to be successful in open positions within the digital agriculture industry. The academic articles were found using search engines from Google Scholar and academic institutions from which the EMILI staff are affiliated. The search included words such as, “digital agriculture,” “re-skilling,” “human skills,” “technology,” ”innovation,” “talent,” etc. The aim was to find articles that have identified skills that would be relevant for digital agriculture upskilling and to support the need to address skills shortages including what has been done in this sector as well as future opportunities. Articles were published no later than 2015 to demonstrate a current understanding of challenges and opportunities.

Summary of Findings

The agriculture industry is facing a shortage of skilled workers to address and match the technological advances in this sector. As a result there are many unfilled positions and a lack of available talent. Employers who need to hire for these roles will face challenges such as increased wages and competition to attract talent to address current and future talent shortages. Both employers and academia have roles to play in addressing skills gaps, talent shortages and future trends.

Collaboration between stakeholders, industry and academia will provide new opportunities to address these talent shortages and prepare students for future labour trends. Education institutions and researchers will need to focus on developing competencies for the jobs of the future by focusing on employee readiness and the demand for human skills. Curriculum development, work-integrated learning, and cross-sectoral research can address some of these challenges and provide pathways for those entering the workforce to be more prepared for this transition.

Workers who are comfortable using technology or who are trained to adapt to these advances will have a competitive edge in the workforce. Additionally, those with strong human skills such as communication, relationship building, and problem solving will be the most competitive hires. The willingness of current and future employees to commit to lifelong learning opportunities will also be of great importance to the labour market and organizations who provide training for these competencies. The development of non-technical skills will be beneficial for individuals as well as team dynamics; these include leadership abilities, personal skills, communication, relationship building and organization. A strong foundation of business oriented skills will be a complement to technical skill sets.

The cultivation of digital and social skills will benefit jobs that have a technological focus. Through programs and training opportunities that seek to address the development of non-technical competencies, transferable skill sets will emerge. These workers will be able to adapt to new and emerging jobs while addressing labour shortages and participating in meaningful career development.

Academic Articles

Citation: Birner, R., Daum, T., & Pray, C. (2021). Who drives the Digital Revolution in agriculture? A review of supply-side trends, players and challenges. *Applied Economic Perspectives and Policy*, *43*(4), 1260–1285. Retrieved from: https://doi.org/10.1002/aepp.13145

Summary: This article focuses on the uptake of digital technologies in the agriculture field and the overall impact to the ecosystem. As the cost of high speed internet and telecommunications decrease the higher the demand and supply trends. With increased access to telecommunication software, new ways of approaching agri-food production will emerge.

There are four main groups supplying digital agriculture: agricultural input firms, software/big data companies, engineering and hardware companies, and the influx of small and medium sized companies. These companies target different categories of farmers and this can range from large-scale industrial farms to smaller farms in developing countries. Birner et al. (2018) suggests that the collaboration of new actors/companies and public efforts will help to accelerate the supply of digital agricultural technologies, manage the threats of market concentration, and harness the opportunities of digital agriculture. The acceleration of technological advances in agriculture will create new opportunities and challenges for this sector while providing new innovative solutions to addressing current and future resource issues.

Citation: Brown, P., & Keep, E. (2018). Rethinking the Race Between Education & Technology. *Issues in Science and Technology, 35*(1)*, 31-39.* Retrieved from: https://www.jstor.org/stable/10.2307/26594284

Summary: In this article, the authors explain that digitization is rapidly changing the nature of many jobs and the requirements employers seek in their workers. They claim that there will be a rise in the demand for high-skilled workers and that low-skilled workers are particularly at risk of being displaced as more routine jobs are being adapted with a range of automated systems. As a result, low-skilled workers will need to relocate to jobs or tasks that require creativity and social intelligence skills that computers can not yet automate to remain relevant in the workforce.

