

# Manitoba Potato Industry Research Impact Narrative



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## **List of Acronyms**

ARDI: Agri-Food Research and Development Initiative

CMCDC: Canada-Manitoba Crop Diversification Centre

KPPA: Keystone Potato Producers Association

NSERC: Natural Sciences and Engineering Research Council

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## Key terms

Hundredweight (cwt): one hundred pounds.

Inputs: The actual research activities, processes, and resources invested towards a project. Examples include the knowledge and expertise of the researcher.

Impacts: The contribution(s) that research makes beyond academia and that directly or indirectly affects all areas within society, the environment, culture, and the economy.

Outcomes: Intended or unintended benefits or effects that derive from the intended results of the research activities. Outcomes can be short or long-term. Examples include licensing agreements, new or revised processes, standard or policy changes, changes in perception or awareness on an issue.

Outputs: The intended results of research activities, including tangible and intangible findings and products of research. Examples include knowledge and discoveries resulting from the research, publications, patents, works of art, partnerships or enhanced trust that were developed.

Potatoes for processing: potatoes that are grown to be processed to create certain potato products, mainly French Fries and chips. They are not grown to be sold as raw potatoes to consumers.

Potato virus Y: formally called common mosaic virus, is one of the oldest potato plant viruses and now exists as several strains based on ability to cause foliar and tuber symptoms. PVY<sup>O</sup> is the traditional or ordinary strain, while PVY<sup>N:O/N-Wi</sup> and PVY<sup>NTN</sup> are novel recombinant strains of the virus that continue to be more aggressive and faster spreading in different potato areas of world, including North America.

Prebiotic: non-digestible carbohydrate that induces the growth or activity of positive gut bacteria.

Resistant starch: a type of starch that goes through the stomach and small intestine undigested. Once in the large intestine it feeds the healthy bacteria found there. Type two resistant starch is found in raw potatoes.

Sugar end disorder: physiological disorder that causes high sugar content in the basal end of the potato tuber and could lead to dark end in fries or chips.

Verticillium wilt: a fungal disease, caused by Verticillium, that can cause early dying of the potato plant.



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## Executive Summary

The purpose of Research Manitoba's impact narrative is to document the outcomes and impacts of research in the province. The goal of the impact narrative is two-fold: a) to communicate the impacts of research to a wide variety of audiences such as academics, industry, community groups, the public, and other users of research findings, and b) to link outcomes and impacts to the original research.

Historically, Manitoba's potato industry has been the second largest in Canada, after Prince Edward Island's. From 1980 to 2018, we calculated that the approximate direct monetary value of funding into potato research was \$5.91 million for projects that were either partially funded by the Governments of Manitoba and/or Canada or took place at the Canada-Manitoba Crop Diversification Centre. The Manitoba potato industry grew dramatically between 1990 to 2017. The cash receipt amount for potatoes in Manitoba increased by 695% from 1990 to 2017. In terms of the monetary value, the increase in dollar value from cash receipts from 1990 to 2017 was \$224.69 million. The domestic export for potatoes from Manitoba has increased by 8,805% from 1990 to 2017. In terms of a monetary value, there was \$480 million increase from 1990 to 2018. The objective of this impact narrative is to investigate how research funding focused on potato production in Manitoba has contributed to the \$1.4 billion Manitoba potato industry complex.

In Manitoba, producers often make investment decisions for their potato crop based on locally piloted research. Potato research is an innovative domain and one that focuses on tailoring practices and technologies. Research conducted locally is the best way for producers to implement best practices for potato production. If the research is completed outside Manitoba, there is potential it will not be feasible with local growing conditions. Continued investment in Manitoba for potato research is necessary for the potato industry to flourish.

Research funding in Manitoba for potatoes during the period of 1980-2018 had impacts in various domains including:

- Implementing aerial application of fungicide
- Improving the late blight disease forecasting
- Identifying the ideal tuber seed size
- Wireworm management
- Reducing sugar end disorder
- Potato rotation study
- Nitrogen and phosphorus management for irrigated potatoes
- Reducing nitrogen emissions for irrigated potatoes

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- Verticillium wilt research
  - Potential of a probiotic and raw potato starch as antimicrobial agents in nursery pig diets
  - Resistant starch as a prebiotic for humans
  - Water management and ideal irrigation

Potatoes are known to be one of the most expensive crops to produce in Manitoba and they are the fourth most economically significant crop in Manitoba after canola, wheat and soybeans. In 2018, it was calculated that the overall input costs to produce one acre of potatoes was \$3,816, excluding the cost of labour. Research investment in the areas outlined in the domains above, has had an impact in increasing potato yields, which has permitted the sustainable reduction in the amount of land dedicated to growing potatoes. The Manitoba economy and rural communities in the potato industry have grown from the dedication of Manitoba Agriculture, processors, and the Keystone Potato Producers, have towards research. The citizens of Manitoba benefit from the direct impacts such as employment in the processing plants, as well as in off shoot companies from potato industry, and the transportation sectors.

The 38-year history of potato research in Manitoba as described in this impact narrative demonstrates that research funded by Manitoba Agriculture and other sources have contributed to the overall growth of the industry and to the economic strength of the province. It is the partnership of the provincial and federal governments, processors, scientists, and producer associations that drives the implementation of best practices based on research.

## Contributions of Manitoba Agriculture towards Manitoba Potato Industry development

Manitoba Agriculture has provided significant support to the potato industry, both by direct funding, and through staff directly working with those in the trade. The Entomologist, Field Crop Pathologist, Potato Pest Management and Irrigation Specialists, work directly with the growers to support the work that they do. Some examples of this support are:

- Pathology support is provided in order to forecast of Potato Late Blight, through data from the Manitoba Agriculture Weather program. Disease and insect pest surveys are also conducted, including monitoring for Bacterial Ring Rot Disease, a quarantine pest under The Plant Pests and Disease Act (C.C.S.M. c. P90);
- Entomology support is provided. This support includes aphid and potato psyllid monitoring and studying the occurrence of insecticide resistance in Colorado Potato Beetle;
- Additional agronomy support is provided on issues other than disease/insect management provided through the Soil Fertility Specialist and Weeds Specialist. Irrigation and tile drainage development projects as well as monitoring water availability

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have been supported through staff in Manitoba Agriculture, as well as Manitoba Sustainable Development;

- Manitoba Agriculture Meteorology staff have established a network of weather stations, which are used for monitoring weather conditions for flooding/drought, crop moisture needs, disease forecasting and timing pesticide spray applications to the wind speed and direction. The department has also contributed towards the staffing of agronomist with Manitoba Horticulture Productivity Evaluation Centre (MHPEC) and the operations at the Canada Manitoba Crop Development Centre (CMCDC) sites.



## Part I: Introduction

Historically, Manitoba's potato industry has been the second largest in Canada, after Prince Edward Island's<sup>1</sup>. In light of high input costs, Manitoba's potato producers have worked to dramatically increase productivity by investing in irrigation, improving drainage for their land, in addition to improving their input use efficiency (e.g. fuel, fertilizer, herbicide, pesticides and labour). In Manitoba, producers make investment decisions for their potato crop based on research. In order for research to be most beneficial for producers, it is essential that it is conducted in the province where they grow their potatoes. Manitoba Agriculture and the Government of Canada have been funding research in Manitoba's potato industry since 1942, and it is this specialized knowledge along with the cooperation of the processors that has enabled potato production to flourish in Manitoba. This impact narrative describes the programs, investments, and outcomes in regard to research conducted for Manitoba's potato industry.

### A) The rise of potato production in Manitoba

In 2014, an industry-commissioned economic analysis revealed that the Manitoba potato industrial complex provides \$1 billion to Manitoba's economic output<sup>2</sup>. The best measure of potato production is the yield by average hundredweight per harvested acre. This data provides the true number regarding endpoint productivity. Statistics Canada provides data beginning in the year 1908 regarding potato production. From the 1970s onward there was an increase in potato yields (Figure 1). Starting in the early 1990s a more dramatic yield was obtained, and by 2014 onwards a steady increase in average yield occurred due to multiple production factors. (Figure 1.).

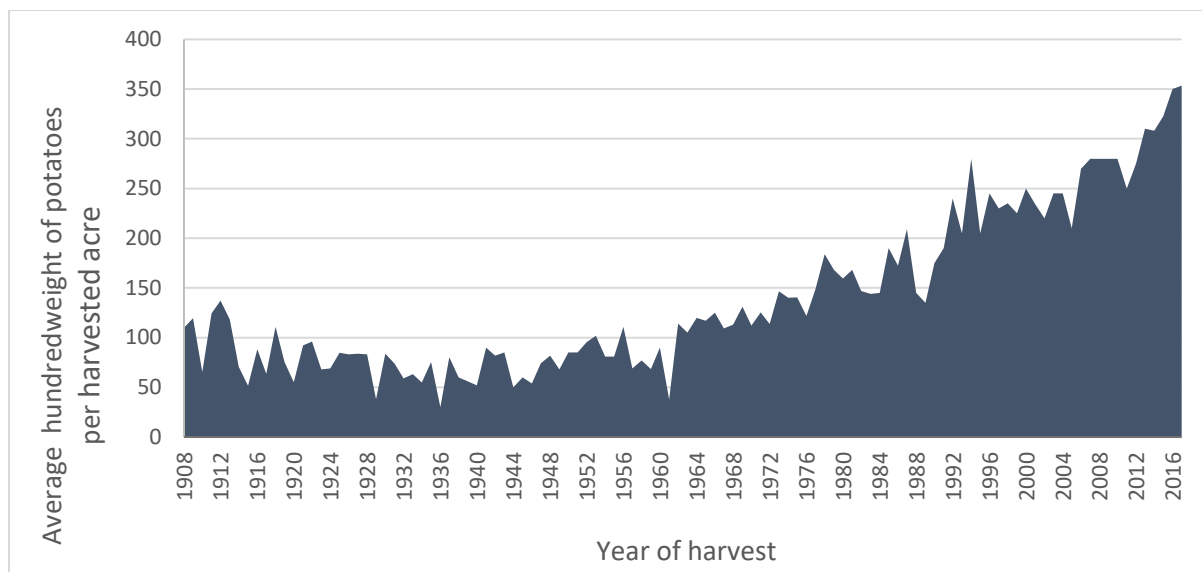


Figure 1. Average potato yield measured in hundredweight per harvested acre. \*Data from Statistics Canada.

