

'Resilient Farms' for Southern Vancouver Island

A Resource Guide for Farm Water Management in a Changing Climate



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Hatchet & Seed



Hatchet & Seed



Making a difference...together

I. About this Resource Guide

This Resource Guide has been compiled by [Hatchet & Seed](#) as part of the project: “**Keyline Water Management: Field Research & Education in the Capital Region.**”

More about the project which ran from 2015-2017, including a project overview and the results of our keyline plow monitored field trials, can be found at the project website www.crkeyline.ca.

II. Acknowledgements

This resource guide would not have been initiated without the help received for the above mentioned project from our funders, project partners, advisors, host farms and farmers, as well as all of the participants who shared their farming insights at seminars & field days.

Funders

Funding for that project has been provided by the Governments of British Columbia and Canada through the Investment Agriculture Foundation of BC under *Growing Forward 2*, a federal-provincial-territorial initiative. The program is delivered by the BC Agriculture & Food Climate Action Initiative. The Capital Regional District (CRD) Integrated Watershed Management Division also contributed funds for water management seminars on the Gulf Islands as well as event space in the CRD Boardroom.

Project Partners

CRD Integrated Watershed Management
BC Agriculture & Food Climate Action Initiative
Peninsula Streams

Advisors & Special Recognition

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III. Disclaimer

Opinions expressed in this document are those of the author and not necessarily those of the funders, project partners and advisors of the associated project, “Keyline Water Management: Field research & Education in the Capital Region.”

IV. Using this Resource Guide & the Reagrarians Platform®

This resource guide is designed as a starting point for solving issues related to farm water management. The intention is to use the theme-based FAQ format to organize online resources that can be used to help answer your questions related to water management. Not intended as a definitive guide, it hopes to leverage the work other organizations, resource people and publications to point you in the right direction in your search for solutions to climate adaptation.

Because we are using the Reagrarians Platform® (see below) as an organizing tool, we have also included resources for non-water management related topics, like resilient Buildings, Fencing, Energy & Economy. While outside the scope of this project, we wanted to share some useful resources on these topics in the context building a resilient *whole* farm.

If you have a question that relates to resilient farm development that you do not find here, please email it to taylor@hatchetnseed.ca. Similarly, if you have further resources or solutions to contribute, [please email them as well](#). Updates can and will be made.

The scope of this guide is limited to the rain shadow climate of Southern Vancouver Island, Canada, however we do hope it can be helpful elsewhere as well. For more on this climate, see section 1.1.

The Reagrarians Platform®

The [Reagrarians Platform®](#) has been developed by Darren J. Doherty of Reagrarians Ltd. It is a built off the work of P.A. Yeoman’s ‘Keyline Scale of Permanence’.

Here are several resources on the Keyline Scale of Permanence and how it is being used a land planning tool:

- [Reagrarians Platform®](#) - Darren J. Doherty
 - [Using the Keyline Scale of Permanence as a Tool for Land Evaluation](#) - Steve Gabriel, Cornell Small Farms
 - [Planning for Permanence with Yeoman’s Keyline Scale](#) - Owen Hablutzel, PRI Australia
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V. Resilient & Regenerative Agriculture Defined

Resilience is defined as “the capacity to recover quickly from difficulties; toughness”.

As we look ahead to the prospect of producing food in the next century and beyond, it is important to consider how we can make our farms more resilient in the face of changing weather patterns. How can we maintain productivity through these climatic challenges?

Potential challenges for agriculture in BC include: increased coastal flooding; increased river/valley/surface flooding; drought; water supply shortages, salinization; fire; nutrient leaching, pest & disease outbreaks, energy input costs & market shocks.

For the purpose of this resource guide, we define ‘resilient agriculture’ as a production system that is capable of both mitigating and adapting to the challenges above.