Similarly, highly-skilled workers will no longer be limited to people holding a degree or having a specific set of professional capabilities. To adapt to the changing landscape of the workforce, employees will need to be lifelong learners who are highly adaptable and can work in multiple contexts. Even though the technical and knowledge requirements of workers change, the social contexts in which they interact, network and produce will remain the same. As such, the development of digital and social skills that complement robotics and artificial intelligence will be crucial for current and future employees to develop.

The authors also mentioned that employers place a very high importance on seeking workers who possess strong human skills, especially communication and organization skills. However, employers vaguely specify these human skills in their job postings and it could mean different things in different organizations. A recommendation for employers is to provide detailed descriptions of what these human skills look like in their organizations to better inform applicants as well as educators and training providers to design their curriculum in such a way that it meets the employers demands and prepares students for the workforce.

Citation: Burch, K. A., & Legun, K. (2021). Overcoming barriers to including agricultural workers in the co-design of new agtech: Lessons from a Covid-19-Present World. *Culture, Agriculture, Food and Environment*, *43*(2), 147–160. Retrieved from: https://doi.org/10.1111/cuag.12277

Summary: A barrier identified in developing new and innovative research practices in the agri-food industry is the lack of collaboration and partnership between AgTech researchers and the agricultural industry. Burch & Legun (2021) argue that to advance research in this field, agricultural stakeholders will need to be involved in the research design process. The involvement of multiple stakeholders in the agriculture industry will allow for diverse knowledge sharing and new practices. Ultimately, this will lead to the development of digital tools and solutions that address the needs of many or all farmers beyond the initial target users of the agtech audience.

Burch and Legun (2021) suggest that AgTech researchers and developers will need to prioritize building close relationships with agricultural industry stakeholders as they move toward an inclusive design process. Social networks and local communities are essential platforms for professionals and agricultural stakeholders to network and share resources.

Citation: Christiaensen, L., Rutledge, Z., & Taylor, J. E. (2021). Viewpoint: The future of work in Agri-Food. *Food Policy*, *99*, 101963. Retrieved from: https://doi.org/10.1016/j.foodpol.2020.101963

Summary: The purpose of this paper is to examine the role of agri-food systems in the future of creating inclusive jobs. Agri-food system (AFS) is made up of input supply, food logistics, food processing, retail, food services, and agriculture. According to Christiaensen et al (2021), employment in the AFS in high income countries has dropped to only 10 percent of the labour force, where the majority of AFS jobs are now off-farm in food processing and services. This is partly due to the adoption of automation in agriculture. While digital technologies are creating high-skilled employment opportunities they are displacing the need for workers, especially low-skilled migrant workers.

Moreover, as AFS adopts more digital technology in its practices they will require a highly skilled workforce, with more engineers, information technology (IT) specialists, and other workers that can easily adopt technical skills. Conversely, not all workers will need to be technical specialists to remain relevant in this digital economy, they should be comfortable using computers and digital applications to perform their responsibilities. This suggests that individuals who are trained in digital technology or who can adapt to new technologies at a rapid pace will be able to take advantage of the labour market and continue to make meaningful career decisions.

Citation: Finnie, R., Mueller, R. E., & Sweetman, A. (2018). Information and Communication Technology Talent: The skills we need—framing the issues. Canadian Public Policy, 44(S1). Retrieved from: https://doi.org/10.3138/cpp.2018-001

Summary: The purpose of this paper is to identify trends in the labour market that reflect a shortage of skilled information and communication technology (ICT) workers in the economy. As there is a shortage of skilled ICT workers in the Canadian economy, we can expect to see a rise in wages for ICT related jobs, an increase in the number of students in STEM and ICT related courses, as well as a rise in the demand for skilled immigrant workers. Particularly, as the worker shortage increases, ICT skilled workers seek competitive wages which can be an additional challenge for employers. Finnie et al. (2018) suggests that we can expect to see more and more people who have some form of ICT skills.