Potatoes are known to be one of the most expensive crops to produce in Manitoba and they are the fourth most economically significant crop in Manitoba after canola, wheat and soybeans<sup>3</sup>. In 2018, it was calculated that the overall input costs to produce one acre of potatoes was \$3,816, excluding the cost of labour<sup>4</sup>. Research investment has had an impact in increasing potato yields which led to a significant increase in output without increasing the amount of land dedicated to potatoes production. According to Statistics Canada data, in 2003, potato acreage peaked at 103,000 acres and six years later in 2009, it was reduced to 81,000 acres, and in 2018 it fell to 64,100 acres (Figure 2.). However, this reduction in acreage did not correspond to a decrease in potato production, as the increase in potato yield is more than the output loss due to the drop in acreage. Reducing the amount of land dedicated to potatoes while maintaining or increasing the output level will result in a substantial production cost savings for producers.

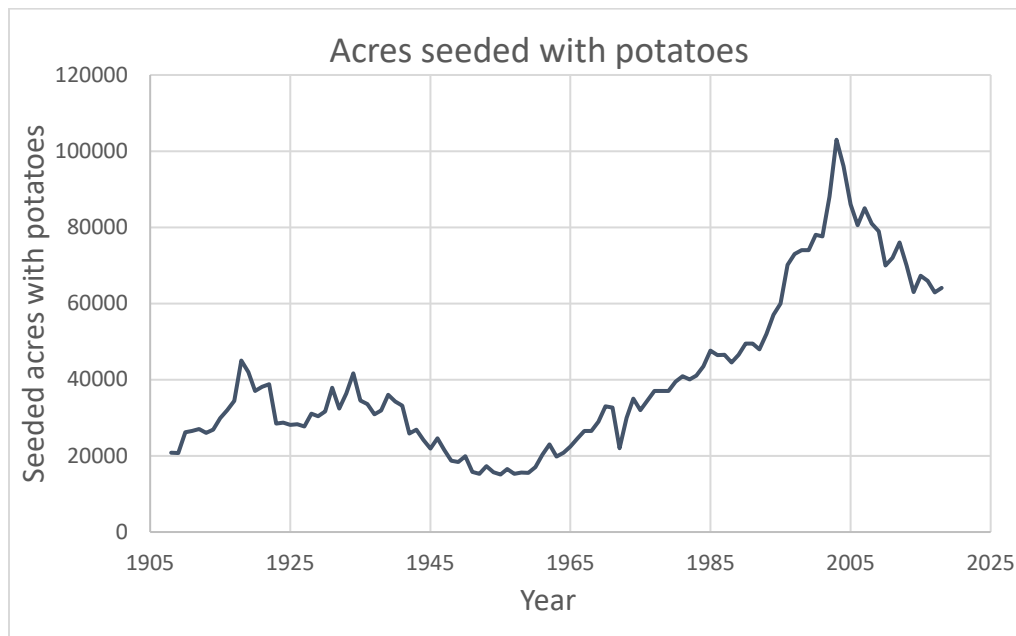


Figure 2. Number of seeded acres in Manitoba with potatoes. \*Data from Statistics Canada.

In Manitoba there are 52 process farms and seven that grow fresh potatoes for a total of 59. There are also a number of market gardeners (those that farm under five acres of potatoes).

The cash receipt amount for potatoes in Manitoba increased by 695% from 1990 to 2017. In terms of the monetary value, the increase in dollar value from cash receipts from 1990 to 2017 was \$224.69 million.

The domestic export for potatoes in Manitoba has increased by 8,805% from 1990 to 2017. In terms of a monetary value, there was \$480 million increase from 1990 to 2018.

## B) Manitoba's potatoes for processing

Two thirds of Manitoba's potatoes are used for processing by McCain Foods Limited, J.R. Simplot Company, and Old Dutch Foods Inc. Except for potatoes used for potato chips by Old Dutch Foods Inc., all other processing potatoes are used primarily for frozen potatoes products such as: French fries, hash browns, and potato wedges. Some processing potatoes are also dehydrated.

One-third of the potatoes in Manitoba are destined either for the fresh market called "table potatoes" or for seed potatoes which are used to grow potato crop in the next year. (Figure 3.).

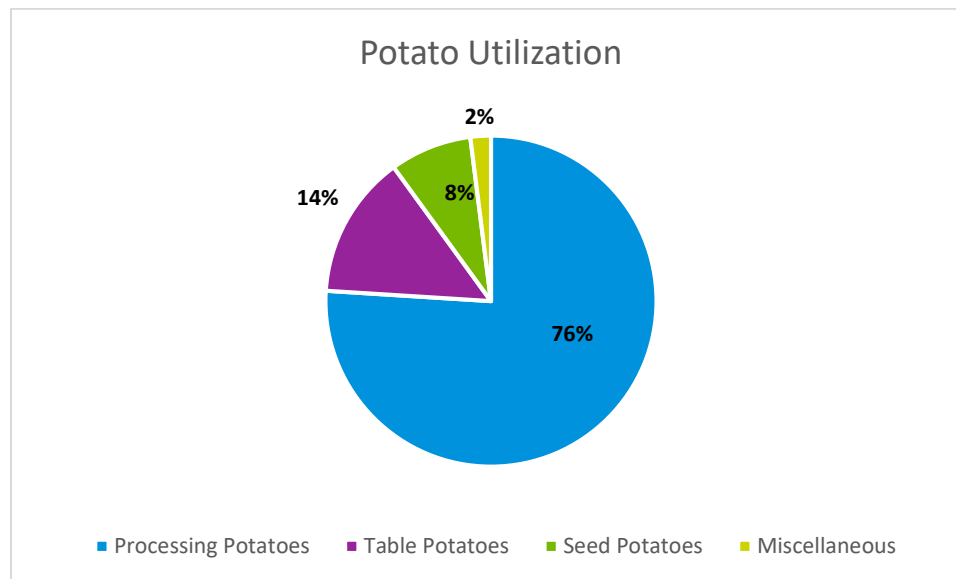


Figure 3. Utilization of potatoes grown in Manitoba during 2018. \*Data from Keystone Potato Producers Association.

Processing potatoes represent a large market share due to the strength and size of processing plants in Manitoba. The first processing plant was opened by the J.R. Simplot Company in 1962 in the Carberry area and the second processing plant was opened in 1978 by McCain Foods Limited in Portage la Prairie<sup>5</sup>. In 2003, the J.R. Simplot Company opened a custom facility to produce French fries from raw potatoes in Portage la Prairie. The J.R. Simplot Company invested \$120 million in the development of the facility and the Manitoba Government provided direct investment dollars and tax incentives<sup>6</sup>. In early 2018, the J.R. Simplot Company announced it will spend \$460 million to expand their previous plant to more than double the production capability<sup>7</sup>. In late 2018, McCain Foods Limited announced an investment of \$75 million to upgrade the Carberry and Portage la Prairie plants<sup>8</sup>. These two large recent investments demonstrate the confidence processing companies have in the future of Manitoba's potato industry.

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### C) Why is Manitoba one of the leaders in potato production?

#### Environmental factors

Growth and quality of potatoes are influenced by environmental factors such as temperature, moisture, light, soil type, and nutrients. The moisture and nutrient levels can be somewhat controlled by potato producers, but the other factors are geographically specific. Some regions in Manitoba have the ideal combination of soil type, temperature, and access to an irrigation water source which creates the necessary environment for large scale potato production. Potato producers are concentrated in areas of silty to sandy soils, primarily in the Portage la Prairie to Carberry region but also in the vicinity of Carman and in the Morden-Winkler-Plum Coulee district (Figure 4.). Ideal potato-growing land requires access to irrigation and good soil drainage. Conditions that are too dry or too wet can lead to poor growth. The best land has coarse-textured soil with good subsoil drainage, which is why potatoes are not grown in the clay of the Red River Valley but are found in the sandy soil to the west.

