CLIMATE CHANGE
ADAPTATION PROGRAM

Climate Change Adaptation and On-Farm Drainage Management in Delta, British Columbia

Current Knowledge and Practices

Report Summary

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SUMMARY

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Current Knowledge & Practices

The lower Fraser River delta of British Columbia is one of the most agriculturally productive regions in the province — yet farmers in this area are challenged with conditions of poor soil drainage and salinization that adversely impact their operations.

Climate change projections include increased intensity of rainfall and variability in weather patterns. Improved drainage conditions are necessary to maintain or improve the production capability of the area in the future.

To better understand the state of existing knowledge and the potential needs for further drainage and subirrigation work on farmland in Delta, a team of researchers from the University of British Columbia were contracted by the Delta Farmers' Institute to:

- compile a comprehensive review of past drainage and sub-irrigation studies in Delta;
- review drainage and sub-irrigation research from other regions that could provide insight for alternative management options in Delta;
- assess how farmers across production and soil types in Delta are currently coping with drainage related problems; and
- gauge the need for, and interest in, further research to address associated challenges.

Literature review & methodology

An extensive literature review was conducted to document information that has already been generated on these issues. Grey literature, including provincial and national reports and scientific literature — focused on Delta — was reviewed. All literature (276 documents) was categorized and saved in a publically available online organization system (*www.mendeley.com*).[1]

The literature review revealed that since the 1980s substantial research has been conducted in the Delta region on topics that include: water table management, sustainable soil management through cover cropping, and soil reclamation (Table 1, next page). Additional literature reviewed from other parts of Canada, as well as the United States and Europe, indicated that similar challenges are being addressed in other areas.

In-person interviews were conducted with vegetable, berry, and forage farmers throughout Delta, to evaluate: management practices currently employed, and perceptions of their effectiveness; which regions within Delta continue to have drainage and salinity problems; and areas of research farmers felt were valuable for moving forward to alleviate drainage and salinity problems. To evaluate regional differences Delta was divided into five sub-regions of interest: Westham Island, Crescent Slough, Ladner South / Brunswick Point, Ladner East / Boundary Bay Airport, and East Delta.

Survey results

A total of 17 farmers participated in the interview process between November 2014 and January 2015. In total 45% of farmable land in Delta was captured by the survey; regional coverage of the interviews is summarized in Figure 1 (next page). Participants were often found to farm land in more than one sub-region of Delta. The majority of participants farmed total areas ranging from 200 to 400 hectares (500 to 1000 acres) in size. Rented farmland comprised 59% of the surveyed area and owned farmland comprised the remaining 41%. The types of production were: 47% mixed vegetables (potato, fresh/processing peas and

TABLE 1 Summary of literature review findings from Delta, BC.

Select research and resource materials	Citation
Water Table Control	
Field trials to design effective drainage and subirrigation systems to increase number of workable days	Prasher (1982); Chieng et al. (1987)
Use of modelling programs (e.g., DRAINMOD) to simulate drainage and subirrigation conditions under different water regimes	Argawal (1985); Chao (1987); Gao (1990); Richard (1988)
Cost benefit analysis for fixed and variable costs of installing and operating drainage and subirrigation systems	Driehuyzen (1985)
Extension materials developed from original research which directly or indirectly provide information on drainage problems and appropriate solutions	Lalonde & Hughes-Games (1997a); BC Ministry of Agriculture and Food (1988a and b); BC Ministry of Agriculture, Food and Fisheries (BC Drainage and Drainage Management Factsheets; BC Constructed Ditch Factsheets; BC Riparian Factsheets)
Soil Structure and Drainage	
Evaluation of cover cropping techniques to maintain soil organic matter and improve soil physical properties for water retention	Bomke et al. (1996); Hermawan (1995); Liu et al. (2005,1995); Krzic et al. (2000); Odhiambo et al. (2007); Issa Ismail (1994)
Evaluation of alternative cover crops (e.g., leaf compost, municipal biosolids) to amend soils and improve various soil properties	Bomke et al. (1995); Temple & Bomke (1990).
Reclamation of degraded land using combination treatments of subsurface tile drains, land levelling, winter cover cropping in combination with cash cropping, and set-aside with forage	Bomke (1992)