Furthermore, we can expect to see more post-secondary students major in ICT related courses or other courses that would allow them to move into ICT jobs where the demand is strong. Finally, they suggest that "although immigration is sometimes posited as a solution to labour shortages in Canada, including in ICT, immigrants often face problems with having the relevant skills recognized in Canada and being employed in their intended occupations, including occupations in ICT (Finne et al., 2018, p.7)."

The overall point that this paper proposes is that in a well-functioning economy, if there is a shortage of skilled ICT workers in the labour market, these shortages can be addressed by more competitive wages for ICT workers, an increase in the number of students studying ICT related courses and a higher demand for migrant workers.

Citation: Hendrix, R., & Morrison, C. (2018). Student perceptions of workforce readiness in agriculture. *Journal of Agricultural Education, 59*(3), 213–228. Retrieved from: https://doi.org/10.5032/jae.2018.03213

Summary: In this study, Hendrix and Morrison (2018) examined the workforce readiness skills of two undergraduate agriculture classes in the School of Human Sciences at Mississippi State University. Their findings revealed that students felt most competent in their problem solving skills and their abilities to maintain harmony at work and less competent in their emotional-related and communication skills.

The authors also reviewed job announcements to determine the most important professional skills required by employers and found that communication skills were the most in demand. They found that students and employers agreed on most of the professional skills with the exception of communication skills. In this area, students felt less competent in their written and verbal communication skills and did not think it was an important skill to have. Employers indicated that communication skills, both verbal and written, were the most important skill they were looking for in their recruits.

Based on their findings, students can benefit greatly from mentorship opportunities as they provide the skills necessary for a successful transition into employment. Agricultural educators will also need to design the curriculums in such a way that it prepares students to smoothly transition into the workforce. The new design should include group projects, class presentations, report writing, and research as a way to develop the skills of students.

Citation: Marion, T. J., Fixson, S. K., & Brown, G. (2021). Four Skills Tomorrow's Innovation Workforce Will Need. *The Next Age of Disruption,* 71–84. Retrieved from: https://doi.org/10.7551/mitpress/13768.003.0009

Summary: In this paper, Marion et al. (2021) argue that the competencies most needed by are business-oriented rather than technical. They claim that technology specialists will need business awareness, an entrepreneurial attitude, bottom-line focus, and ethical intelligence to successfully lead innovation in their companies.

Their findings show that most companies focus on refining the skills their employees already have, which does not prepare the existing employees or new hires for the business challenges they will face when using emerging technologies in their jobs. To maintain competitiveness and advance workplace performance, employees must be able to leverage broader knowledge of the business and future trends. This includes understanding key connections like the links between physical machines and digital systems, between each step of the value chain and between the company's current and future business models. They must also be aware of their customers' businesses, which includes how and when their customers' products and services are used, how their customers' organizational processes work, and the related challenges and opportunities. Additionally, innovation teams must be willing to take more risks by exploring unconventional or "outside the box" methodologies as they develop digital products/systems.

Data has been identified as an important aspect to consider for growing businesses. Having an understanding of how the data will impact the organization and how it is financially beneficial are factors to consider moving forward. By developing skills and understanding of the business model, data technicians can move beyond their current scope of work to ask insightful questions that will benefit the overall organization. Lastly, companies will need to find out how their design decisions and digital systems affect their stakeholders and factor that into the design process. The authors argue that this will build trust between the companies and their users.

Citation: Rinker, S. P., Hainline, M. S., & Smalley, S. W. (2020). Examining Students' Experiences and Perceived Skill Attainment in an Agricultural Capstone Course. *North American Colleges and Teachers of Agriculture Journal, 64*, 254-261.Retrieved from: https://login.proxy.bib.uottawa.ca/login?url=https://www.proquest.com/scholarly-journals/examining-students-experiences-perceived-skill/docview/2535885653/se-2?accountid=14701

Summary: In this paper, Rinker et al evaluate the professional and technical competencies as well as the overall agricultural experiences of students before and during Iowa State University's Ag 450 Course. This paper seeks to evaluate student's workforce readiness based on their perceptions of their professional and technical competence levels. The authors focus on three main objectives that can benefit students in the workplace. They are the importance of experiential learning, competency in technical and non-technical skills, and students' perceived levels of those skills.