The following is a list of organizations working on these issues in BC:

- [BC Agriculture & Food Climate Action Initiative](#)
- [Kwantlan Polytechnic University Sustainable Agriculture and Food Systems programs: UBC Faculty of Land & Food](#)
- [BC Agriculture Council](#)
- [BC Ministry of Agriculture](#)

Regenerative Agriculture

‘Regenerative Agriculture’ is another term being used to describe agricultural production that enhances bio-diversity and soil health. These practises are inherently more resilient. There are several producer groups and research/policy institutes involved in defining and creating standards for ‘Regenerative Agriculture’. The following are some:

- The Rodale Institute is working to create a ‘*Regenerative Organic Certification*’: <https://rodaleinstitute.org/regenerativeorganic/>. The three pillars below represent a good start toward defining the term.
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Regenerative Organic Certificate Goals:

- Increase soil organic matter over time, and sequester carbon in the soil
- Improve animal welfare
- Provide economic stability and fairness for farmers, ranchers, and workers
- Create resilient regional ecosystems and communities

Three Pillars:



Soil Health*

- No/low Tillage
- Cover Crops
- Crop Rotations
- Rotational Grazing
- No Synthetic Inputs
- No GMOs or Gene Editing
- Promotes Biodiversity
- Builds Soil Organic Matter
- No Soilless Systems

* Leverages USDA Organic, Biodynamic, etc.

Social Fairness*

- Living Wages
- No Child Labor
- No Forced Labor
- Maximum Working Hours
- Fair Pricing for Buyers/Farmers
- Long-Term Commitments

* Leverages AJP, Fair Trade, FFL, SPP, etc.

Animal Welfare*

- Five Freedoms
- Grass-Fed / Pasture-Raised
- No CAFOs
- Suitable Shelter
- Minimize Transport Distances

* Leverages GAP 4+, AWA, Cert. Humane, etc.

Other organizations are working to define and standardize the movement:

- [Terra Genesis International](#)
- [Regeneration International](#)
- [Regrarians.org](#)

For the purpose of this Resource Guide, we are focusing on farm strategies and techniques that work to achieve several of the following goals:

- Increasing organic matter % in soil to act as a water & nutrient sponge and sequester carbon in the soil
 - Add perennial, aboveground biomass to the farm landscape in the form of multi-functional trees, shelter-belts and shade trees
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- Foster a healthy, diverse and active soil food web for nutrient & water cycling and disease prevention
- Improved infiltration for effective groundwater recharge
- Responsible aquifer or groundwater management
- Balancing drainage with water retention structures
- Increased surface water storage for use in irrigation

VI. Defining Personal & Farm Context as a Foundation for Decision-Making

While outside the scope of this guide, we cannot over-emphasize importance of defining your personal and farm 'context'. Resilient *farms* need resilient *farmers*, who are capable of making tough decisions while balancing complex and sometimes conflicting interests.

Pioneering work has been done on this exercise (creating a Holistic Context) by Alan Savory, Holistic Management International & the Savory Institute.

- <https://holisticmanagement.org/>
- <https://www.savory.global/>

There have since been others influenced by the concept of creating a 'Holistic Context' and have shared tools & services to help others. Some can be found here:

- [Very Edible Gardens - Step by Step Process Blog](#)
- [Regrarians REX Program](#)
- [Regenerate Land Blog Step by Sheldon Firth](#)
- [Purple Pitch Fork](#)
- [How to Write A Holistic Goal - Holistic Management Canada](#)
- [Creating a Personal Holistic Goal \(Adapted from Holistic Management International; UMass Stockbridge School of Agriculture\)](#)
- [All Points Life Design](#)

Whichever tool or method you use, it is very important to develop a farm decision-making framework that works for *you*, the *ecology* that supports your farm and for your *bottom line*. Resilient *farms* need resilient *farmers*!

1. Climate

a. Overview

i. What factors influence the regional climate?

The climate of Southern Vancouver Island ([the Georgia Depression Eco-Province](#)) brings a unique set of constraints and opportunities for agriculture. Winter rains compact bare soils and leach nutrients, fungal and bacterial pressure is high and many arthropod pests (mites & insects) are capable of overwintering more so than in colder climates. Summer rainfall is low and decreasing, making irrigation economically and agronomically essential for most crops. In lowland areas, fine textured soils are susceptible to waterlogging. On the other hand, it is one of the country's warmest and most frost free regions, so the diversity of crops we can grow is great and many can be grown all year long. (See link above for more about the factors that delineate our eco-province.)

ii. What are the projected climate change impacts for our region?

