Climate Action Initiative
BC AGRICULTURE & FOOD

SUMMARY

Freshet Flooding & Fraser Valley Agriculture

Evaluating Impacts & Options for Resilience

Acknowledgments

This report was prepared for the Fraser Valley Regional District in partnership with the BC Agriculture & Food Climate Action Initiative

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- City of Abbotsford
- City of Chilliwack
- District of Kent
- BC Agriculture & Food Climate Action Initiative
- British Columbia Ministry of Agriculture
- BC Blueberry Council
- BC Dairy Association
- BC Poultry Association
- BC Landscape and Nursery Association

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Fraser Valley Regional District

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Growing Forward 2

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Introduction

Project Background

In 2014–2015, the Fraser Valley Regional District (FVRD) and the BC Agriculture and Food Climate Action Initiative (CAI) partnered to support the development of a plan for agricultural adaptation to climate change for the Fraser Valley. This planning process brought together local governments and agricultural producers to identify strategies and actions for addressing climate change impacts. Implementation of the Fraser Valley Adaptation Strategies plan (including this project) is now underway and is being overseen by a local working group (see Acknowledgements).

Evaluating the potential impacts and costs to agriculture associated with freshet flooding was identified as a priority in the *Fraser Valley Adaptation Strategies* plan[3]. Given the importance of agriculture and related industries to the Fraser Valley's broader economy, protecting agriculture from flood-related disruption is of high priority to the FVRD. The project area constitutes the agricultural lands of the FVRD in the Fraser River flood plain, mainly concentrated in the municipalities of Abbotsford, Chilliwack, Kent and electoral areas F and G, each with various types and intensities of agriculture.

A project management committee, including representatives of partner organizations, oversaw the project (see Acknowledgements). Additional input on the final report was sought from local government staff with related expertise.

Project Objectives

The project objectives were to:

- Assess the overall economic value of agricultural production in the Fraser Valley with a focus on the areas at risk of flooding.
- Evaluate the potential costs and losses for agriculture and associated businesses under one or more flood scenarios.
- Explore options for mitigating agricultural losses, increasing resilience and speeding recovery in case of a large flood.

This Summary

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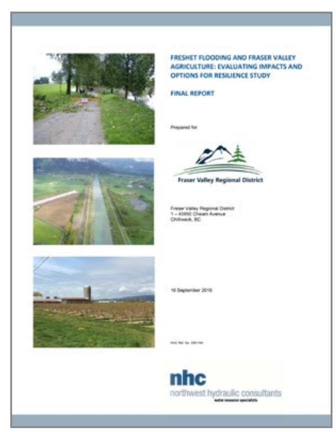

download the full report at

www.bcagclimateaction.ca/regional-project/fv02/

Value of Agricultural Economy in the Fraser Valley Regional District

Overview Information

The FVRD is comprised of six member municipalities (Abbotsford, Chilliwack, Mission, Hope, Kent and Harrison Hot Springs) and eight electoral areas (A to H). The area is an agricultural "powerhouse" within the province of BC. ***The FVRD is home to 2.4% of the total land farmed in BC and 14% of the province's farms, but generates 38% of the provincial gross annual farm receipts.*** It is the most intensively farmed area in Canada.

The FVRD contains 71,675 ha of land in the Agriculture Land Reserve (ALR), which represents 5% of the FVRD's land base. Most of the ALR lands are located in the southern portion of the Regional District, in the fertile valley bottom of the Fraser River. ***Almost 30,000 HA or 42% of the Fraser Valley's ALR lands are vulnerable to freshet flooding.***

FVRD farms produce a diversity of crops and livestock, and the region is the first or second leading producer of many key commodities within the province (Table 1).

As a primary industry, the production of food and other agricultural products provides inputs to other sectors of the economy and is also a consumer of goods and services. The agriculture and agri-food sectors contribute significantly to the Gross Domestic Product (GDP) and employment at both national and provincial levels.