Their findings indicate that students participated in a wide variety of agriculture internships, including agricultural technology before the course. Students also reported engaging in a wide array of experiential learning activities (ELA) such as, farm equipment precision technology, grain marketing, and working with industry representatives while in the course. Secondly, they sought to determine the students' perception of their competency levels with regards to technical agricultural skills before and after the Ag 450 course. Students had a tendency to overstate their competence levels in technical skills like grain management, commodity production knowledge, farm management, project management, and understanding of commodity markets before taking the Ag 450. Thirdly, the authors sought to determine students' perceived level of attainment of important professional skills identified by industry leaders. The results show that students agreed with the industry leaders that skills like being trainable, respectful, accountable, and demonstrating positive work ethic were important professional skills. Conversely, when it comes to skills like being safety-minded, being organized, working out of their comfort zone, and adjusting to various communication styles, students did not think they were as important. In conclusion, Rinker et al (2020) suggests that agriculture educators should consider integrating a service-learning component or other teaching methods that focus on developing professional skills and preparing students for the workplace culture.

Citation: Rotz, S., Gravely, E., Mosby, I., Duncan, E., Finnis, E., Horgan, M., LeBlanc, J., Martin, R., Neufeld, H. T., Nixon, A., Pant, L., Shalla, V., & Fraser, E. (2019). Automated Pastures and the digital divide: How Agricultural Technologies are shaping labour and rural communities. *Journal of Rural Studies*, *68*, 112–122. Retrieved from: https://doi.org/10.1016/j.jrurstud.2019.01.023

Summary: The shift to incorporating digital practices in agriculture brings to light challenges around traditional farming technical skills and practices. Additionally, there are concerns around issues of equity and fairness. This study is important because it identifies these key themes and continuous research in this area.

Overall, the automation of agricultural processes has been linked to greater productivity and more efficient practices. However, as more farmers adopt automation as a way to cut-down costs and improve the efficiency of their farms, “there are concerns that this will occur at the expense of labour equity and fairness (Rotz et al., 2019, p.117)”. The authors argue that using digital technologies such as self-driving tractors in agriculture will change the role of farmers and displace low-skilled workers in agriculture. They claim that the role of farmers will move beyond traditional farming practices to include more advanced technology skills like engineering, information technology (IT), manufacturing, operating heavy machinery and other non-technical skills like supervisory, data entry, and managerial skills.

In conclusion, as more sectors of the economy adopt technology in their practices, only workers with some form of technical skills will remain relevant in the labour market. The authors suggest that workers should continually develop their skills and knowledge so that they can adapt to any changes or trends in the future.

Citation: Sørensen, L. B., Germundsson, L. B., Hansen, S. R., Rojas, C., & Kristensen, N. H. (2021). What skills do agricultural professionals need in the transition towards a sustainable agriculture? A qualitative literature review. *Sustainability, 13*(24), 13556. Retrieved from: https://doi.org/10.3390/su132413556

Summary: The purpose of this paper is to identify and analyze skills needed for professionals in the agricultural system to move towards, and navigate within, sustainable agricultural practices. Sørensen et al (2021) identified five main categories of skills: systems perspective, lifelong learning, knowledge integration, building and maintaining networks and learning communities, and technical and subject-specific knowledge and technology in the move to a more sustainable agricultural system.

The authors encourage professionals to be more inclusive and adopt knowledge and practices from diverse agricultural stakeholders. This practice ensures that all stakeholders are actively involved in the agricultural system. Professionals also need to be lifelong learners who possess the ability to respond and be proactive in a constantly changing world. Some of the skills embedded in lifelong learning include innovation, creative thinking, problem solving and critical thinking. Additionally, the need to learn how to navigate the technical and technological developments that are constantly evolving and those who can adapt or have these skills will be at an advantage. Specifically, knowledge integration is important because it helps agricultural professionals to understand and operationalize global issues and solutions with individual local and contextual settings. This category of skills is especially important for future agronomists and agricultural innovators who need to facilitate change at the farm to society level.

