B.C. Agricultural Drainage Manual

Chapter 7

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The primary purpose of the B.C. Drainage Manual is to provide farmers as well as water management professionals and consultants with technical information on the design, installation and maintenance of agricultural drainage systems.

Individual chapters may rely on information that is presented in other chapters of the manual. There is a risk that downloading individual chapters may not present all of the required information in its entirety. A complete bound manual is available from the Irrigation Industry Association of BC.

While every effort has been made to ensure the accuracy and completeness of these materials, additional materials may be required to design and implement more advanced subsurface drainage systems. Advice of appropriate professionals and experts may provide additional local or site information that is not covered in this Manual.

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Evaluation of Drainage Improvements 7

7.0 Economic and Financial Considerations

Land which is wet for prolonged periods of time normally cannot be farmed profitably. Under extreme conditions cropping is not feasible, yet drainage of such areas constitutes a benefit, which is similar in magnitude to the economic value of the same crop on a well drained piece of land. However, drainage conditions vary from extremely poor to excellent and the economic benefits from drainage vary accordingly.

Any discussion of drainage works must consider the bottom line, which is usually the economic aspects of the drainage system. Economic benefits from farm productivity are the expected outcome of the installation of a drainage system. Chapter 6 discussed the overall benefits of drainage in terms of improved crop performance resulting from changes in yield and quality. The soil and water conservation benefits of erosion control and enhanced utilization of nutrients were also discussed in Chapter 6. This chapter will discuss the benefits of drainage strictly from an economic perspective.

Drainage system development, operation and maintenance are not free of costs. Some of these costs are capital costs that may be depreciated over time. Other costs arise from the operation and maintenance of the system. A simplified method of calculating a rough cost of a drainage system based on information which can be collected by the land owner is given. Sample partial budget analysis for two common crops, forage grass and blueberries, are used to demonstrate the potential financial benefits of drainage.

The economic benefits of a drainage system should be evaluated before proceeding with installation and construction. If an economic return is not forecast for the design approach taken, the drainage system proposal should be re-evaluated and modified in light of the economic aspects.

7.1 Cost

The capital costs of drainage systems will depend on many factors: field conditions, size of project, labour and material cost, availability of drainage materials and machinery, and the design criteria for the project. The design criteria in turn is dependent on field size, soil conditions, runoff conditions, annual rainfall, outlet conditions and level of drainage required. In addition to the material and installation costs, other costs, such as maintenance and operation of the drainage system must be considered. The decision to install ditches instead of drainpipes to lower the water table of a field may seem to minimize initial capital cost. However, long term maintenance costs, effectiveness of the drainage system, and loss of usable land need to be considered.

As an example, for each hectare of a field with a typical ditch (i.e. 2.5:1 side slope, 1 meter deep and 1 meter bottom width, 0.5 meter buffer on each side and crossing the center of a square field) the loss of land to construction of this ditch would account for about 7% of the area. To achieve a drainage coefficient equivalent to a subsurface drain spacing of 20 meters, 4.5 times more land would be lost. This is equivalent to 31% of the land area. This is an extreme example but it serves to illustrate the often forgotten additional costs of land required if ditching is used in place of subsurface drains. These ditches will also require periodic maintenance and cleaning to keep water flowing freely.

For most situations, a combination of subsurface drains and ditches are required. Minimizing the construction of ditches and utilizing collectors may require a more sophisticated drainage plan and increase the initial capital cost of the system. Increased pressures for control and widening of riparian zones, as well as considerations of fish habitat protection related to water courses, could substantially increase the costs of ditching. The use of collectors could reduce the potential for this type of cost and potential problems with fish or wildlife habitat conflicts from occurring.

7.2 Estimating Cost

The first step in designing a drainage system is to verify the economic feasibility of the drainage works. In order to do an initial cost estimate of a drainage system the first information required is the size of the field. The second, is the generalized drainage spacing required. This is based on the soils found on the site and cropping practices which are planned. This generalized drainage spacing information can be obtained from Tables 5.3 and 5.4.