TABLE 1 FVRD production by commodity type and ranking in BC

Commodity/Category	% of BC's Total	Rank in BC
blueberries *(hectare)*	39 %	#2
broccoli *(hectare)*	79 %	#1
brussels sprouts *(hectare)*	95 %	#1
cauliflower *(hectare)*	51 %	#1
dairy cows	60 %	#1
goats	23 %	#1
greenhouse floriculture area *(square mile)*	33 %	#2
greenhouse vegetable area *(square mile)*	27 %	#2
hens and chickens	63 %	#1
mushroom growing area *(square mile)*	42 %	#2
nursery area *(hectare)*	37 %	#1
farms with organic products	13 %	#2
raspberries *(hectare)*	81 %	#1
sod *(hectare)*	45 %	#1
total area in vegetables *(hectare)*	33 %	#2
turkeys	56 %	#1

Agriculture in the FVRD has shown steady real growth in the last 15 years. Between 1996 and 2011, total farm capital tripled from $2.5 to $7.5 billion; total gross farm receipts doubled from $535 million to $1.1 billion; and total wages and salaries paid doubled from $86 million to $173 million. More details of the assessment of the value of the local agricultural economy are provided in the full report and its Annex A.

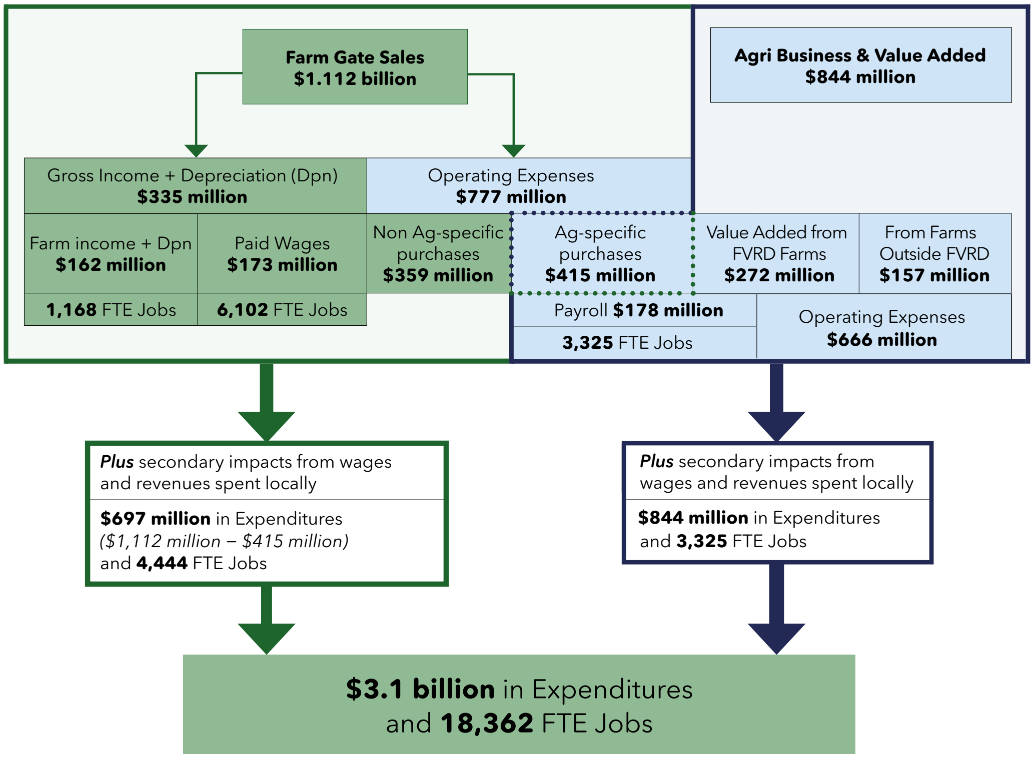

FIGURE 1 The economic impact of agriculture in the FVRD

Source: NHC, 2016. Data from Stats Can 2011 Census of Agriculture

Economic Impact of Agriculture

The impact analysis includes an assessment of the overall economic value of agriculture in the Fraser Valley. Following this broad assessment, estimates were generated for the potential costs and losses for agriculture and associated businesses under one or more flood scenarios (in areas at risk of flooding). The approach adopted for the economic impact assessment was to first evaluate the losses in expenditures on goods and services and the loss in jobs if agricultural production ceased in the FVRD.

Most economic impact studies rely on a survey of the industry for information. With primary agriculture production, Statistics Canada conducts a census every five years that provides reliable information on revenues, employment and operating expenditures in the farming community. This information, along with other types of data, was utilized for the present evaluation. Details about the methodology utilized for the economic impacts analysis are provided in the full report and Annex A.