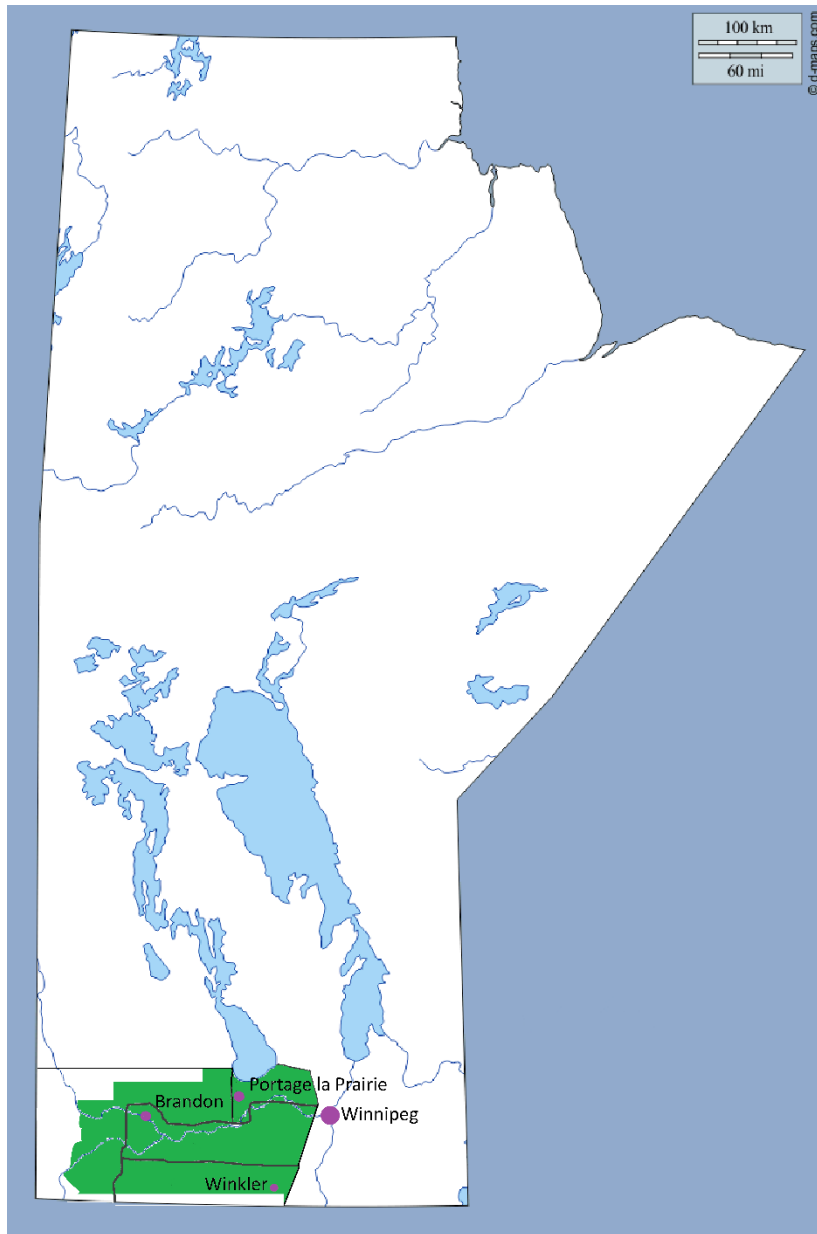


Figure 4. Regions (green) in Manitoba where potatoes for processing are grown.

The end product of the potato plant is the tuber, therefore the particular growing conditions for the tuber must be met. To maximize yields, ideal growing conditions include average daytime temperatures of 21°C (limited high temperatures of 30°C), whereas cool night temperatures are important because they affect the accumulation of carbohydrates and dry matter in the tuber. At lower night temperatures, respiration is slowed, which enhances storage of starch in tubers<sup>9</sup>. Thus, potatoes are sensitive to increases in temperature, and Manitoba's potato production thrives in historically similar summer temperatures.

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### Location to Market

Canada's number one producer of potatoes is Prince Edward Island whose eastern location can easily serve the highly populated east coast of United States. Manitoba's central location, which is a transportation hub for both road and rail networks, provides potato products to the mid-west region of the United States of America and central and western provinces of Canada. When the J.R. Simplot company first came to Manitoba to scout the Carberry area for a potential processing plant they did so under an initiative known as "miles to market". Carberry and Portage la Portage are located in the heart of the continent with proximity to the McDonalds restaurant headquarters in Chicago, Illinois, providing a location that is ideal to transportation routes. It is this strategic location relative to large markets that provided and continues to provide opportunities for processors to build and upgrade their processing plants.

### Keystone Potato Producers Association (KPPA)

Potato producers in Manitoba are required by law to sell many kinds of vegetables, including potatoes, to one of the two not-for-profit marketing corporations: Peak of the Market for table potatoes and specific root-vegetables, and Keystone Potato Producers Association (KPPA) for processing potatoes. KPPA's Executive Manager Dan Sawatzky explains, "the role of the Keystone Potato Producers Association would be to look out for the interests of the growers who are members". KPPA negotiates contracts with processors on behalf of the producers. Part of this negotiation includes the discouragement of surplus production by growers that is outside the amount stipulated in the contract. Surplus production can lower the contract price and can create negative competition for lower prices between processors. Through negotiation and planning KPPA assures that the parties involved in the Manitoba potato industry achieve the best economic outcome.

KPPA also promotes research and best practice implementation. Every year KPPA organizes and facilitates "Manitoba Potato Production Days" which aims to share current and relevant potato production information to the producers and agronomists. KPPA, McCain Foods and Simplot Canada have formed Manitoba Horticultural Production Enhancement Center (MHPEC) which invests \$100,000 per year into research for potatoes. A majority of this research funding goes towards Manitoba trials conducted at the Canada Manitoba Crop Diversification Centre (CMCDC). Additionally, \$80,000 per year is provided to The Alliance for Potato Research & Education (APRE) which targets nutritional sciences for potatoes.

KPPA is the voice of Manitoban process growers to the Government, Canadian Horticultural Council, United Potato Growers of Canada, United Potato Growers of American, and the Potato Marketing Association of North America. The dedicated executive managers, office managers, and board members throughout the history of KPPA have contributed to the success of Manitoba's potato industry.



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## Manitoba Agriculture

Manitoba Agriculture has and continues to support the potato sector directly through its staff, who provide late blight disease forecasts, disease and insect pest surveys for timely management of diseases and insect pests. Manitoba Agriculture staff also, monitor the Bacterial Ring Rot Disease under the Plant Pest Act; while providing additional irrigation and tile drainage development support. Manitoba Agriculture has financially supported the potato sector through its financial contributions to the packaging plant for Peak of the Market, waste water management at the McCain Foods processing plant and provided financial incentive to attract increased processing capacity at the Simplot Canada's Portage La Prairie facility. Direct funding of various research projects by MB Agriculture has also played a significant part in the potato research in the province.

### D) Impact narrative approach and methodology

Research Manitoba develops impact narratives to document the outcomes and impacts of research in the province. The goal of the impact narrative is to: a) link outcomes and impacts to the original research, and b) communicate the impacts of research to a wide variety of audiences such as academics, industry, community groups, the public and other users of research findings. Specific goals of the Research Manitoba impact report are to:

- Determine the return on investment on funded programs and projects;
- Record accountability and transparency (a reporting tool to the Government of Manitoba –Manitoba Agriculture);
- Encourage a proactive and prospective measurement and monitoring of research impacts among researchers, funders and users of knowledge; and,
- Contribute to the growing practice of research impact assessment in Canada and globally.

Outputs, outcomes and impacts in this narrative are examined through the lens of the Research Manitoba impact framework, which is divided into five categories:

- a. **Advancing knowledge** involves creation/co-creation of knowledge, new discoveries and breakthroughs arising from research, and contributions to the knowledge pool.
- b. **Building capacity** refers to the development and enhancement of the ability of individuals and teams to conduct and sustain research.
- c. **Influence on perceptions, thinking, awareness, and decision making** because research activities/findings can take numerous forms, but this largely refers to the influence and effects on government; industry; the research enterprise; not for profit organizations; individuals, groups and communities; educational institutions; and the public.

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- d. **Applications and changes** are the outcomes and impacts that result from research in natural sciences and engineering disciplines.
  - e. **Broad benefits** include economic, technological, environmental, social/societal, and cultural impacts such as wellbeing and prosperity.

To identify and understand the extent of the impacts that potato research funding has had in Manitoba, this narrative poses two evaluation questions:

- 1) What is the impact of research in the growth of Manitoba's potato industry?
- 2) To what extent has funded research contributed to the growth of the industry?

To answer the first evaluation question, Research Manitoba held a meeting with represents of Manitoba Agriculture to discuss an impacts-and-research diagram (Appendix 1) and the approach of the impact narrative. The diagram illustrates, in broad strokes, the scope of the impact narrative including:

- Determining the impacts that will be highlighted,
- Identifying the evidence that connects the impacts with the original research activities,
- Linking the appropriate research activities and inputs to the identified impacts.

For the second question, contribution analysis or a theory of change model is used to show how funded research in potato production, processing or industry have led to the identified impacts. Contribution analysis is a causal model that shows the links between activities, outputs, outcomes, and impacts<sup>10</sup>. Through this model, it can be shown how research in potatoes has contributed to the success of potato producers and the economy in Manitoba.

To collect data for the impact narrative, 11 key informants were contacted and subsequently shared data. Seven of these 11 key informants were also interviewed. Due to the range of topics in potato research, multiple interview guides were developed (Appendix 2). The key informants included (further details may be found in Appendix 3):

- 2 scientists
- 1 executive manager of the Keystone Potato Producers Association
- 1 office manager of the Keystone Potato Producers Association
- 3 processing companies
- 1 retired manager of the Keystone Potato Producers Association and current researcher
- 2 Presidents and CEOs of companies built on co-products created from potato processing
- 1 founder of an agriculture research consulting firm

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KPPA also distributed surveys on the behalf of Research Manitoba to its members at their December 2018 meeting. The questions in the survey were centered around where they receive research, how important research was, and if they thought further funding for potato research was required.