In 2017, the Capital Regional District commissioned and published a Climate Projections Report in 2017. [It can be found here](#). Below is a summary of their findings, (pg. II):

- *The number of summer days above 25°C is expected to triple, from an average of 12 to 36 days per year.*
 - *1-in-20 year hottest day's temperature is projected to increase from 32°C to 36°C by the 2050s.*
 - *22% increase in the growing season length and a 49% increase in growing degree days by the 2050s.*
 - *69% decrease in the number of frost days*
 - *Annual precipitation projections are a modest 5% increase by the 2050s and 12% by the 2080s. Projections indicate the fall season will see the greatest increase in precipitation. This precipitation is expected during increasingly extreme events, with about 31% more precipitation on very wet days (95th percentile wettest days precipitation indicator) and*
-

68% more on extremely wet days (99th percentile wettest days precipitation indicator).

- *Despite the projected increased intensity of wet events, the amount of rain in summer is expected to decrease by about 20%, while the duration of dry spells will lengthen by about 20%.”*

iii. How can I better understand weather systems/patterns?

- [Earth Wind Map](#) - Real-time wind, ocean, particulate map
- [Weatherstats](#) - Daily rainfall for Victoria , BC

b. Risks & Opportunities

i. What are the main challenges to our agricultural sector?

While the specific impacts of climate change to agriculture are highly dependent on regional climate, micro climate and the commodities produced, the following list identifies how climate change is expected to impact agriculture in general across the province:

1. More frequent occurrence and severity of summer drought; water shortages in more regions
2. Decreased snowfall in alpine areas leading to reduced snowpack and to water shortages
3. Increased precipitation (frequently through more extreme events) and subsequent vulnerability to flooding, erosion, nutrient loss
4. More frequent and intense “extreme” weather and weather related events (wind-storms, forest fires, hail, droughts and floods)
5. Increase in growing degree days (heat unit accumulation) and a longer frost free season
6. Potential for broader range of viable crops in some regions
7. Increase in pest and disease pressure due to increased overwintering survival rates

Source: (<http://www.bcagclimateaction.ca/overview/why-adaptation/>)

ii. Where can I find more resources to help deal with these challenges?

The [BC Climate Action Initiative](#) has created several farm adaptation practice fact sheets which can be found here:

<http://www.bcagclimateaction.ca/farm-level/farm-practices/>

Other specific resources will be listed below in the relevant chapters.

iii. What are possible opportunities?

Some potential opportunities related to climate change include: longer growing season, less frost free days, availability of new crops and cultivars, new markets, growing market for local and organic food production.

- [BC Food & Agriculture Climate Action Initiative: Risks & Opportunities](#)

2. Geography

a. Landform

i. Where can I find information about the geological factors that produced my farm landscape and soils?

- [CRD - Geological History of Vancouver Island](#)

- [Geology of Vancouver Island - Steven Earl, Ph.D](#)

- [Soil Formation & Parent Material: Landscape Evolution](#) - UBC

- [Virtual Soil Science Learning Resources \(VSSLR\)](#)

ii. Where can I find my farm's soil texture & drainage, and agricultural classification?

- [BC Soil Information Finder Tool](#) - Free Online GIS Software that lets you find your farm's soil type, drainage characteristics and provides access to the BC soil survey reports created during the 1970s-1980s.

iii. Where can I find free GIS tools (topography and aerial imagery) for my area?

Some municipalities offer very accurate 0.5m-1m contour lines, having done either LiDar or photogrammetry fly-overs for their region. Other municipalities have aerial images only, or 5-50m contour intervals, both of which are inadequate for the purpose of detailed waterworks planning.

- [Capital Region Web Map](#)

- [North Saanich GIS Map](#)

- [Central Saanich GIS Map](#)

- [Nanaimo GIS Map](#)

- Ask your regional government to see if they have open-access data they can share.

iv. If my regional government does not have readily available and accurate topographic information, what other options do I have?

- Surveying technology has come a long way in the last decade and with the introduction of drones, we can now obtain relatively inexpensive, highly accurate contour data & aerial imagery from either LiDar, photogrammetry (using ground control points) or RTK. Contact a surveyor in your area for an estimate.

b. Keyline Geometry

i. What is keyline geometry and how might I apply it on my farm?

- [CRKeyline.ca](#) - What is Keyline Design FAQ & Resources

- [Free E-Book, Understanding the Application of Keyline Geometry](#),

Georgi Pavlov

- [Regrarians Handbook](#), Geography Chapter

- [Free Webinar by Darren J. Doherty for Keyline Water Management Project](#), 2015

- [Before Permaculture: Keyline Planning & Cultivation](#), Mark Feineigle, PRI Australia

ii. How is this technique being utilized elsewhere by farmers, ranchers & agro-foresters?