For example, a landowner has a 16 hectare field, his soil profile has 50 centimeters of coarse textured material over a fine dense subsoil. Tables 5.3 and 5.4 indicate a 16 m and 0.8 m spacing depth. The crop to be grown has a high drainage demand, from Table 5.5 an adjustment factor of 0.9 is used giving a drain spacing of 14 meters. The total length of pipe required can be estimated by using Table 7.1, in this case it is 11 400 meters. Based on an average cost in 1997 of about $2.50 per meter of installed drainage pipe, the rough cost estimate for this system is $28,500 or $1781 per ha.

As mentioned in the previous section, there are several factors which influence the cost of a drainage system. On average, when fields are larger than 8 hectares in size, additional costs for a collector or ditching should be added to the above initial cost estimate. This added cost increases the initial cost by approximately 5%. In the next section, two examples of partial budget analysis are given. In each case the drainage costs are given as a complete system on a per hectare basis as was calculated above. These are partial budget calculations which include the benefits and costs directly associated with the use of drainage.

Table 7.1 Length of Drain Pipe Required per Hectare for Various Spacings, meters

Field Size (hectares)	Drain Spacing (meters)					
	8	10	12	14	18	20
2	2500	2000	1600	1400	1100	1000
4	5000	4000	3300	2800	2200	2000
8	10 000	8000	6700	5700	4400	4000
16	20 000	16 000	13 300	11 400	8800	8000
30	37 500	30 000	25 000	21 400	16 600	15 000
60	75 000	60 000	50 000	43 000	33 300	30 000

7.3 Economic Analysis

The benefits of drainage have been discussed in Chapter 5; this section is meant to put a dollar and cents perspective on the benefits. The cost of complete and properly designed drainage systems have been estimated for two crops. In the partial budget analysis below, only the costs which are directly associated to the presence or lack of a drainage system have been included. Other costs or benefits have not been considered unless they are specifically mentioned in the assumptions or the partial budget tables.

Example 7.1 is for a grass forage crop grown in South Coastal British Columbia. The drainage design includes a grid of parallel drain lines installed every 18 meters and draining directly to a ditch. The second example, Example 7.2, is for an established blueberry crop planted at a density of 585 plants per hectare on a mineral soil in South Coastal British Columbia. The drainage system design for the blueberries includes a grid of parallel drain lines spaced at 14 meters connected to a mainline.

In each case the drainage system is installed by a drainage contractor. The drainage system is depreciated over 30 years. Regular maintenance is expected, and an annual operating cost should be estimated to ensure that the drainage system functions properly. Costs of ditching or pumping have not been included, however, these may need consideration for some sites.

It should be noted that the following two examples, are for explanatory purposes only. These examples are for specific situations, actual costs and benefits will vary based on site specific situations. Some assumptions have been made for each example and they are listed at the top of each example. To ensure there is a complete assessment of drainage benefits it is necessary to consider all financial aspects including the estimated cashflow. In both examples depreciation and interest costs are included. In the assessment of cash flow, factors such as loan payments, for financing the drainage system capital cost, and taxation benefits must be considered.

Example 7.1: Economic Benefit for Forage Production – South Coastal British Columbia

Assumptions:

Added crop production	extra yield 3.4 tonne/hectare
Market value of local hay	$200 / tonne
Cost of drainage	$1350 / ha
Interest rate	8%
Reseeding changed from every 4th year to every 6th year	

Benefits		Costs	
Added Annual Returns		**Added Annual Costs**	
3.4 tonne hay / ha x $220 / tonne	= $748 / ha	Harvesting	
		• variable costs (e.g. fuel, labour, materials)	$110 / ha
		• fixed costs (e.g. depreciation)	$ 10 / ha
Reduced Annual Costs		Drains	
reseeding	$ 22 / ha	• depreciation ($1350 / 30 years)	$ 45 / ha
		• Interest (average) (1350 / 2) x 8%	$ 55 / ha
		Reduced Annual Costs	**0 / ha**
TOTAL BENEFITS	**$770 / ha**	**TOTAL COSTS**	**$220 / ha**

The net benefit of the drainage system works out to be ($770 - $220) $550 per hectare.

In this example the extra yield is anticipated to come from an increase in the total number of cuts of forage per year. In particular the timing of first cut. Increases in total yield as well as improved quality are expected, however an economic benefit from improved quality was not calculated.