As shown in Figure 1, Fraser Valley agriculture drives $3.1 billion in annual economic activity and supports 18,000 Full Time Employment (FTE) jobs. Farm-based production in the FVRD supported 11,700 FTE jobs and $1.4 billion in expenditures on goods and services. The agri-industrial and value-added sector provided an additional 3,300 FTE jobs and $1.69 billion in expenditures on goods and services. Farms outside of the region support 18% of the agri-industrial and value-added sector located within the FVRD.

Fraser River Flooding & Flooding Impacts

Flood History & Diking Infrastructure

The Fraser River annual peak flow (i.e., the freshet) typically occurs between mid-May and early July. The magnitude of the peak flow is a function of the snowpack in the basin and the springtime weather, with a large snowpack in combination with sudden warm temperatures and heavy precipitation resulting in high flows.

The two largest freshet floods on record occurred in 1894 and 1948:

- The 1894 flood had an estimated peak flow of 17,000 cubic meters per second at Hope, corresponding roughly to a 500-year flood.
- The 1948 flood had a peak flow of 15,200 cubic meters per second at Hope, corresponding roughly to a 200-year flood.

Other large freshet floods occurred in 1950 (12,600 cubic meters per second), 1972 (13,000 cubic meters per second) and 2012 (11,900 cubic meters per second).

Over time, a network of dikes has been built to various standards to protect FVRD lands from Fraser River flooding. However, widespread flooding could still occur as a result of dike failures. Potential breach mechanisms include bank erosion, seepage and overtopping.

A recent assessment of Lower Mainland dikes for the Ministry of Forests, Lands, and Natural Resource Operations [5] found that a large portion of the dikes along the Fraser River do not meet current standards. The Nicomen Island Dike is one of the most vulnerable dikes in the FVRD.

Although extreme flooding would occur from a dike failure, inundation may also be associated with seepage through a dike. For instance, the City of Abbotsford has mapped seepage flooding areas on the Matsqui Prairie during large freshet events.

Climate Change Impacts on Flood Flows

Climate change has the potential to impact the Fraser River flow regime. Peak river flows are anticipated to occur earlier in the spring and the magnitude and frequency of peak flood flows are expected to increase.[8] The Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO) reviewed potential climate change impacts on Fraser River flood levels.[4] Based on the future flow time-series developed by the Pacific Climate Impacts Consortium, it is estimated that the present design flow, equivalent to the 1894 flood, could increase in the order of 17% under certain moderate greenhouse gas emission scenarios.[7]

In response to more significant increases in greenhouse gas emissions, a flood equivalent to the 1894 flood of record with a present return period of roughly 500-years could have a return period in the order of 50 years at the end of the century. It should be recognized that a great deal of uncertainty surrounds these results.

Although there is a range of sea level rise estimates for BC, MFLNRO recommends adopting a 1 meter sea level rise for the period 2000 to 2100 for planning purposes.[1] Modelling by MFLNRO showed that this increase in the ocean level boundary condition influences flood levels as far upstream as the Sumas River confluence, 15 km upstream of Mission[4], potentially affecting flood levels in Matsqui Prairie and parts of Nicomen Island.

Flood Scenarios

For evaluating economic losses corresponding to severe flooding, three scenarios were considered in the present project, and are listed below. The naming and definition of Scenarios C and D are as previously defined for Fraser Basin Council's Lower Mainland Vulnerability Assessment.[6] Scenario E was selected with input from the Project Management Committee. At the request of local producers, a fourth scenario equivalent to Scenario E, but with only the Matsqui dike breached, was added to the assessment.

- Scenario C — A recurrence of the Fraser River 1894 flood of record (17,000 cubic meters per second at Hope and approximate return period of 500-years). FVRD dikes were assumed to breach.
- Scenario D — A present-day 500-year flood incorporating a 17% flow increase for year 2100 (19,900 cubic meters per second at Hope) and a one meter sea level rise, in consideration of climate change. FVRD dikes were assumed to breach.
- Scenario E — A present-day 100-year flood (14,300 cubic meters per second at Hope), assuming FVRD dikes in "fair" condition or better hold and those in less than "fair" condition fail.[6]

Flood levels for the three scenarios are as modelled by MFLNRO[4] and assume that flows are confined by diking. Maps and more details about the modeling for the flood scenarios — and their sources and limitations — are provided in full report.