- CRkeyline.ca - What is Keyline Design FAQ & Resources

iii. Under what circumstances might a keyline layout not be the best option for my farm?

- If a keyline layout for trees means a significant compromise on solar orientation for high-density orchards, a more thorough cost-benefit analysis must be applied

- If soil drainage is your primary limiting factor and methods to improve the soil's internal drainage through organic soil building are insufficient, you will need to consider other drainage options. That being the case, it is possible that a keyline cropping and irrigation layout could be super-imposed on top of other drainage structure like ditches or subsurface drains. Mounds may also be an option.

3. Water

a. Sources, Catchment & Storages

i. What are the potential advantages & disadvantages of different farm water sources?

Water Source	Advantages	Disadvantages
Well	<ul style="list-style-type: none"> (+) no chloramine (+) can be sustainable if aquifer is known to recharge quickly (+) minimal surface disruption (+) no loss of arable land (+) typically easier to filter than pond water 	<ul style="list-style-type: none"> (-) can have high iron/magnesium and need to be aerated (can be as simple as holding tank for it to splash into before being used in irrigation system) (-) colder water not preferred by plants / soil organisms (-) prone to groundwater contamination; ongoing testing is advised (-) aquifer may be vulnerable to salt water intrusion or low recharge (-) earthquake preparedness - major seismic activity may disrupt well
Pond	<ul style="list-style-type: none"> (+) warmer, biologically active water (+) creates micro-climate on property (+) adds value to the property (+) increases bio-diversity & contributes to integrated pest management by enhancing habitat for predatory insects (+) increases long-term water resiliency (+) possibility for trout/carp stocking if large enough (+) can be used as economical storage for low-yielding well (night-time top-up) (+) can be used for water-fowl (although nutrient levels must be managed to ensure crops are not burnt) 	<ul style="list-style-type: none"> (-) removes surface area from agricultural production (-) up front cost (-) requires filtration & pump system with ongoing maintenance (-) some water 'lost' to evaporation (can be as much as 10-20%, or more if surface area-to-depth ratio is poor) (-) requires removal of excess sediment to keep water clear (certain design factors play a role) (-) seal can sometimes be challenging or take time (depending on clay levels found)
Municipal	<ul style="list-style-type: none"> (+) comes pressurized from source (+) many people rely on it; thus minor issues are generally quick to be dealt with (+) typically subsidized for agriculture (often less than \$200 / ML) after domestic allotment 	<ul style="list-style-type: none"> (-) earthquake preparedness: very long pipelines from large centralized reservoirs would take a long time to fix after major earthquake (-) comes with residual chloramine which is not ideal for soil organisms (although can be neutralized with enough humus: scientific evidence is hard to find on this topic, making a cost benefit analysis difficult) (-) future increase in municipal & industrial growth may significantly increase water draws from reservoirs, leading to more dramatic restrictions and competition (-) risk of major cost increase in the future
Greywater	<ul style="list-style-type: none"> (+) recycled water reduces overall usage (+) includes nutrient (+) can use gravity if available (+) new regulations allow its use 	<ul style="list-style-type: none"> (-) typically less volume than is required for agriculture (-) filtration, maintenance & pumping requirements can dissuade some

Source: Tayler Krawczyk, Hatchet & Seed.

ii. How do I complete a catchment analysis to assess the volume of surface water I have access to on my farm?

- [Ponds: Planning, Design & Construction](#) - USDA (pg. 13-22)
 - [Farm Water Dugouts](#) - BC Ministry of Agriculture (pg.22)
 - [Water From Small Dams](#) - Erik Nissen-Petersen
 - [Catchment Calculations](#) - Treeyo Permaculture
 - [Runoff Calculator](#) - Compute peak discharge from a drainage basin
-

using the Rational Equation Method

iii. Where can I find information on my well?

- [BC Well Log - Online Records](#)
- [BC Guide To Finding Well Water Information](#)

iv. How can I access surface water and develop springs for farm use?

- [Accessing Surface Water Sources for Springs \(spring or springs?\)](#) - BC Ministry of Environment
- Under the new [BC Water Sustainability Act](#) & [BC Water Sustainability Regulation](#) you will need to apply for a water license to develop a spring

b. Choosing Irrigation Types

i. What resources exist to help choose my irrigation type?