#### E) Limitations

The two limitations that were encountered was the lack of records regarding research conducting on potato production between 1950 and 1979. Thus, we are unable to fully understand the historical research investment that has supported the economic growth of Manitoba's potato industry. We were also unable to obtain the details of the research conducted in Manitoba that was funded solely by processors and agribusiness companies. Thus, this impact narrative focuses on research that received a portion of public funding or were conducted at the Canada-Manitoba Crop Diversification Centre (CMCDC) through the Manitoba Horticultural Productivity Enhancement Centre.

### Part II: Findings

#### A) Initial inputs into research

The Government of Manitoba formed the *Manitoba Potato Committee* in 1942, with the goal of directing needed research into potato production<sup>11</sup>. One of the first recommendations of the *Manitoba Potato Committee* was to create the Manitoba Potato Breeding Program in partnership with the University of Manitoba. By 1946 the research program had some success in identifying ideal varieties<sup>11</sup>. A number of varieties had also been introduced by the United States Department of Agriculture, the Dominion Experimental Farm Service and private potato breeders in Canada.

Between 1950 and 1979, there was some research investment by the Government of Manitoba, but we were unable to come across this information through our key informants and the archives.

#### B) Research funding from Manitoba Agriculture

Manitoba Agriculture has funded several important projects and initiatives that have proven instrumental in moving provincial potato production forward:

##### **Agro-Man Program:**

The Agro-Man Program started in April 1979 and ended in March 1984 and was co-funded by Manitoba Agriculture and Agriculture and Agri-Food Canada. We were unable to find the funding amount for this funding program but at minimum one full-time salaried position was funded throughout the four-year period. If the salaried position is considered, a minimum total of \$72,000 would have been invested in the four-year period.

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### **Agri-Food Program:**

When the Agro-Man Program ended in 1984 the provincial government developed the Agri-Food project. This project consisted of demonstrating technologies and best practices that were piloted outside of Manitoba. This provided the dissemination of research from elsewhere in North America to Manitoba and allowed the practices to be tailored to Manitoba's growing environment.

Table 1. Manitoba Agriculture Agri-Food research program funding (1985-1990).

Year	Total amount of funding
1985-1986	\$18,488
1986-1987	\$42,085
1987-1988	\$42,795
1988-1989	\$43,378
1989-1990	\$50,573

\*Original accounting document shared by Blair Geisel.

### **MCDC/CMCDC:**

The Manitoba Crop Diversification Centre (MCDC) was established in 1993 under a ten-year agreement among the Government of Canada, the Government of Manitoba, and the Manitoba Horticulture Productivity Enhancement Centre Inc. In 2004, a new agreement was reached with the same partners and the name was changed to the Canada-Manitoba Crop Diversification Centre (CMCDC). Currently, the Centre is operating as an extension of the previous agreements. From 1993 to 2018 the CMCDC Carberry location, has received approximately \$1.25 million in operating costs for the centre, from the Governments of Manitoba and Canada. The program outcomes for the CMCDC are classified as 1) Partnerships and communication, 2) Water Supply and Irrigation, 3) Potato Industry Support (applied research and technology transfer), 4) Environment, and 5) Crop Diversification. Some of the projects at the CMCDC are partly funded by Manitoba Agriculture. The majority of the projects carried out are in collaboration with other public or private agencies. The organizations that are involved in funding the research trials conducted at the CMCDC are: the Keystone Potato Producers, Simplot (II) Canada, and McCain's Food Ltd. From 1993 to 2018, \$2.5 million was contributed by these organizations for potato research, through the Manitoba Horticultural Productivity Enhancement Centre. The CMCDC describes that the, "nature of the cooperative agreements are almost as numerous as the projects themselves-whatever is required to get the job done by using the resources of both parties efficiently"<sup>12</sup>.

### **ARDI:**

Agri-Food Research and Development Initiative (ARDI) was created in 1998 to fund industry-led innovative research and development activities in crops, livestock, environment and food. The goal of this research funding initiative has been to improve the competitive position of

Manitoba's agricultural, agrifood and agriproducts sectors by accelerating production, proactive risk management, and market development<sup>13</sup>. There have been two stages of funding; ARDI I from 2004-2008 and ARDI II from 2013-2018 (we were unable to find funding information for projects before 2004). The total funding distributed for potato research projects under ARDI I was \$461,380 dollars. The range of potato research that was investigated with the funding focused on the increasing the yield or quality of processing potatoes (Table 2.). The total funding distributed for potato research projects under ARDI II was \$691,070 dollars (Table 3.).

Table 2. ARDI stage I funding projects (2004-2008).

Project name	Total amount of funding project received between 2004-2008
Potential of Probiotic VSL#3 and Raw Potato Starch as Antimicrobial Agents in Nursery Pig Diets	\$126,060
Green Manures and Organic Amendments for the Control of Early Dying of Potato in Manitoba	\$175,120
Nitrogen Management for Irrigated Potato Production in Manitoba	\$14,000
Potato Innovation Network 2020	\$31,000
Evaluation of Verticillium Wilt Resistant French Fry Processing Potato Varieties	\$40,200
Pathogenic Status of Manitoba Populations of Verticillium Species on Sunflower and Potato	\$75,000

\*Data provided by Manitoba Agriculture

Table 3. ARDI stage II funding projects and Growing Forward 1 (2009-2016).

Project name	Total amount of funding project received between 2009-2016
Evaluation of Advance Potato Selections in Manitoba	\$60,000
Use of Potato Starch and Probiotics to Control Inflammatory Bowel Disease in Humans: Infectious Diseases Model in Pigs	\$48,000
Evaluation of Tile-drainage / Sub-irrigation System for Sustainable Production of Potato and Corn	\$85,875
Evaluation of Fall Soil Preparation Methods on Potato Yield and Grade	\$48,068
Evaluation of Reservoir Tillage on Run-off, soil moisture, potato yield and grade	\$26,908

Potassium Management for Irrigated Russet Burbank Potato Production in Manitoba	\$68,641
Assessment of MSP (RS) Potato Starch as a Health-Promoting in the Animal and Human Nutraceutical Industries	\$50,500
Development of protocol for tile-drainage/sub-irrigation system for sustainable production of potato and corn	\$70,000
Survey of potato and tomato late blight pathogen <i>Phytophthora</i> infesting Manitoba and Canada	\$159,048

\*Data provided by Manitoba Agriculture

### **Growing Forward 2:**

*Growing Forward 2* was a five-year (2013-2018) policy framework for Canada's agricultural and agri-food sector and was based upon a partnership between federal and provincial governments<sup>14</sup>. *Growing Forward 2* focused on innovation, competitiveness and market development to ensure Canadian producers and processes had the tools and resources they needed to create and cultivate new market opportunities<sup>14</sup>. *Growing Forward 2* in Manitoba funded a diverse set of innovative agriculture research. Potato research and marketing development received a total of \$743,287.43 dollars over the period of 2013-2018.

Table 4. *Growing forward 2* funding projects and amount received (2016-2018).

Project name	Total amount of funding project received between 2013-2018
Manitoba Potato Industry Development Initiative	\$528,000
CMCDC applied research trials	\$168,750
Influence of Nitrogen on the Yield and Quality of Dark Red Norland, Sangre and Viking Potato Varieties	\$20,490
Evaluation of Management Strategies to Control Insecticide Resistant Populations of Colorado Potato Beetle	\$12,325
Determination of Aerial Spore Counts of Black dot ( <i>Colletotrichum coccodes</i> ) and Silver Scurf ( <i>Helminthosporium solani</i> ) in Potato Storages	\$13,722

\*Data provided by Manitoba Agriculture



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### C) Advances through research – Scientists

Supporting and conducting research is an important part of how the potato industry continues to grow. In this province alone, there are a number of researchers whose discoveries and insights have helped propel advances in potato growth and production. We have highlighted some of these scientists and their research below.

- Dr. Martin Scanlon is the Dean of the Faculty of Agricultural and Food Sciences at the University of Manitoba. Dr. Scanlon brings a history of research focused on food storage and processing, and on how these factors change the properties of the food's materials such as its textural quality.
- Professor Daayf, from the Department of Plant Science at the University of Manitoba is internationally known for his research on verticillium wilt (premature dying) in potato plants and has produced 27 peer reviewed journal articles on the subject. Professor Daayf's research has provided added knowledge regarding verticillium wilt research and the research has piloted potential management strategies for controlling the pathogen.
- Dr. Mario Tenuta from the Department of Soil Science at the University of Manitoba heads the Applied Soil Ecology Lab, which focus areas include controlling Potato Early Dying, control and understanding of plant nematodes, soil ecology, nitrogen 4R management, and reduction of greenhouse gas emissions in agricultural systems. Dr. Tenuta also works to inform growers, crop consultants, and members of the industry on how research discoveries can be readily utilized.
- Dr. Debra McLaren is a scientist in crop production pathology at the Brandon Research and Development Centre. Dr. McLaren's areas of expertise include: the development of improved disease management strategies, and evaluating the impact of farming practices (e.g., tillage systems, fertilizer inputs), on the rates and severity of plant diseases in pulse crops, soybean and canola. Although Dr. McLaren no longer works in the area of potato research, she led a 2006-2008 project "Potato virus Y (PVY<sup>O</sup> and PVY<sup>N:O</sup>) impact on potato cultivars and management through oil sprays", the findings of which led to the Pest Management Regulatory Agency of Health Canada approving the use of Bartlett Superior 70 mineral oil to reduce the spread of PVY.
- Dr. Ramona Mohr is a Research Scientist in Sustainable Systems Agronomy at the Brandon Research and Development Centre. Dr. Mohr's previous research involved developing agronomic and nutrient management practices for irrigated potato systems to optimize yield and quality while minimizing environmental impacts and included developing guidelines for sustainable irrigated potato rotations to maintain soil and crop quality and yield.
- Dr. Merv Pritchard (retired) was the Director at the University of Manitoba's School of Agriculture. Dr. Pritchard's research interests included post-harvest handling and storage management to ensure processing quality of potatoes for French fries, as well as

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sprout inhibitor application, and effects of ethylene contamination on potato processing quality.