Lastly, Sørensen et al (2021) highlights the need to build and maintain networks and learning communities as a way to provide farmers from diverse backgrounds and demographics a way to develop alternative pathways towards a sustainable agricultural system in contrast to conventional farming practices. Networks and local communities are essential platforms for professionals and agricultural stakeholders to share resources and socially engage with each other.

Citation: Steinke, J., Ortiz-Crespo, B., van Etten, J., & Müller, A. (2022). Participatory design of digital innovation in Agricultural Research-for-development: Insights from practice. *Agricultural Systems*, *195*, 103313. Retrieved from: https://doi.org/10.1016/j.agsy.2021.103313

Summary: In this paper, Steinke et al aims to contribute practical insights to the recent discussions on including agricultural workers in the co-design of agricultural technology. They shared three practical insights that development researchers can incorporate for digital development to reach its full potential, including managing the expectations of stakeholders, considering future scaling in the design process, and re-using existing services, tools, or concepts to address current challenges.

Steinke et al (2022) suggests that development researchers may need to adopt new research methods and acquire new skill sets, especially non-technical skills for digital development to be successful. Many digital design processes require collaborative efforts from multiple stakeholders from diverse backgrounds and development researchers are responsible for facilitating these projects. Researchers are responsible for managing the expectations of stakeholders throughout the project lifecycle and as such, they must be up-front about the iterative and collaborative nature of the design process from the beginning and properly communicate the progress of the project to ensure everyone is on the same page.

Furthermore, Steinke et al. (2022) suggests that development researchers should consider future scaling from early on in the design process.The authors explain that information and communication technology for agricultural innovations should be dynamic in nature and have the potential to address the needs of many or all farmers far beyond the initial target users. They suggest using prototypes, which typically involves showing the design participants the first model of the design tool or idea. Prototypes are useful in soliciting feedback from the target users and other stakeholders that may be impacted by the digital tool.

Citation: Walker, V., Bowkett, G., & Duchaine, I. (2018). All companies are technology companies: Preparing Canadians with the skills for a Digital Future. *Canadian Public Policy, 44* (1). 1–6. Retrieved from: https://doi.org/10.3138/cpp.2018-011

Summary: The purpose of this paper is to explore practical ways to cultivate a broad skill set by immersing post-secondary education students into the workplace and by engaging them in a private-sector research environment. This will help students to transition smoothly into the workforce and help them grow within their careers.

According to Walker et al. (2018), as Canada continues to grow economically, it will require a workforce with a well-rounded skill set for technical and non-technical employees. Some examples of relevant careers and technical skills would include architects and engineers of the digital age who possess knowledge of programming languages, big data analytics, understanding of artificial intelligence, and knowledge of how to operate complex software. However, not all Canadians need to be information technology (IT) specialists or "coders", most just need to be proficient in the generic computer skills such as sending emails, electronic scheduling, accessing web pages and digital apps.

There will be an increased value of non-technical skills or human skills as we leverage technology within the workplace. As a result, companies across a range of industries will increasingly demand new combinations of technology skills, workforce digital skills, and human skills. Similarly, a survey released in March 2016 by the Business Council of Canada *Developing Canada's Future Workforce: A Survey of Large Private-Sector Employers*, revealed that the most important skills and competencies for companies hiring entry-level candidates are ability to collaborate, teamwork, communication and functional skills. The top tier skills needed for mid-level hires included leadership competencies, personal skills, and collaboration and teamwork proficiencies.

Work-integrated learning was identified in this article as a potential solution to developing the skills needed for the successful transition into the workforce and developing the most needed competencies for businesses. Work-integrated learning pathways would provide workers with the opportunities to develop human, technical, and digital skills. It is also beneficial to both employers and students.