- [BC Irrigation Management Guide](#) - Editor: Ted W. van der Gulik, P.Eng.; Authors: Stephanie Tam, B.A.Sc., T. Janine Nyvall, P.Eng., Lance Brown, Eng Tech
- [Large Scale Irrigation Methods](#) - Ted Van Der Gulik, p.Eng
- [Drip Irrigation Calculator for PNW](#) - Washington State University

ii. Is 'dry farming' (no irrigation) an option?

Yes, on some water retentive soils, 'dry farming' has proven to have some success. Soil type, crop selection, preparation and timing are critical factors. While one can expect lower yields, the drastically lower input costs could make a business case in some instances. Oregon State University has published fact sheets on the practise in a similar bio-region:

- [Common Misconceptions about Dry Farming](#) - OSU
- [Dry Farming Oregon](#) - OSU

c. Water Usage

i. How much water do my crops need?

- [BC Agriculture Water Calculator](#) - comprehensive calculator that takes into account evapotranspiration rate, crop, irrigation type, soil type/ texture and depth

ii. What steps can I take to ensure I am being efficient with my irrigation water?

One of the most effective ways to hold water in your soil is by increasing the water storage capacity by adding organic matter.

- [BC Irrigation Management Guide](#) - Editor: Ted W. van der Gulik, P.Eng.; Authors: Stephanie Tam, B.A.Sc., T. Janine Nyvall, P.Eng., Lance Brown, Eng Tech

- [Large Scale Irrigation Methods](#) - Ted Van Der Gulik, p.Eng

d. Pond Design & Construction

i. What regulatory measures need to be addressed to construct a farm pond?

- [BC Water Sustainability Act](#)

- [BC Water Sustainability Regulation](#)

- [Dam Safety Regulation](#) - BC Government

- Check your local municipal bylaws and with the Agricultural Land Commission (ALC) regarding soil movement, as most municipalities will require a permit to remove soil from the farm.

ii. How big should my pond/reservoir be?

- Use the [BC Agriculture Water Calculator](#) to determine what your crops will need

- [Water Stoprae video \(Climate Action Initiative\)](#)

- Add domestic usage if from the same water source

- If relying on a surface pond, it is a good idea to design the volume to be 1.5 - 2 times that amount to accommodate for evaporation, seepage & an environmental reserve

iii. What construction details need to be considered to build a safe, sealed pond?

- [Water Storage](#) - BC Climate Action Initiative
- [Ponds: Planning, Design & Construction](#) - USDA
- [Farm Water Dugouts](#) - BC Ministry of Agriculture
- [Quality Farm Dugouts](#) - Alberta Gov.
- [A Primer on Dam Design - Darren Doherty](#)

e. Pumping Systems

i. How do I choose which pump is right for my pond irrigation system?

- [Selecting a Pump Type Page 1](#) - Irrigation Tutorials.com
- [Selecting a Pump Type Page 2](#) - Irrigation Tutorials.com
- [Pumping From Your farm Pond](#) - Presentation by Gord Baird as part of the Keyline Water Management Project

ii. Is solar powered pumping an option?

Solar powered pumping is an option for some on farm applications, especially low pressure systems like tank/pond top-ups and stock watering. High pressure, high volume irrigation systems will typically require costly PV arrays. If you require irrigation water when the sun is not shining, then a battery system will be required, which is typically higher than the cost of the rest of the PV/pump system.

There are many good DC-power pumps on the market for this application. They can be suitable for drip irrigation and micro-sprinkler systems.

Some excellent suppliers include:

- Sundog Solar - <https://www.sundogsolarwind.com/>
- Backwoods Solar - <http://www.backwoodssolar.com/>
- Keln Solar - <http://kellsolar.com/>
- CAP Solar: <http://www.capsolar.com/>

Below is a sample solar pump system that keeps an upper pond topped up from a lower reservoir on a 2.5 acre market garden.