#### D)Advances through research – Collaborations:

The University of Manitoba has a longstanding history of collaborating with various agricultural stakeholders to advance research and innovation in agricultural practices and products. Research conducted within the Faculty of Agricultural and Food Sciences at the University of Manitoba (UofM) to help advance the Canadian potato industry has been supported by numerous partners including: McCain Foods, J.R. Simplot Company, Dow AgroSciences, Peak of the Market, Carnation Foods, Midwest Food Products, StanChem, Manitoba Starch Products, KPPA, the Manitoba Horticulture Productivity Enhancement Centre, the Manitoba Association of Agricultural Societies and the Seed Potato Growers Association of Manitoba. Various provincial and federal funding programs have been used to leverage these investments, including: NSERC Discovery and Partnership programs, Agriculture and Agri-Food Canada supported programs such as the Growing Forward AgriScience Clusters with the Canadian Horticultural Council and the Organic Federation of Canada, various Manitoba Agriculture programs, the Manitoba Rural Adaptation Council (MRAC), the Alliance for Potato Research & Education, the Manitoba Agricultural Services Corporation, the Canadian Bureau for International Education, Mitacs and University of Manitoba Institutional grants. Total funds supporting potato related research at the UofM has exceeded \$3 million. The data provided in this section was shared by the Faculties of Agriculture and Food Sciences at the University of Manitoba.

Research within the Faculty of Agricultural and Food Sciences focuses on sustainably increasing yields and improving the quality and profitability of potato crops and products in Manitoba. Research on potato pest and disease management and sustainable production practices has provided the basis for many of the recommendation's potato growers follow today. For example, determining spray losses from sprinkler irrigation systems has helped producers select the best irrigation method for maximum water and energy conservation. The development of storage and process optimization strategies has been instrumental in helping Canada's potato processing industry.

Table 5. Highlights of research projects conducted at the University of Manitoba

<p><b>Diseases and Pests</b> – (i) Surveys of plant pathogens; (ii) Development of new methods to detect potato pathogens and control diseases in the field and during storage using sustainable, environmentally sound alternatives to chemical pesticides; (ii) Insect pest sampling and management practices; and (iii) Development of economic thresholds for pest/pathogen/yield interactions.</p>
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<p><i>Key researchers:</i> Drs. Fouad Daayf, Lakhdar Lamari and Lorne Adam (Department of Plant Science) and Dr. Neil Holliday (Department of Entomology).</p>
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**Productions-Soils, Irrigation, and Agrometeorology** – (i) Sustainable potato crop rotation practices on pesticide persistence, efficacy and leaching in soils; (ii) Surveys to assess the suitability of Manitoba’s land base to potato production; (iii) Evaluating weather data based models, sprinkler irrigation systems and soil moisture sensors to fine-tune irrigation timing and predict yields; (iv) Water and nutrient movement under controlled tile-drainage; (v) Green manures and organic production to control early dying of potato in Manitoba; (vi) Nitrogen for improved yield, quality and profitability of potato; and (vii) Fertilizer best management practices to reduce greenhouse gas emissions.

*Key researchers:* Dr. R. Sri Ranjan (Department of Biosystems Engineering), Drs. Annemieke Farenhorst, Mario Tenuta, Carl Shaykewich and Paul Bullock (Department of Soil Science), and Drs. Martin Entz and Fouad Daayf (Department of Plant Science).

**Storage and Processing** – (i) Postharvest handling and storage management to ensure processing quality, including sprout inhibitor application; (ii) Evaluation of processing treatments on sensory qualities of french fries; (iii) Recovery of protein from potato effluents; (iv) Determination of the impact of cooking method on the quality of potato protein; and (v) Consumer acceptability testing of baked potato products.

*Key researchers:* Drs. Martin Scanlon, Arnie Hydamaka, Beverly Watts and Jim House (Department of Food and Human Nutritional Sciences), Dr. Merv Pritchard (Department of Plant Science).

**Nutraceutical/Health Research** – Assessments of processed potato fractions as health-promoting prebiotic, antioxidant and antimicrobial agents for the animal and human nutraceutical industries.

*Key researchers:* Drs. Curtis Rempel, Peter Jones, Arnie Hydamaka, Trust Beta, Jim House (Department of Food and Human Nutritional Sciences) and Drs. Martin Nyachoti and Ehsan Khafipour (Department of Animal Science)

## E) Outcomes and immediate impacts of potato research

Potato research is an innovative domain and one that focuses on tailoring practices and technologies. The outcomes and impacts of agriculture research depend first upon disseminating the results of best practices to growers, and second to providing support on how to implement these changes<sup>15</sup>. Changing agriculture practices is approached by growers in a serious manner. There is often a large monetary investment required, and there must be valid research demonstrating that cost-benefit ratio is in the growers favour. As growing conditions for potatoes vary across North America, research that demonstrates the benefit of a certain practice outside Manitoba may not show the same results here. Thus, some of the funded research described below demonstrates the benefits of previously proven methods from elsewhere, in Manitoba soil and growing conditions.

This section explores in chronological order some outcomes of funded research programs that have had the greatest impact. The vast outcomes described here demonstrates that research in

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the Manitoba potato industry facilitates growth in the economy, creates innovative industry opportunities, and has the potential in improving the health of Canadians.

#### Implementing aerial application of fungicide

Launched in April 1979, the bilateral federal-provincial Subsidiary Agreement on Value-added Crops Production, also known as Agro-Man Program, supported research projects that conducted field trials and investigated seed spacing, seed size, and agronomy practices around seeds. Fungicides for blight were also examined. Garry Sloik led an investigation into tractor wheel impact on rows of developing potato plants, and the impact of sprayers wheels for fungicides on rows. Sloik shared that:

“it showed that there was enough damage done to the potato plants by compaction and running on the tops or trampling of the tops, that you could pay for the aerial application and then avoid those clods, compacted soil leads to clods, and [it] made harvesting easier by using aerial application”<sup>16</sup>.

It is estimated that in 2018, eighty-five percent of potato acreages used aerial application.

#### Identifying the ideal tuber seed size

Among research projects funded under the Agro-Man Program (1979-84), there were trials that identified ideal tuber seed size and also improved the mechanical seed cutting technology. First, it is important to understand that potatoes for seed are cut into numerous pieces mechanically which leads to a wide variation of seed size. It was common for producers to use seed sizes that were approximately three-quarters of an ounce. These trials identified that the ideal seed size was two ounces. Since that time period the ideal of about two ounces for each potato tuber seed has been utilized within the potato industry. The identification of the ideal potato tuber seed size leads to more stable growth and higher yield rates.

#### Wireworm management

From 1985 to 1990, the Agri-food projects supported research demonstrations and tailoring for the Manitoba growing environment for wireworm management<sup>17</sup>. Wireworms are the larvae of click beetles and often perform the most damage in early spring and may require acreages to be reseeded. Wireworms can bury into the potato seed tubers in the spring creating an entry for pathogens and remain in the potato subsequent to harvest in the autumn<sup>18</sup>. This produces blemished potatoes that are considered to be of low-grade and not what the processors need for the in-demand flawless frozen French fries. Through the Agri-food program, different options for control and management of wireworms were investigated. Although wireworms have not been eliminated, during the late 1980s the Agri-food program demonstrated the benefit of particular insecticides for the predominant species at the time<sup>17</sup>. The implementation of this practice increased the harvested potato quality.

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### Reducing sugar end disorder

The Agri-food project trialed research that had been demonstrated elsewhere to reduce sugar end disorder in potatoes. Sugar end disorder is a physiological disorder that causes high sugar content in the basal end of the potato tuber<sup>19</sup>. Potatoes with the sugar end disorder produce French fries that are dark on one end are not aesthetically pleasing and are often rejected by consumers. At the processing plant, sugar end disorder causes time and profit losses due to the need to blend batches to meet specifications and change processing protocols. For the producer, sugar end disorder can be costly if the potatoes are of insufficient quality and the crop is rejected for processing<sup>19</sup>. The trials conducted by the agri-food project examined how water stress and either insufficient or excessive nitrogen caused sugar end disorder. This research demonstrated to producers the importance of irrigation and precise nitrogen application. The impact was increased potato quality which is essential for processing.

Blair Geisel who led the trials shared:

“Well there was research around North America that identified the causes of that problem [sugar end disorder] but it wasn’t being taken up in Manitoba, and so we replicated that research here to prove to the potato growers of Manitoba that this technology would improve or reduce the incidence of this physiological condition”<sup>17</sup>.

### Potato rotation study

In 1998, the CMCDC with partial funding from Manitoba Agriculture, began a ten-year trial to study the impact of crop rotation on the long-term viability and sustainability of irrigated potato production<sup>20</sup>. The outcomes demonstrated that although there was no benefit in crop rotation during the initial years, the positive effects became noticeable in the later years. It was found that two-year rotations of Potato-canola reduced soil pathogens and overall generated the highest net outcome<sup>21</sup>. The results of this Manitoba study have been utilized by some producers, and this contributes to the long-term sustainability of the Manitoba potato industry. There have been two peer reviewed publications as a result of the potato rotation study<sup>21,22</sup>.