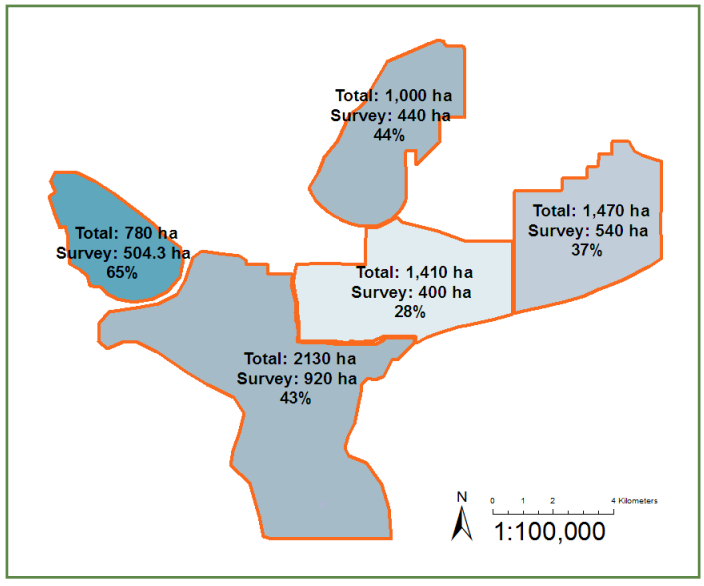


FIGURE 1 Total farm area captured in each sub-region through participant interviews as reported by participants on field maps.

beans, sweet corn, pumpkin, squash, cabbage, turnip, beet, parsnip), 29% forage (hay, grain, corn), 12% berries (strawberry, blueberry, raspberry, blackberry, cranberry), and 12% an even mix of forage, vegetable, and berry production.

The majority of farmers experience flooding and salinity problems in their fields. Drainage was reported as a concern for 76% of farmers interviewed, and only 24% responded that drainage was either manageable or not a concern. A higher incidence of drainage issues in Ladner South / Brunswick Point may be the result of naturally higher clay content — which can cause massive soil structure with poor drainage capacity

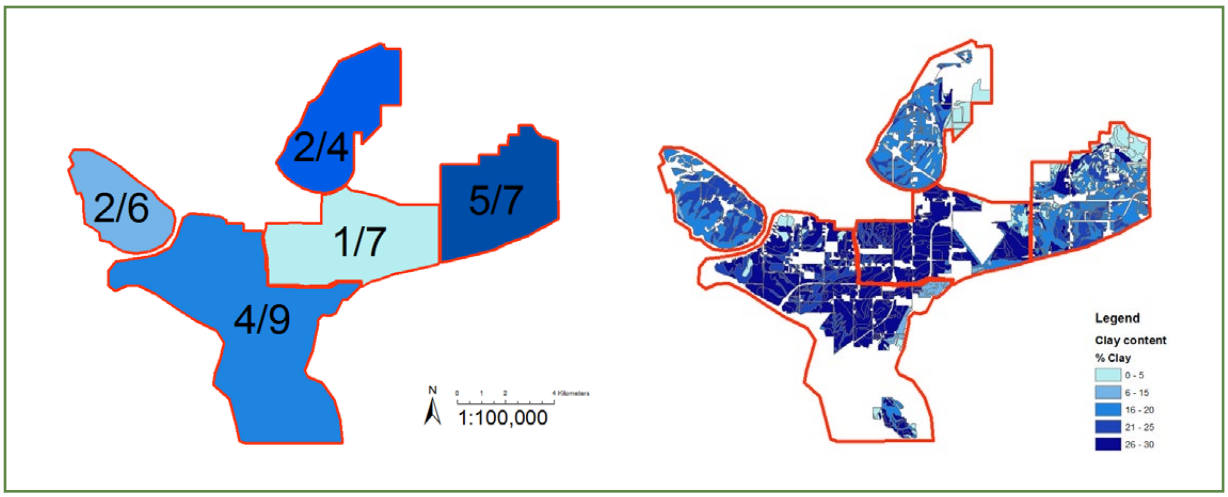


FIGURE 2 Occurrence of drainage problems reported by farmers (at left, sample size of 17) and soil clay content (at right). For each region, drainage problems are reported out of the number of farmers interviewed that farm fields in that region.