13 M of lift (42 ft.)
350 M of transfer (1137 ft.)
3 million liter storage
consumption is estimated at 15000 liters / day (3300 imperial gallons)
Season of use = may 1st to October 15 th

Here is the average amount of good solar sun per day per month at Comox, British Columbia

May - 5.54 hrs. / day x 60 minutes/ hr. = 332 minutes x 10.9 gpm = 3623 gallons per day in May (

June - 5.75 hrs. /day x 60 minutes /hr. = 345 minutes x 10.9 gpm = 3760 gallons per day in June

July - 6.31 hrs. / day x 60min = 378 x 10.9 = 4127 gallons per day in July

August - 5.36 hrs./day x 60 min = 321 x 10.9 =3505 gallons per day in August

September - 3.79 hrs./day x 60 min = 227 x 10.9 = 2474 / day in September

October - 1.90 hrs. / day x 60 min = 114 x 10.9 =1242 gallons per day in October

Using a 1.5 inch transfer pipe we can assume we will produce 10.9 gpm, which includes all friction loss calculations.

Equipment Required:

2- 250 watt Solar Panel Modules
2- Heavy Duty High Wind load Solar Panel Module Mounts
50 ft. Submersible Solar Pump Cable
1-Sub 750 KU4-0214-48 volt stainless steel Submersible Solar Pump
1- Submersible Pump float if required (floats the pump approx. seven inches below surface)

Total Cost = \$ 4910 CAN (2016 pricing)

Other Resources:

- [Pumping from Your farm Pond](#) - Presentation by Gord Baird
- [Backwoods Solar Pump Catalogue](#)
- [Sundog Solar](#)

f. Gravity Flow Pipe / Pond Siphons

i. Is a gravity flow pipeline system an option for my farm pond/tank?

Gravity flow water pipelines are capable of offering 0.43 psi per foot of head pressure. The larger the pipe size, the higher the flow rate. This makes it ideal for low pressure systems like stock-tank top-ups and drip irrigation. Large elevation drops can make low-pressure sprinklers an option as well.

The minimum PSI required to run thin-walled driplines optimally is 8-10psi, meaning one would require approximately 19 feet of head pressure.

- [Gravity Flow Pipelines](#) - BC Ministry of Agriculture

g. Keyline Subsoil Cultivation for Increased Infiltration

i. What is keyline subsoil cultivation and how might it help improve water management?

- [CRKeyline](#) - What is Keyline?
- [Before Permaculture: Keyline Planning & Cultivation](#)

ii. Is there any research on this application?

- [CRKeyline](#) – Final Report
- [Keyline Cultivation Field Monitoring Results \(Vermont\)](#)

h. Drainage Strategies & Other High Water Table Options

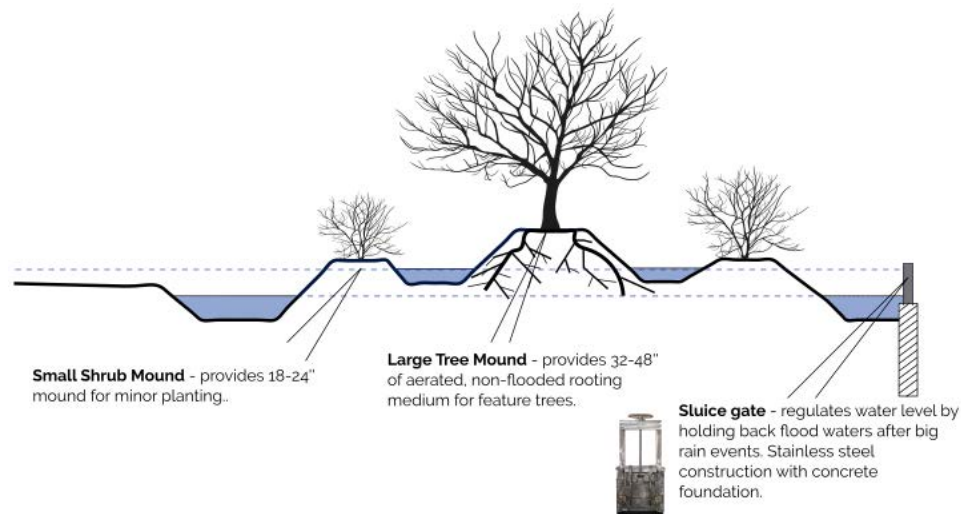
i. What options do I have to deal with standing water in my fields that limit production capacity?

Before excessive drainage is installed, it is important to optimize the soil's internal drainage by incorporating cover crops, organic matter, biological inoculants and other soil best management strategies.

Mounding is also an option. Similar to the '[chinampas](#)' of Meso-American societies in Mexico, some sites could benefit from permanent earthworks to establish seasonally flooded pathways and raised mounds for growing. This ensures permanently aerobic soils in areas with a high water table. The main disadvantages are the energy output to initially create the earthworks and the areas lost to waterways. It is also most suited to perennial crops, unless specialized equipment is utilized. More temperate climate zone research is needed on this technique.