### Nitrogen and phosphorus management for irrigated potatoes

Finding the ideal amount of nitrogen and phosphorus is necessary for growth. These amounts are dependent upon soil and growing conditions. Scientists at the CMCDC conducted field studies between 2003-2006, which demonstrated that increased phosphorus application may increase yields but increases in yields are not predictable. A peer-reviewed paper was published as a result of this research<sup>23</sup>. ARDI I, provided direct funding to investigate nitrogen management for irrigated potato production in Manitoba. Finding ideal nitrogen management is vital in achieving optimal yield and potato quality.

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### Reducing nitrogen dioxide emissions for irrigated potatoes

Nitrogen and phosphorus applications cause emissions. Nitrogen application to the soil releases the greenhouse gas, nitrogen dioxide, into the atmosphere. Scientists at the CMCDC, with funding from ARDI I conducted field studies, which demonstrated that nitrogen dioxide emissions can be reduced: 1) if nitrogen fertilizer application does not exceed optimal marketing yield, 2) if irrigation directly after nitrogen application is limited, and 3) there is management of irrigation to prevent soil furrows (a trench created by a plow or other implement in agriculture for planting crops within, or as a means to create irrigation pathways). This research added Canadian knowledge regarding greenhouse emissions and demonstrated that a slight change of potato production practices can reduce emission. As a result of this unique research, two peer reviewed papers were published<sup>24,25</sup>. Reducing greenhouse gas emissions is vital, as a change in average growing season temperature by climate change can negatively impact multiple aspects of agriculture. The economic impact of this research cannot be evaluated immediately and requires long-term follow-up.

### Verticillium wilt research

Dr. Daayf from the Department of Plant Science at the University of Manitoba is internationally known for his research on verticillium wilt and has produced twenty-seven peer reviewed journal articles on this topic. Manitoba Agriculture and NSERC have funded several studies investigating verticillium wilt in Manitoba. Dr. Daayf's research has provided added knowledge regarding verticillium wilt research and the research has piloted potential management strategies for controlling the pathogen. Dr. Mario Tenuta and his students have also conducted extensive field research on verticillium wilt, including green manure, fumigation and molecular work on enumerating the verticillium spore counts in soils.

### Potential of a probiotic and raw potato starch as antimicrobial agents in nursey pig diets

Piglets for pork production often experience post-weaning diarrhea which leads to slowed growth. ARDI I funded a groundbreaking trial at the University of Manitoba that consisted of multiple arms for comparison. It was found that raw potato starch was most effective in limiting diarrhea in weaning piglets, which indicates resistant starch from potatoes likely has potential to reduce antibiotic use in piglets. This study led to a peer reviewed publication<sup>26</sup>. The results of this study lead to continued research in the Department of Animal Science at the University of Manitoba, furthering the comparison of raw potato starch and prebiotics<sup>27</sup>. This research stream has led to three peer-reviewed publicaions<sup>26-28</sup>. Manitoba is home to the only potato starch processing facility in Canada and is well situated to continue this research stream and ARDI II has continued to invest in this innovative research area.

### Resistant starch as a prebiotic for humans

ARDI II funded the studies that contributed to laying the foundation for the creation of a new company and first of its kind industry in Canada, that of resistant starch from potatoes which is



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produced by MSPrebiotic INC. The first project that received funding was the, “Use of potato starch and probiotics to control inflammatory bowel disease in humans: infectious diseases model in pigs”. The second project that received funding was, “Assessment of MSP (RS) potato starch as health-promoting in the animal and human nutraceutical industries”.

This second project provided some data that contributed to developing a randomized controlled trial with humans, conducted by Dr. Michelle Alfa at the St. Boniface Research Centre<sup>29</sup>. The trial examined the gut microbiome of elderly persons living in a long-term care facility and middle-aged persons living in the community. Resistant starch from potatoes is a prebiotic, and this complex carbohydrate stimulates the growth of good bacteria in the intestines, which is crucial for optimal health. The randomized controlled trial demonstrated MSPrebiotic® meets the criteria of a prebiotic and increased the healthy *Bifidobacteria* in the gut microbiome. The trial was funded by MSPrebiotic INC., Carberry, MB, and the National Research Council of Canada. The results were published in a peer-reviewed paper<sup>29</sup>.

Derek McLaren Vice-President of MSPrebiotic INC., shared the following about the value of the MSPrebiotic® which was discovered upon further examination of the trial’s outcomes:

“Another part of the research was in the blood lipid side. We were really interested in looking at impacts on, for example, diabetes. Our research showed that we could lower insulin resistance, which is a huge impact for people that have diabetes through lowering blood sugar levels”<sup>30</sup>.

The results showed that for older adults living in a long-term care facility, the consumption of MSPrebiotic® lowered blood glucose and insulin levels. MSPrebiotics INC., utilizes potato starch from Manitoba’s processors to produce resistant starch, and these results demonstrate that it has the potential to enhance the health of one of Canada’s most vulnerable populations.

#### F) Publications

The total number of peer reviewed-publications that could be directly linked towards funding received from Manitoba Agriculture for potato research is ten<sup>21-27,31-33</sup>.

#### G) Building capacity

##### Education and training of scholars

A search was completed on the University of Manitoba electronic theses and dissertation database (Mspace) which retrieved the research works of 60 graduates who studied potatoes in Manitoba. The first graduate student defended their potato research in 1945, which was titled “The effects of seed piece size and spacing relationships on the yield and quality of three potato varieties”. The majority of theses and dissertations were completed in the Department of Plant Science. Starting in 1947, the Department of Foods and Nutrition began research in the processing of potatoes. In 1960, the first graduate of the Agricultural Economics and Farm Management program studied, “The Primary Marketing Costs for Manitoba Potatoes”. The first PhD awarded for potato research at the University of Manitoba occurred in 1960, and the

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dissertation research was conducted by Dr. May Fan in the area of potato amylases. There were also PhDs and M.Sc. degrees awarded in potato research from the Department of Entomology, Department of Soil Science, and Biosystems Engineering. The numerous departments at the University of Manitoba that have been and continue to be involved in potato research demonstrates the breadth of research that has been focused on potatoes at the graduate level in Manitoba. The scholarly achievements of the sixty graduate students trained in potato research is a testament to the training ability of the University of Manitoba to cultivate future potato researchers.

### Summer field research training

Starting with the Agri-food program in 1985, between four to eight university summer students each year have spent their summers learning and performing field research for potatoes. This has provided students with the needed field research skills as well as financial means to support their pursuit of post-secondary education. It is estimated at minimum 165 summer students have been trained from funding received from the Manitoba Department of Agriculture.

## Part III: Discussion

The multifaceted funding approach that has produced potato research in Manitoba provides a varied lens in which to view the growth of the Manitoba potato industry.

### A) Impact of research on industry growth

Establishing the linkages between the growth of an industry and research helps to highlight the value of the research to the public, funders, stakeholders, and the researchers themselves. It also helps to understand the uptake and the effects of the research findings.

Contribution analysis is an approach that helps assess cause and effect in program evaluations, and helps those involved (e.g., researchers, policy makers, managers), see what outcomes the contributions of their programs have made. The strength of this analysis approach is that by understanding why the results occurred, it helps pinpoint how the intervention(s) have contributed to the observed outcomes or results. It addresses the difference (e.g., the growth of industry), that the research has made, and how much of that growth can be attributed to the research. Here, contribution analysis is used to answer the following questions:

- 1) What is the impact of research in the growth of Manitoba's potato industry?
- 2) To what extent has funded research contributed to the growth of the industry?

The theory of change (Appendix 6) diagrammatically addresses these questions and shows the connection between the funding Manitoba Agriculture has distributed to certain projects throughout a thirty-eight-year time period.

The investment in potato research by Manitoba Agriculture in the 1980s, provided evidence for the implementation of best practices tailored to the Manitoba environment. This enabled

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improvements in yields and in the quality of potatoes produced. The establishment of the CMCDC in 1993, enabled Manitoba to continue and expand research trials for potatoes in Manitoba. It is vital to understand that there is not one single practice or technology that improved irrigated potato yield; rather the accumulation of multiple practices lead to the dramatic increase in potato acreage productivity. Thus, the multifaceted approach to potato research at the CMCDC provided the tailoring for many of the best practices for Manitoba's potato producers.

The research projects developed during the stages of ARDI I and ARDI II furthered the key areas of verticillium wilt research, nitrogen application, and positively impacted the future use of resistant starch from raw potato.

#### Farm size

The growth of the potato industry can be demonstrated in the average size of farms that grow processing potatoes in Manitoba. The average size of potato acreage is about 900 acres<sup>34</sup>. Farm size does vary within the industry with the smallest scale farm growing about 200 acres of potatoes and the largest farm has 4000 acres devoted to potatoes<sup>34</sup>.

The increase in productivity for potatoes in Manitoba, was dramatic between 1990-2017. The cash receipt amount for potatoes in Manitoba increased by 695% from 1990 to 2017. In terms of the monetary value, the increase in dollar value from cash receipts from 1990 to 2017 was \$224.69 million. The domestic export for potatoes in Manitoba has increased by 8,805% from 1990 to 2017. In terms of a monetary value, there was \$480 million increase from 1990 to 2018.