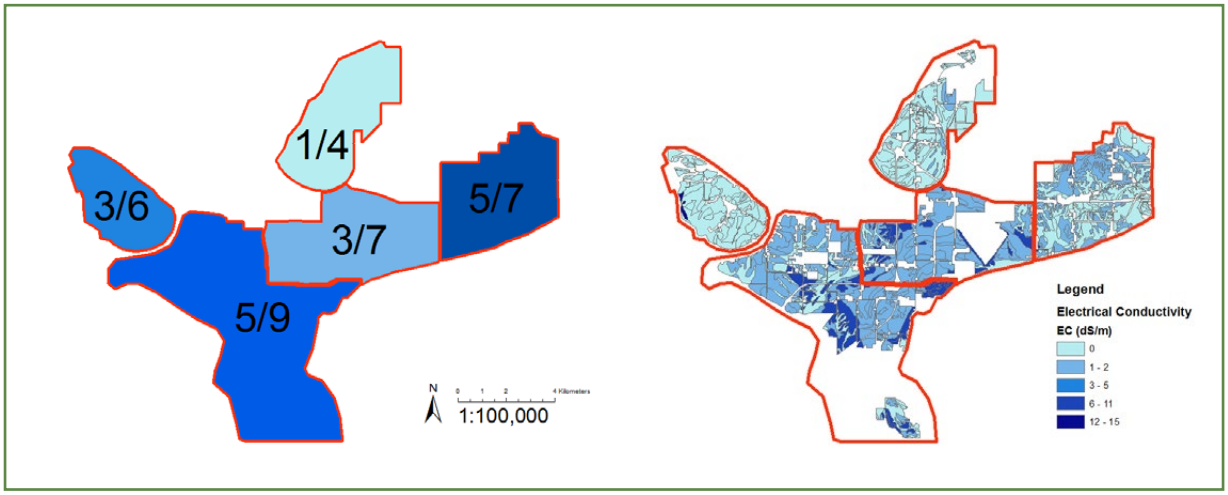


FIGURE 3 Occurrence of salinity on farmland reported by farmers (at left , sample size of 17) and digital soil survey map (at right, as reported by electrical conductivity). For each region, salinity problems are reported out of the number of farmers interviewed that farm fields in that region.

(Figure 2) — in these soils relative to other sub-regions in Delta. In East Delta, farmers reported that drainage problems were due to low-lying fields.

The majority (76%) of farmers interviewed also identified salinity as a problem, but not necessarily the same farmers that were having issues with drainage. Higher incidence of soil salinity in Ladner South / Brunswick Point corresponds to the high salinity values previously mapped in the soil of that region (Figure 3). Farmers in East Delta reported salt in ditches that they use for irrigation as a major concern.

Issues of drainage and salinity are prominent at different times in the production season; the fall-winter period for drainage and the spring-summer period for salinity. In some circumstances, the combined impact of flooding and salinization on the arable soils and irrigation water in Delta influence the productive capacity of the land and crop health. Farmers identified the low-lying nature of Delta as the dominant (41%) reason for continued drainage issues. Other reasons farmers identified were: ineffective farm drainage systems (24%), an ineffective municipal drainage system (6%), and proximity of their fields to the Fraser River (6%).

To mitigate drainage problems farmers described using a variety of management tools. Less permanent measures used by farmers included mole drains, shallow surface drains, and subsoiling, while more permanent measures employed included drainage tiles, laser levelling, and open ditches. Less permanent measures are those that need to be renewed almost annually to be effective, while more permanent measures are designed to be effective for more than five years. Past measures are those that a farmer no longer uses in their farming operation, but has used at an earlier time in their practice. Current measures are those that the farmer uses for regular operations today. Some of these strategies are designed to manage water at the soil surface while others change the flow of subsurface water. The use of these practices has changed over time (Figure 4; Figure 5). The majority of farmers interviewed stated that they now use a combination of these approaches.

Mole drains were tried by some participants before the 1960s, but today they are mainly used experimentally or opportunistically today to complement other drainage management practices. Installation methods for mole drains using 10 to 13 cm (4 to 5 inches) diameter torpedoes in the fall, at a depth range of 50 to 80 cm (20 to 54 inches) anywhere from 8 to 18 metres (25 to 60 feet) apart. Almost all participants reported that they have stopped using mole drains, because they tended to collapse, become plugged by rodents, or removed too much soil from the fields to ditches.