Estimated Agricultural Flood Losses

There is much uncertainty around the nature of a future flood event and how it will impact different farms and different production systems. Variables related to the flood event include: the flood duration, the season in which the flood occurs, the flood depths and the area inundated. Variables on the farm production side include: the type of commodity produced, the production system used, the buildings and equipment involved and the topography of the farm site. From an agricultural perspective, the characteristics that influence the severity of flood impacts are extents, depth, duration and velocity.

Based on the typical freshet hydrograph, the analysis assumes a flood that begins on June 1. A flood duration of 14 days has been shown to be the threshold for significant impact on agriculture production, and this project estimates the impact of both short duration (< 14 days) and long duration (≥ 14 days) floods under each scenario. Commodities more commonly produced in the FVRD were grouped into "commodity groups" for the purpose of this analysis. Significantly more detail about the underlying approach and methodology for this analysis, along with estimated losses differentiated by commodity and land cover are provided in the full report.

Results

Agricultural Flood Losses by Flood Scenario

Table 2 summarizes the total cost to farmers and the cost per hectare flooded for the flood scenarios with different flood durations.

Agricultural Flood Losses by Local Government Area

Table 3 (following page) summarizes the farmer costs by local government area.

In all cases, a long-duration flood more than doubles the cost to farmers compared to a short duration flood. This is primarily driven by the impact on perennials and the extended disruption to lactating cows.

TABLE 2 Flood losses for the flood scenarios under different durations

Flood Scenario	Hectares Flooded	Short-Duration Flood		Long-Duration Flood	
		Total Farmer Cost	Farmer Cost per Hectare	Total Farmer Cost	Farmer Cost per Hectare
Scenario C	29,029 ha	$ 365,000,000	$ 13,000 / ha	$821,000,000	$ 28,000 / ha
Scenario D	29,481 ha	$ 372,000,000	$ 13,000 / ha	$833,000,000	$ 28,000 / ha
Scenario E	11,977 ha	$ 112,000,000	$ 9,000 / ha	$269,000,000	$ 23,000 / ha
Scenario E (Matsqui Breach alone)	3,486 ha			$120,000,000	$ 93,000 / ha

TABLE 3 Flood losses for the flood scenarios under different durations by local government area, shown as farmer costs

Community	Scenario C		Scenario D		Scenario E		Scenario E (Matsqui Breach alone)
	Short	Long	Short	Long	Short	Long	Long
Abbotsford	$149,150,000	$282,860,000	$149,780,000	$284,020,000	$1,460,000	$6,170,000	$119,760,000
Chilliwack	$147,080,000	$348,330,000	$151,550,000	$363,300,000	$57,680,000	$126,170,000	
Hope	$390,000	$420,000	$460,000	$490,000	$320,000	$350,000	
Kent	$22,130,000	$81,960,000	$23,060,000	$83,520,000	$7,640,000	$51,260,000	
Mission	$1,190,000	$1,420,000	$1,210,000	$1,470,000	$0,870,000	$0,920,000	
Elec. Area	$45,210,000	$106,380,000	$45,480,000	$106,930,000	$43,930,000	$84,500,000	
Total FVRD	***$365,170,000***	***$821,370,000***	***$371,550,000***	***$832,740,000***	***$111,900,000***	***$269,370,000***	***$119,760,000***

TABLE 4 Economic impact of agricultural flood losses to the community

Flood Scenario	Short-Duration Flood			Long-Duration Flood		
	Farm Sales Lost	Secondary Benefits Lost	*Total Economic Impact*	Farm Sales Lost	Secondary Benefits Lost	*Total Economic Impact*
Scenario C	$132,000,000	$132,000,000	***$264,000,000***	$574,000,000	$574,000,000	***$1,148,000,000***
Scenario D	$133,000,000	$133,000,000	***$266,000,000***	$580,000,000	$580,000,000	***$1,160,000,000***
Scenario E	$30,000,000	$30,000,000	***$60,000,000***	$183,000,000	$183,000,000	***$368,000,000***
Scenario E (Matsqui Breach alone)				$93,000,000	$93,000,000	***$186,000,000***

A Matsqui Dike breach is assumed to result in a long duration flood. A flood in Matsqui Prairie was found to have a higher cost per hectare than other scenarios. This is a result of the higher proportion of perennials, particularly blueberries, and other intensive crops in the area compared to other locations.