#### Local economic impact

The Manitoba potato industry consists of three main processors and combined they employ at minimum 771 Manitobans. The majority of the employment opportunities are in rural Manitoba.

Table 6. Potato processors use of potatoes and employment in Manitoba.

Processor	Annual pounds of potatoes processed in 2018	Number of employees in 2018
McCain Food Ltd.	329,471,000	333
Simplot Canada (II) Ltd.	~299,999,000	275
Old Dutch Food Ltd.	11,500,000	163

\*Values received directly by processors, key informants listed in Appendix 3.

Historically, Manitoba has been the second largest potato producing province in Canada. In 2018, September rains delayed harvesting and a hard frost during October 10<sup>th</sup> to the 11<sup>th</sup> damaged the potatoes that were left in the ground<sup>36</sup>. In total 5,200 acres were not harvested in 2018<sup>37</sup>. This caused Alberta to become the second largest potato producing province in Canada for 2018. Across Canada, due to challenging growing and harvesting conditions, potato

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production decreased by 2.6% when compared to the values obtained in 2017<sup>37</sup>. The strength in Alberta's potato production is recommended to be used as an incentive to invest in further research in Manitoba in order to enable the Manitoba potato industry complex to have continued growth.

## B) Knowledge translation

Dissemination of research is a vital part of agriculture production. Since the 1950s, when the Vegetable Committee of the Manitoba Horticulture Association was formed, producers and scientists have come together to create educational days in January<sup>38</sup>. KPPA began organizing in the 1970s, an in-depth research conference combined with a tradeshow. This event spans multiple days and is titled, "Manitoba Potato Production Days". The attendees of Manitoba Potato Production Days are mostly potato producers, agronomists, and technology specialists. In 2019, the number of attendees for the three day event was 549. The list of speakers always includes multiple university professors from the United States and Canada who have specialized in potato research, experts in potato industry coordination, agronomists, and those speaking about agriculture management. The tradeshow displays exhibitors for: fertilizers, aerial application, financial services, irrigation technology, heavy-duty equipment, drainage, building, farm machinery and soil testing.

### Results from knowledge translation survey

All 22 potato producers who filled out the knowledge translation survey prepared by Research Manitoba, indicated that the majority of their research knowledge came from Manitoba Potato Production Days. Ninety-six percent of the respondents listed the CMCDC annual report as a utilized resource for the latest research. Thirty-two percent of the respondents listed academic journals as an additional primary source for new research.

All respondents indicated that research conducted in Manitoba was more important than research conducted elsewhere. All respondents also indicated that more research funding for potatoes in Manitoba was necessary.

The results of this survey demonstrate the high value of Manitoba Potato Production Days as a knowledge translation event. Potato producers are knowledgeable in research and understand the value of the on-going investment needed to continue to provide growth in the Manitoba potato industry.

### Local research is essential

The benefit of potato production research being conducted in Manitoba was explained by Dr. Alison Nelson who is a Federal Scientist:

"With any crop there's going to be local challenges based on the environment, on the particular soil types we have, the environment and what pests are present in the

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environment. So it's important with any crop, including potatoes, that we do research locally to understand how practices, how management change can impact the crop"<sup>35</sup>.

In Manitoba, producers make investment decisions for their potato crop based on research. Potato research is an innovative domain and one that focuses on tailoring practices and technologies. The outcomes and impacts of agriculture research depend firstly upon disseminating the results of best practices to growers, and the secondly data and support must be provided to implement these changes.

### C) MSP Starch Products Inc.

Economic geography influences industrial growth and the close spatial distribution of the Manitoba potato processors has provided the opportunity for MSP Starch Products Inc. in Carberry to become Canada's only starch processing plant currently in operation. MSP Starch Products Inc. is ideally situated to some of the largest processing plants in Canada that produce a co-product that MSP Starch Products Inc. can isolate food-safe starch from.

Initially, when Earl and Derek McLaren purchased the original MSP Starch Products Inc. it produced non-food grade products. Through the insight of the McLaren brothers they researched processes and utilized contacts from the National Research Centre, the Food Development Centre in Portage la Prairie, and consulting firms that would permit food-grade quality starch to be developed. The factory then switched to high-grade human consumption processing.

The largest market for potato starch is gluten-free foods and the Edmonton based company Kinnikinnick Foods® exclusively utilizes MSP Starch Products Inc. In North America, peanut processors use potato starch in order to have their flavours stick to their dry roasted peanuts. MSP potato starch is also used in the shredded cheese industry to keep the cheese from sticking together or to the bag.

There is a strong relationship between the MSP Starch Products Inc. and the potato processors. President and CEO Earl McLaren shared, "we work with them extensively, even at times going back in and helping them with training of their employees to properly run the starch extraction equipment within their own factories". The dedication MSP Starch Products Inc. has in achieving the high-grade potato starch is evident in the steps the company takes to ensure all levels in the production chain are running optimally in order to produce a high-quality finished product.

As the only potato starch production facility in Canada, President and CEO Earl McLaren has the following perspective regarding their success, "We've had the privilege of being able to stay in our own local community. We are very proud to be able to create jobs in our own community".

In total MSP Starch Products Inc. employs approx. 20 persons from the Carberry and surrounding area. MSP Starch Products Inc. also contributes extensively to community

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investment, volunteering, and fundraising in Carberry, including contributing to sporting teams, art councils, youth dances, the fire department, Ronald McDonald charity, and Cancer Care. The success of rural communities depends upon successful local business, and MSP Starch Products Inc. has positively impacted the citizens of Carberry and increased the economic growth of the Manitoba potato industry.

#### D) The future of Manitoba's potato industry

There have been large investments by Manitoba's two largest processors that will expand the Manitoba potato industry. In early 2018, the J.R. Simplot Company announced it will spend \$460 million to expand their previous plant to more than double the production capability<sup>7</sup>. In late 2018, McCain Foods Limited announced an investment of \$75 million to upgrade the Carberry and Portage la Prairie plant<sup>8</sup>. The expansion by J.R. Simplot will create an additional 90 factory employment opportunities in Portage la Prairie, ensuring that the growth of the Manitoba potato industry will continue.

#### E) Future research to support the growth of industry

A majority of the potatoes for processing in Manitoba are irrigated. Thus, in order for the Manitoba potato industry to expand, irrigation practices must also increase. The majority of irrigation water is sourced from the Assiniboine Delta Aquifer, which is centered around Carberry and extends 3,855 square kilometers<sup>39</sup>. The aquifer experiences large withdrawals for human use. It was estimated in the 1990s, that 11% of water is withdrawn for industrial purposes, 20% for domestic household use, and 69% for crop irrigation<sup>40</sup>. This high usage has led to limits regarding the amount of water that can be sourced from the aquifer for irrigation purposes. Garry Sloik shared, "one of the challenges that we have now is going to be water, limited water, because I know that they're irrigating more and that has pushed the yields"<sup>16</sup>.

To help support the continued growth of Manitoba's potato industry it is recommended that further research be conducted regarding the groundwater capacity of the Assiniboine Delta Aquifer. New technologies will allow for a more precise calculation of the annual recharge capacity of the aquifer based upon current withdrawals. This would allow a sustainable allocation of water for irrigation to be developed.

### Part IV: Conclusion

The thirty-eight year (1980-2018), history of potato research in Manitoba that is described in this impact narrative demonstrates that research funded by Manitoba Agriculture and other sources have contributed to the overall growth of the industry and to the economic strength of the province. It is the partnership of processors, scientists, governmental institutions and producer associations in agriculture that drives the implementation of best practices based on research. The Manitoba potato industry was calculated to be valued at 1.4 billion dollars in 2014, and when the expansions of McCains Food Ltd. and J.R. Simplot are incorporated, the value of the industry will be much higher<sup>2</sup>.



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The commitment the Manitoba potato industry has in rural Manitoba is vital for communities in these locations to be sustained. Research focusing on sustainability and the possibility of increasing irrigation use, will be vital for Manitoba to continue its growth in potato production.