Shallow surface drains were reported to be commonly used by farmers, but over a much smaller field area than in the past. Farmers reported using shallow drains at depths ranging from 20 to 90 cm (8 to 36 inches) either in the spring or fall. Farmers reported that the need for surface drains has been reduced by the practice of laser levelling. Other reasons for discontinuing the practice of surface drains include labour requirements and field soil loss into ditches.

The practice of subsoiling has been performed in Delta for two to three generations. Of the farmers who reported subsoiling, 64% performed their subsoiling in the fall, 21% in the spring and fall both, 7% in the spring only, and 7% did not specify the time of year they subsoiled. Subsoiling was reported to range from 40 to 60 cm (16 to 24 inches) deep (to break up the plow pan) and 50 to 60 cm (18 to 24 inches) apart.

Permanent subsurface drainage measures, specifically drainage tiles to manage the water table level, have been used in Delta for decades. Initially — between

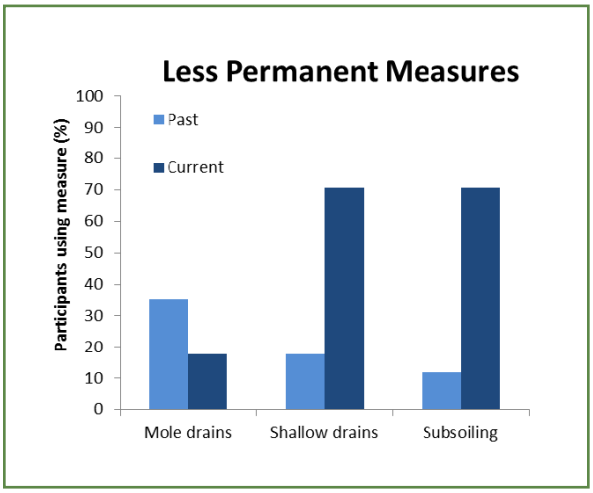


FIGURE 4 Less permanent measures that were practiced in the past or are currently practiced by farmers (sample size = 17).

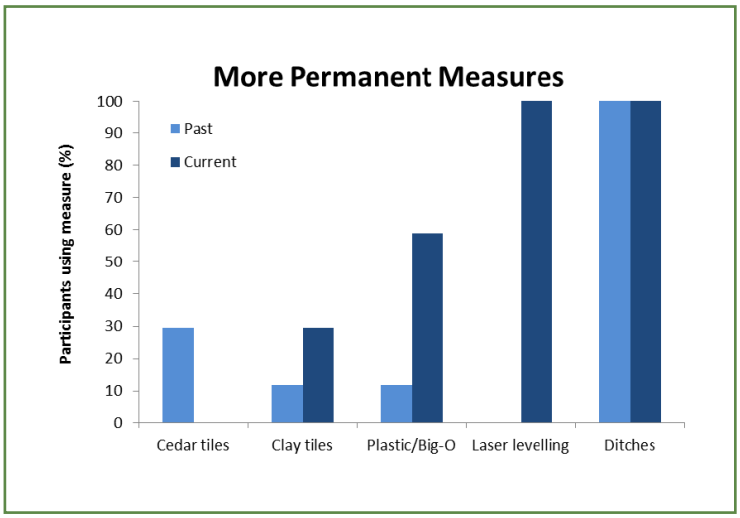


FIGURE 5 More permanent measures that were practiced in the past or are currently practiced by farmers (sample size = 17).

the 1950s and 1970s — clay tiles were installed and these were reported to have been effective, and in some cases still remain effective today. Installation depths have ranged anywhere from 60 to 120 cm (24 to 48 inches) deep, and the spacing ranged from 9 to 18 metres (30 to 60 feet) apart. Generally, their performance was reported to be longer lasting than the newer, and more prevalent, plastic tiles. Plastic tiles (also known as Big-O) installed between the 1970s and the present day, were reported as being used by 59% of participants. Installation depths ranged anywhere from 20 to 120 cm (9 to 48 inches) deep, and the spacing ranged from 5 to 23 metres (15 to 75 feet) apart. Spacing of 13 metres (42 feet) has been identified as optimal for the soil conditions in Delta.[2]

Of the farmers who have used or are using tile drains, 50% adopted a spacing below 13 metres (42 feet), 42% above 13 metres (42 feet), and spacing was unknown for 8% of the systems. While plastic tile drains are a common current practice, 51% of the users indicated having observed diminishing performance of the Big-O within one to five years of installation. Overall, it was reported that the plastic tile did not work as well as clay tile, particularly if not regularly maintained. Further, the high cost of installation was a major deterrent from using this practice on all fields. Nevertheless, the main reasons farmers have moved away from past drainage systems are that they are too labour intensive, no longer effective, or newer, more efficient, and affordable technologies have become available.