Different parts of the agri-industrial sector would be impacted in different ways. Those in the packaging and value added sector would lose the portion of their business that relied on crops from the flooded area. Agri-industrial businesses that provide inputs to production would experience an increase in business because farms would be replanting and rebuilding damaged infrastructure.

Economic Impact of Agricultural Flood Losses on the Community

When farmers lose farm receipts, the community loses the economic benefit that those revenues create. The estimated economic impact (associated with agricultural flood losses) in the community from the different flood scenarios is summarized in Table 4.

In the worst-case scenario (Scenario D) of the 1 in 500-year flood with climate change considered, a long-duration flood would result in an economic impact of $1.1 billion on FVRD communities. This would be in addition to significant non-agriculture related losses.

Summary

A major flood event, similar to the flood in 1894, would cause over $800 million in damage to farmers' crops, buildings and equipment. The overall economic impact of agricultural flood losses to FVRD communities would be $1.1 billion.

- Because agriculture production per hectare in the FVRD is two to three times higher than in other areas, the estimate of farmer losses in this assessment is higher than the losses reported in earlier studies.[2]

- Estimates of the impacts of a potential flood tend to be higher than actual post-flood analysis because:

  - → Estimates of flood damage assume that floodwaters flow unimpeded to the full extent of the flooded area. During a flood event, internal infrastructure and uneven topography will result in patchy inundation. As a result, different farms will be affected differently in terms of flood duration and flood depth.

  - → Farmers will make every effort to mitigate losses. The estimates also do not consider insurance payments or government support payments to cover farm damages.

- The impact of climate change on flood extents is small in the FVRD due to its topography. For the 500-year flood scenario, climate change only increased the flood extent by 2% and the farmer costs by 1% (assuming no inflation).

- Climate change has a greater effect on flood depths, but this does not have a significant impact on production losses; it may have a small effect on building losses.

- Whereas the economic impact from a single flood event is assessed here, climate change is expected to increase the frequency of flooding, bringing additional losses over time. Also, peak river flows associated with the freshet are anticipated to occur earlier in the spring. While an earlier freshet flood would change the impact on some commodity groups, the net impact on the estimate of losses is expected to be small.

Conclusions & Key Opportunities for Improvement

Conclusions

Based on the work completed, the following main conclusions are drawn:

- The total economic impact of agriculture in the FVRD exceeds 3 billion in expenditures and over 18,000 FTE jobs.
- Forty percent (40%) of lands within the Agricultural Land Reserve are vulnerable to flooding.
- Fraser River dikes do not presently meet provincial standards, and climate change impacts are likely to increase flood hazards.
- Agricultural flood losses are primarily a function of seasonality, flood duration and commodity type.
- A number of broad regional, agricultural sector and farm level flood mitigation measures are in place but currently do not provide adequate protection.
- There is no single solution to increasing flood resiliency in the Fraser Valley; rather, a number of measures will need to be introduced over time.

Key Opportunities: Flood Mitigation & Resilience

An extensive discussion of current flood mitigation, as well as opportunities for improvement, is provided in the *full report*. This discussion includes: multi-partner measures, sector-level measures and farm-level measures and also provides a comparative evaluation of the range of potential measures. The key opportunities to improve flooding mitigation and resilience are highlighted here. (Following this section are key opportunities to improve flood recovery.)

Multi-Partner Opportunities

- Implement upgrades to critical dikes, including their erosion protection, to present standards.
- Support the dike patrol measures implemented by local governments as developed by the Province. Ensure that trained staff is available for dike inspections in the future, or standing agreements are in place as needed.

- Maintain and update the (MFLNRO) Fraser River hydraulic model as a key tool for simulating the design profile and forecasting flood levels.

- Maintain and expand the (MFLNRO) flood level forecasting system by continuing to read staff gauges during freshet periods and facilitating the installation of additional gauges (preferably continuous reporting gauges).

- Undertake modeling of the FVRD river reach in 2D (to refine the design flood profile for the north and south river banks) as there are significant flood level variations between the two banks.

- Develop a program to monitor changes to river morphology and/or the riverine ecosystem that may result from sediment removals.

- Develop detailed, up to date, floodplain maps for FVRD to more accurately define flood hazards.

- Address less extreme flooding — such as seepage — through installation of groundwater relief wells (where suitable).