Here is a sample concept:

Temperate Climate Flood-Plain 'Chinampa'- Inspired System



Source: Hatchet & Seed – Tayler Krawczyk

Lastly, choosing crops that are more suited to seasonally flooded conditions will ensure more reliable production.

ii. **Where can I find specifications for agricultural drainage design?**

Due to the predicted increased severity and intensity of storms, field drainage specifications are being updated by engineers and agrologists. In some areas, stormwater impact is exacerbated by rural development and the associated stormwater runoff increases.

Resources for drainage design include:

- [Climate Change Adaptation and On Farm Drainage Management in Delta, British Columbia: Current Knowledge and Practices](#) (updated research that takes future climate projections into account)
 - [Drainage: BC Farm Practices & Climate Change Adaptation](#)
 - [BC Agriculture Drainage Manual](#)
 - [Questions and answers about drainage water](#)
-

[management for the Midwest](#) - University of Minnesota Extension
- [Water Table Management](#) - Food and Agriculture Organization of the United Nations - Natural Resources and Environment

4. Access

a. Multi-Functional Roads & Access Ways

i. What resources are available to help design integrated farm roads to help manage water?

- [Farm Roads: Assessment & Design Criteria](#) - Georgi Pavlov
- [Farm Roadways: Design & Construction](#) - Tom Ryan
- [Water from Farm Roads](#) - Erik Nissen-Petersen
- [Water Harvesting from Low-Standard Rural Roads](#) - Bill Zeedyk
- [Water/Road Interaction: Introduction to Surface Cross Drains](#) - USDA
- [Rural Roads: A Construction and Maintenance Guide for California Landowners](#) - University of California
- [Handbook for Forest, Ranch & Rural Roads](#) - Pacific Watershed Associates

5. Forestry

a. Orchards

i. What resources exist on orchard design, establishment & maintenance for our climate?

- [Tree Fruits & Nut Production](#) - OSU (includes
- [Tree Fruits](#) - BC Ministry of Agriculture
- [West Coast Food Forestry](#) - Rain Tenaqiya

b. Alley Cropping, Silvo-Pasture, Shelterbelts, Windbreaks, Nitrogen-Fixing Species & Shade Trees

i. Where can I find information on using trees to perform multiple functions on the farm?

- [Shelterbelts](#) - BC Farm Practices & Climate Change Adaptation
- [Agro-Forestry Systems in BC](#) - BC Ministry of Agriculture
- [Okanagan Farm Demonstrating Alley Cropping with Black Walnut and Pawpaw](#)
- [Agroforestry Projects in BC](#) - UBC

6. Buildings

a. Design

i. What are some resources for designing multi-functional, resilient farm buildings & structures?

Many regenerative farm enterprises are moving towards multi-functional and moveable infrastructure, particularly when it comes to livestock. Examples include chicken tractors, moveable greenhouses that double as winter chicken shelter, moveable milking stations and portable shade structures. There is also growing interest in mobile abattoirs.

Here are some resources on these topics:

- [Chicken Tractor Plans](#)
- [BC Abattoir Regulation](#)
- [Mobile abattoirs: the BC experience](#)
- [Mobile Egg Mobile – Ridgedale Permaculture](#)
- [Making a very inexpensive grain silo – Ridgedale Permaculture](#)
- [Chickens & moveable greenhouses – Ridgedale Permaculture](#)

Other green building resources include:

- [Magwood, Chris. Making Better Buildings. Chelsea Green Publishing, 2014](#)
 - [Snell, Clarke, and Tim Callahan. Building Green: a Complete How-to Guide to Alternative Building Methods. Lark Books, 2009.](#)
-

7. Fences

a. Design

- i. **What are some resources for designing and using multi-functional, resilient farm fencing?**

- [Deer Fencing Guide](#) - BC Ministry of Agriculture
- [Kiwitech](#) - Innovative Grazing Management Technology from New Zealand
- [Gallagher Fencing Canada](#)
- [Premier Fencing Supplies](#)

8. Soils

a. Sustaining Soil Fertility

- i. **What resources are available to help farmers better understand building and maintaining soil fertility?**