There is no change made in fertilizer costs or application rate. This assumption is based on the anticipated improved utilization of the fertilizer that was applied. Drainage will also improve trafficability, allowing access to fields in the wetter periods of the year. This improved access will allow for better utilization of the manure resource.

Improved drainage is expected to reduce the frequency of reseeding. This is expected as soil compaction and rutting will be reduced and overall stand health will be improved. Some additional costs in terms of machinery operation are anticipated due to the increase in harvest yield.

Example 7.2: Economic Benefit for Blueberry Production – South Coastal British Columbia

Assumptions:

Added crop production	extra yield 5350 kilograms/hectare
Average price of berries	$1.32 / kg
Berry picking	20% by hand and 80% by machine
Hand Picking costs	$0.70 / kg
Carton cost (10 lb. carton)	$0.85 each
Cost of drainage	$1800 / ha
Interest rate	8%
Undrained losses include:	about 5% of plant loss per year about 35% of maximum yield

Benefits		Costs	
Added Annual Returns		**Added Annual Costs**	
Yield		Variable	
5350 kg berries / ha x $1.32 / kg	= $7,060 / ha	• hand picking	$755 / ha
		• hired labour	$255 / ha
		• marketing & promotion	$ 68 / ha
		• cartons	$690 / ha
Reduced Annual Costs			
		Fixed (drainage costs	
Replacement Plants and Planting	$540 / ha	• depreciation ($1800 / 30 years	$ 60 / ha
		• Interest (average) ($1800 / 2) x 8%	$ 72/ha
		Reduced Annual Returns	0 / ha
TOTAL BENEFITS	**$7,600 / ha**	**TOTAL COSTS**	**$1900 / ha**

The net advantage of the drainage system works out to be ($7,600 - $1,900) $5,000 per hectare.

In the example there was no change in fertilizer application rate as it was assumed the there would be improved utilization of the applied fertilizer at full production. The yield used in the cost benefit analysis was equivalent to 13.45 ton per hectare, which is an average yield for blueberries in the region. There may be other economic considerations that are required for a small fruit crop such as blueberries that would improve or reduce the net advantage of drainage.

Limited data is available for the impact of drainage on blueberry yields. In one trial in Delta, British Columbia, an increase of almost 4,800 kilograms per hectare of berries was measured when the site was drained. At the same site, 30% of the plants in the undrained area died in the first winter due to a high watertable and surface ponding.

Some of the other considerations are the increased timeliness of applications of pest control products and the trafficability of the fields for mechanical harvest. Improper drainage design or over drainage in some soils may increase the need for irrigation which would increase operation or capital cost.

7.4 Putting It All Together

Once a need for drainage has been recognized, and after consideration of the rough estimate of drainage costs given in section 7.2 and the example partial budget analyses in Section 7.3 have been done, it is decision time. Do the rough costs and economics look promising? Can your cashflow tolerate the investment? If the results are encouraging it is then time to consider having a drainage plan prepared.

A drainage system needs to be well planned and properly installed to achieve maximum benefit. The soil conditions need to be correctly assessed. Subsurface drains, collectors and ditches should be properly located and spaced. Minor changes in elevation can have a significant impact on the performance of a drainage system so a topographic survey should be an integral part of the plan and cost. Good equipment and skilled individuals can ensure a high level of accuracy during installation. None of this will be achieved without a proper plan.

A drainage plan will give a better estimate of the materials required for the drainage system. It will also identify structures and installation requirements that are not usually identified in a broad brush initial cost estimate such as the previous examples in section 7.2. For more detail on what a proper drainage plan entails please refer to Section 8.3.3 which covers this topic in more detail.

A qualified professional or drainage contractor can be hired to prepare a complete drainage plan. Once the plan has been prepared a more detailed cost calculation can be carried out. Check and compare the cost estimates provided by a contractor based on the detailed plan.

A reminder, that before a drainage system is installed, a partial budget assessment and cash flow projection should be completed for the operation. This will ensure that the capital cost of installation can be covered. In most cases there is a net economic advantage to installation of a drainage system even for small portions of a farm rather than the whole farm.