- Evaluate benefits and limitations of opening up sloughs and side channels that were blocked off in the past (for improvement of flow conveyance/ co-benefit of improved fish habitat).

- Continue to participate in the Fraser Basin Council's initiative to develop a flood management strategy for the Lower Mainland.

- Encourage and support flood resilient design and construction for agricultural buildings including:

    → Minimizing low-level windows, installing heat and electrical equipment on upper floors, using impervious cladding, using flood resistant insulation, etc.

    → Availability of incentives would likely increase adoption of flood resilient construction.

Agriculture Sector Level Opportunities

- Coordinate workshops to present the current and future flood risks (to improve knowledge of impacts and obtain buy-in for action).

- Identify trigger levels for relocation in various sub-areas of the Fraser Valley

- Prepare proactive strategies for larger commodity groups that do not currently have specific emergency plans (e.g., blueberries, greenhouses).

- Develop collective livestock relocation plans and conduct periodic rehearsals or exercises with producers in rotating areas. Include steps such as:

    → Develop letters of agreement/memorandums of understanding with potential suppliers and facilities (for moving and housing livestock).

    → Survey the region to identify safe shelters for farm animals or storage facilities for agricultural products.

    → Revisit agreements/resources on a semi-regular basis to ensure they are up to date (and usefulness is maintained).

    → Identify any key measures out of Nicomen Island plan (particularly when other plans are completed) to identify high priority needs

Farm-Level Opportunities

- Develop a concise pamphlet for FVRD producers regarding flood hazards preparation, evacuation, recovery from a flood and financial options.

- Refine materials from Delta farm-level flooding preparedness and mitigation guidebook (to improve Fraser Valley relevance). Undertake information sessions to promote this and other resources.

- Develop a specific fact sheet (and possibly cost-share incentives) for actions to reduce potential for agricultural pollution in the case of a flood event.

Key Opportunities: Flood Recovery

Flood recovery refers to the actions taken to restore and rebuild impacted areas. Recovery is generally divided into short-term and long-term actions. In the context of the agricultural sector, recovery can be divided into immediate actions taken to recover from a disaster and long-term actions to restart business operations. An extensive discussion of current and potential flood recovery measures is provided in the ***full report***. The key opportunities to improve flood recovery capacity are highlighted here.

Disaster Recovery Opportunities

- Implement drainage improvements and maintenance such as:
  - → Undertaking laser leveling or installing tile drains on farm fields in advance of a flood.
  - → Maintaining both on-farm and municipal ditches (to promote faster flood recovery).
  - → Clarifying and communicating recent changes to the Fisheries Act that alter (some) restrictions on farmers' ability to maintain drainage ditches.
- Develop an efficient means (ahead of flooding) for farmers to report on flood damage sustained to their properties (e.g., Flood Damage Report On-line Submission tool).
- Create a local restoration and repair program that is positioned to respond following a flooding event (an organized response to: restoring agricultural drainage, cleaning drainage ditches, removing sand and debris from fields, repairing fences and — primarily — supplying technical assistance post-flood).
- Consider establishment of program for flooding easements.
- Develop a pumping program to ensure pipes and high capacity pumps are available to assist with drainage (identify equipment availability and offer technical assistance for proper operation).

Business Continuity Opportunities

- Ensure agreements with truck/equipment suppliers for livestock relocation also covers the return of animals and products to the home farm.
- Create advance arrangements (with Ministry of Transportation) to ensure that agricultural products can be moved through road repair areas to get to market.
- Initiate a program to support producers to proactively plan to prevent potential pollution in the event of a flood.
- Develop clear plans for (post-flood) supports for agricultural operations with ensuring equipment and water supplies are clean:
  - → Organized process for response, cleanup and information dissemination in the case of contamination related to release of agricultural chemicals.
  - → Provision of free well-water testing for a period following a flood.
  - → Ensure that inspectors are available to producers (in a timely fashion) to ensure that contaminants haven't negatively impacted food safety/organic certification.
- Establish a "Farming Recovery Fund" to provide both technical services and incentives for producers to rebuild more resilient operations (possibly re-siting to less vulnerable locations, increasing building elevations, flood resilient exterior finishes, etc).
- Model post-flood financial support programs on those offered by Alberta in 2013 (Flood Recovery Loan Guarantee Program and Flood Recovery Interest Rebate Program).

Publications Referenced

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