- [Comprehensive Assessment of Soil Health](#) - Cornell University
- [Guidelines for Soil Quality Assessment in Conservation Planning](#) - NRCS
- [Soil Quality Indicator fact Sheets](#) - NRCS
- [Building Soils for Better Crops](#) - SARE

b. DIY Soil Testing & Monitoring

- i. **What resources are available for DIY soil testing & monitoring?**

- [Soil Infiltration Testing](#) - OSU
- [Soil Texture Field Test](#) - BC Ministry of Agriculture

c. Lab Soil Testing

- i. **What is the difference between various soil testing services available in Western Canada?**

- [Soil Nutrient Testing](#) - BC Ministry of Environment

d. Dealing with Compaction

i. What information is available on keyline plowing or subsoiling to reduce surface compaction or a plow pan?

- CRKeyline.ca: Final Report
- [Before Permaculture: Keyline Planning & Cultivation](#)
- [Keyline Cultivation Field Monitoring Results \(Vermont\)](#)

ii. What other methods are available to help alleviate compaction?

- There is strong evidence to suggest that plant roots and their subsequent biology may be as, or more effective than steel implements to break up compaction. Alfalfa and radishes are two well established examples of this.
- [Plants Are Better Than Subsoilers For Reducing Soil Compaction](#) - On Pasture

e. No Till & Conservation Tillage

i. Where can I find information on no-till and conservation tillage farming?

- [Conservation Tillage](#), BC Climate Action fact sheet
- [Beyond Black Plastic](#), Rodale Institute
- [Conservation Tillage/Seeding Equipment](#) - BC Ministry of Agriculture Fact Sheet

f. Cover Cropping

Where can I find information on cover-cropping?

- [Beyond Black Plastic](#), Rodale Institute
- [Winter Cover Cropping on Fraser River Delta](#) - Delta Farmland & Wildlife Trust
- [Cover Cropping & Relay Crops](#) - Agriculture and Agri-Food Canada
- [Plants Are Better Than Subsoilers For Reducing Soil Compaction](#) - On Pasture

g. Grazing Management

Where can I find information on grazing management for soil health?

- [Bulls eye: Targeting Your Rangeland Health Objectives](#) - Kirk Gadzia & Todd Graham
 - [Using Management-Intensive Grazing for Adapting to and Mitigating Climate Change](#) - BC Food & Agriculture Climate Action
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- [BC Management Intensive Grazing](#) - BC Food & Agriculture Climate Action

9. Economy

a. Enterprise Budgeting

i. **Where can I find sample enterprise budgets for different crops in our region?**

- [Enterprise Budget Blog & Webinar](#) - Young Agrarians
- [Enterprise Budgets for Small Scale Organic Farming](#) - Institute for Sustainable Food Systems, Kwantlan Polytechnic University
- [Enterprise Budgets](#) - BC Ministry of Agriculture
- [Organic Grains Transition Enterprise Budget](#) - Planning for Profit series

ii. **Where can I find other business resources to help make my farm a success?**

- [Smart Farm BC: Building Business Success](#)
- [Young Agrarians Business Tools](#)
- [Managing Risk on the Small Farm - SARE](#)
- [SARE Book Resources](#)

iii. **What innovative practices exist for direct local marketing?**

- [Island Farm Fresh](#) - Direct Marketing Association
- [Cow-op.ca](#) - Cowichan Valley Co-operative Marketplace (CVCM) in partnership with Cowichan Green Community

10. Energy

a. Consumption

i. **How can our farm decrease our energy use and cost?**

- [Saving Energy on Your Farm](#), BC Agriculture & Food Climate Action Initiative
 - [Removing GHG Emissions](#), BC Agriculture & Food Climate Action Initiative
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- [Reducing GHG Emissions](#), BC Agriculture & Food Climate Action Initiative

b. Production

i. How can renewable energy play a role on our farm?

- Wood gasification systems may be an option for farms with excess woody debris and the means to process it. Here are a couple of commercial models available for producing electricity:

- <http://www.gocpc.com/biomax-systems.html>
- <http://www.allpowerlabs.com/products/20kw-power-pallets>
- [Report on the chipping & screening requirements for cottage-scale wood gasification energy production](#), by Hatchet & Seed

Solar energy is becoming increasingly cost-effective, especially when combined with more frugal and efficient energy usage.

- The [Backwoods Solar Catalogue](#) provides an excellent place to start learning more
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