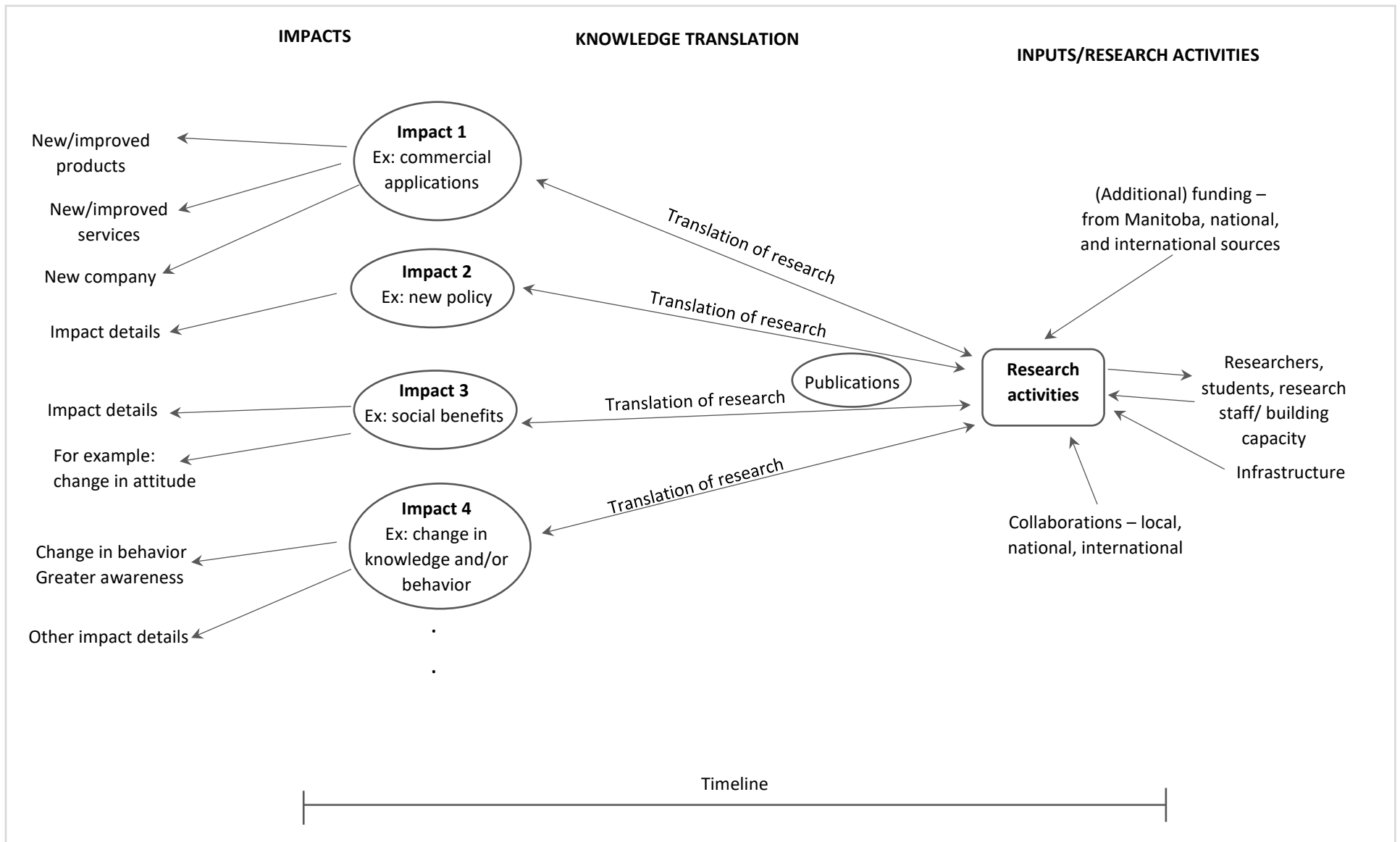
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## Appendix 1. Linking impacts and research



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## Appendix 2. Interview guides.

### Keystone Potato Producers Association (KPPA)

#### Interview Guide

##### Questions about KPPA:

- 1) Could you please describe what the Keystone Potato Producers Association does?
- 2) When was the association first created?
- 3) A) How do you work with McCains and Simplot?  
B) We are trying to contact the 3 main processors, McCains, Simplot Canada and Old Dutch regarding economic numbers such as: employment numbers at the processing plant, how many producers are in contract with each processor.

##### Questions about Manitoba Agriculture Diversification Centre:

- 4) What is the involvement between KPPA and the Diversification Centers?
- 5) A) Please describe the involvement of KPPA in the research conducted at the Diversification Centers?  
B) What are some research projects conducted at the Diversification Centers about potatoes that you have knowledge of?
- 6) To your knowledge what has been the impact of the research conducted at the Diversification Center for Manitoba's potato producers?
- 7) We have come across the names of two projects from the Diversification Centre that are about potatoes: 1) Is from 2016 titled, Potato Seed Age, the effect of operation timing and irrigation on performance of subsequent potato seed; *do you know anything about this project*?
- 8) We have also come across this project from 2017 from the Diversification Centre; unmanned aerial vehicles support for potato yield, variability project, *do you have any information about this project*?
- 9) To your knowledge what has been the impact of the research conducted at the Diversification Center for Manitoba's potato processors?
- 10) Which diversification center do you recommended we interview, and do you have a contact there who would be most knowledgeable and beneficial for us to interview? Do you have any documents about the potato related research conducted at the diversification centers?

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**Interview Guide for Scientists employed by the Federal or Provincial  
Government for Potato Research**

- 1) Can you please describe your educational background and then your current position?
- 2) What has your involvement been in potato research?
- 3) Why is research conducted specifically in Manitoba regarding potatoes of value?
- 4) With your background can you please describe how the region in Manitoba where potatoes are grown is ideal for potato growth?
- 5) From your knowledge what is the most important area of research for potatoes in Manitoba?
- 6) What has been (if past research) or what will the potential impact (if future research) be for growers ideally?

Manitoba Starch Products

General Questions:

- 1) How did you first get involved in the potato industry?
- 2) How did you hear about potato starch?
- 3) From your knowledge how many other starch processing plants are there in North America?
- 4) Can you describe the history of the company since you acquired it and the growth in terms of how many people you employ? Are there any other types of numbers that you can share with us maybe regarding expansion, since we know sales is not something we can publish?

Questions about how starch is produced and utilized?

- 5) Can you describe the journey of one potato that is harvested out of the field and how it becomes the starch that the Manitoba Starch Companies creates?
- 6) What is your biggest market for the starch? What do they do with it?
- 7) For the Manitoba Starch company do you utilize research?
- 8) Have you benefitted from any provincial funding programs? Perhaps at arms-length through the processors (McCains or Simplot utilizing research) which increased yields and benefitted you?
- 9) Are you interested in research?
- 10) What does the future look like for the Manitoba Starch company?

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### **MS-Prebiotic Inc. Interview Guide**

- 1) Can you please tell the history of MS-Prebiotics
- 2) How did you come up with the idea of utilizing the resistant starch from the potato?
- 3) How did you end up collaborating with Dr. Alfa?
- 4) How has your company grown? What type of numbers can you share with us? Employment, geographical reach? Interest from researchers, consumers? A map of distribution?
- 4) How has research affected your company?
- 5) Have you or the investigators sourced funding for research?
- 6) Why do you value research?
- 7) What does the future of MS-Prebiotic look like?

### **Interview Guide for Gaia Consulting**

- 1) When did you first begin to conduct research in potatoes?
- 2) When did you first begin working for Gaia Consulting?
- 3) How long have you been involved in Gaia consulting?
- 4) Looking back on your years of research what were the research projects that contributed to changing and improving the practice of potato producers.
- 5) Do you remember in what years this research occurred in?

*Any idea would provide us the opportunity to look at through the Potato Research Reports?*

- 6) Who were the funders (if necessary, can be vague—Agribusiness, processors or producers) of the research completed by Gaia Consulting throughout the years? Overall who do you think provided the most funds during your involvement? Has this changed? Is there less of a grower/producer initiative in research? Is additional Provincial funding necessary or matching funding?
- 7) Why is it important to conduct research on potatoes in Manitoba versus trying to utilize it from any other region.
- 8) Do you build capacity in research by training and hiring students? If so, how many through the years have you trained and hired?
- 9) How do you disseminate your findings that are public?

### Appendix 3. Key informants.

Category	Name, Current and Previous Titles.
Scientist from the Canada-Manitoba Crop Diversification Centre	Alison Nelson, PhD Currently: Scientist and Agronomist for Agriculture and Agri-Food Canada/Government of Canada Previously: Agronomist for the Canada-Manitoba Crop Diversification Centre (2010-2017)
Scientist from the Manitoba Horticulture Productivity Enhancement Centre	Dale Tomasiewicz, PhD Currently: Irrigation Agronomist for the Canada- Saskatchewan Irrigation Diversification Centre Previously: Manager of the Canada-Manitoba Crop Diversification Centre and the Manitoba Horticulture Productivity Centre (2003-2012)
Keystone Potato Producers Association and long-term research involvement	Garry Sloik Currently: Retired but also works in research at the Canada-Manitoba Crop Diversification Centre. Previously: Government of Manitoba, Department of Agricultural 1974-1978 Managed the Agro-Man research projects from 1980-1984 Potato Producer 1984-2006 Keystone Potato Producers Association 1984-2013
Keystone Potato Producers	Dan Sawatzky Executive Manager of the Keystone Potato Producers 2013-Present Potato producer from 1977
Processor	Morgan van der Zweep, McCain Foods Limited Human Resources Administrator
Processor	Scott Keleman, Old Dutch Foods Inc. Sr. National Director of Marketing and Product Management
Processor	Nicole, Nichole, J.R. Simplot Human Resource Administrator
Manitoba Starch Products	Earl McLaren President and CEO
MSPrebiotics INC.	Derek McLaren President and CEO
University of Manitoba Professor	Fouad Daayf, PhD Professor, Plant Science
Gaia Consulting	Blair Geisel Founder of Gaia Consulting and previous potato producer



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## Appendix 4. Survey distributed to Keystone Potato Producers Association Members.

Please fill out the following questions:

**1) Please check the options that describe you best (you may select more than one)**

A) A Potato Producer ☐

B) An Agronomist ☐

**2) Where do you receive the majority of your information regarding potato research?**

A) Manitoba Potato Production Days (MPPD) ☐

B) Canada-Manitoba Crop Diversification Centre Research Report (CMCDC) ☐

C) Academic Journals ☐

D) Other (please write down the name of the resource or organization)

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**3) How important is it to you to have research regarding potatoes that is conducted in Manitoba instead of other regions?**

A) Important ☐

B) Indifferent ☐

C) Not Important ☐

**4) Do you think that more funding towards research in potatoes in Manitoba is necessary?**

A) Yes ☐

B) No ☐

## Appendix 5: The theory of change for the Manitoba Potato Industry.