Laser levelling, for instance, is reported as one of the most common and well-received drainage management practices in Delta. The reasons for adoption include: demonstrated effectiveness by a farmer in the community, available levelling equipment in the region, and the fact that the activity is subsidized by Delta Farmland & Wildlife Trust (DF&WT). Many farmers reported that they started laser levelling 25 to 30 years ago and have been doing several fields per year since that time. Participants indicated that fields need to be redone every 10 to 20 years to maintain levelled field conditions. Many of the original fields were crowned, but practices have moved toward mainly flat or naturally sloped laser levelling.

Surface ditches were largely established prior to the purchase of land, though some farmers have installed private ditches to improve water movement or access on farms. Farmers made it clear that ditches are the backbone of the drainage and irrigation infrastructure in Delta, and need to be maintained to enable the best overall drainage performance by all other systems. Municipal ditches are reported to be on a five-year cleaning rotation[3] while private ditches were reported as being cleaned by excavator every one to seven years.

To better manage on-farm drainage, 18% of farmers have established closed (controlled) drainage systems on their farms. However, most farmers (65%) have open (uncontrolled) systems and 18% have a combination of fields that have closed or open systems. To manage the movement of water for either drainage or irrigation purposes 47% of participants have one-way stationary pumps, 35% have pumps to manage their water movement, 12% use portable pumps, and 6% have two-way pumps. Of the farmers interviewed, 94% currently practice cover cropping; several of the reasons farmers provided for cover cropping have direct and indirect benefits to on-farm water management.

Key findings

From this research, it is clear that Delta farmers recognize that flooding and excess soil moisture are negatively impacting productivity but struggle to find a clear solution to remediate these problems. Similarly, farmers are having difficulties with salinity in spite of their management efforts, and questions remain about how best to remove excess salt from both the soil and open ditch irrigation water in a cost effective way.

Results of this study have shown that financially supported practices such as laser levelling, cover crops, and set-asides, as well as proven techniques such as subsoiling are the most commonly applied drainage management strategies in Delta. It is clear that there are substantial hurdles for the adoption of other promising drainage management practices such as subsurface drainage tiles. These hurdles include installation and maintenance costs, and concerns

about investing in lands without secure tenure. Results also show that — in addition to drainage — some farmers are attempting to mitigate the effects of changing weather patterns by: growing alternate crops that are less weather sensitive, increasing planting and harvesting capabilities, and/or accepting a loss of production once every few years.

The results of the literature review and interviews highlight areas of priority and need including: addressing gaps in available information and outreach regarding drainage and flood management options, strengthening approaches to regional drainage/flood management and improving communication and information sharing among farmers as well as between farmers and the municipality. To address the concerns highlighted in the literature review and interviews, future research should include an evaluation of the effectiveness of tile drainage (and enhanced spacing) to accommodate increased precipitation intensity and a cost benefit analysis across the variable farming landscape in Delta. This assessment would significantly supplement research done in the past and could then be used to update and enhance existing drainage and soil salinity management resources.

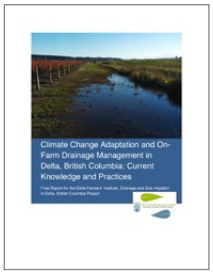
Additionally, it is clear from this study that providing information is likely not enough to ensure the adoption of the more costly practices that may enable farmers to adapt to future climate related challenges in Delta. Given the positive response reported by the farmers to cost share initiatives provided by the DF&WT and the Environmental Farm Plan, incentive programs for the adoption of appropriate drainage and soil salinity management practices — particularly in the context of short-term land tenure — are likely to contribute to adaptation efforts in the future.

Endnotes

1 To access the full set of documents reviewed, please visit *www.mendeley.com* where you will be required to create an account. Once prompted to search, please enter: "Delta BC Drainage and sub-irrigation" to locate the documents.

2 Lalonde, V. & Hughes-Games, G., 1997. BC Agricultural Drainage Manual.

3 Personal communication, Angela Danyluk, Corporation of Delta, December 18, 2014.



download the full report at

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