Wetland Drainage User Guide

9/10/ 2020

Version 1.1

Document Revisions

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| Date | Version Number | Document Changes |
| 9/10/2020 | 1.1 | Initial Draft |
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# Introduction

## Scope and Purpose

The product is called Wetland drainage decision tool (WetlandDrainage Tool). The purpose of the product is t………

[Introduce the product and its purpose, highlighting key features and benefits]

The user guide will cover the key variables of WetlandDrainage Tool. The variables are grouped into two main types, those that can be changed by the user and those that cannot be changed.

[Introduce the purpose of the user guide, what functionality or workflows will be covered? Are there any assumptions about the users’ knowledge or experience, or prerequisites? ]

## Process Overview

In this section, the main components of the wetland drainage decision tool are described. In the descriptions, we categorize input variables into decision and fixed variables. The decision variables are those that can be changed by the user whiles the fixed variables cannot be changed by the user; the fixed variables have already been specified in the system to run it. Also, the assumptions underlying the calculation of the components of the decision tool are stated. Below is a flow of the main components of the system:

1. Revenue
   1. Yield
   2. Price
   3. Insurance
   4. CAIS
2. Cost

2.1. Drainage Cost

2.1.1. ….

2.1.2……

2.2. Input cost

1. Time Available for Drainage
2. Decision Rule and Net Present Benefit of Drainage and

[You may choose to include a process flow diagram to accompany the text. Consider including subprocess diagrams throughout the guide to introduce new or subsequent workflows]

1. Revenue

The revenue component brings money to the operator. The main components are crop yields (Y), price of the crops (P), crop insurance, and Canadian Agriculture Income Stabilization Program (CAIS). It is assumed that the planning horizon of the farm is 20-years, which means that in that period the farmer will be receiving revenue from farm operations. It is calculated as:

Payments

***Crop Yield***

It is assumed that:

1. the operator follows a 5-year crop rotation: Canola, Barley, Flax, Spring Wheat and Summer-fallow.
2. Growing season is from …..
3. Crop yield is modelled as a quadratic function of, census of agricultural region-specific constants, crop price last year, input price index, growing season precipitation, growing degree days, trend term. A list of functional forms for crop yields in North America, including that for the current study are provided in Table 1 in appendix 1.

After the yield function is estimated, the input variables that will be used or estimated crop yield for an operator are:

Decision variables: crop price, census of agriculture region specific-constant (the region of the operator is assigned value of 1 and other constants zero), and crop price last year.

Fixed variables

All other variables are controlled by the decision tool system. In particular, a logistic distribution is assumed for the climatic variables, to predict values to predict the yield fucntion. All other variables are fixed at the means of the historical data of that variable.

***Crop Insurance***

The farmer receives compensation if the yield of quarter-section falls below the insurance coverage level. The default coverage level is 70% of the yield of the crop determined by the insurance program.

Decision variable: The first variable is a dummy variable which is 1 if the user is in an insurance program. The other variable is coverage level, which the user will change depending on the specifics of his/her insurance program.

**Canadian Agriculture Income Stabilization Program**

The program offers protection to farmers that experience negative deviations from their average farm production returns.

Assumptions:

1. Three tiers of protection levels; 0-70% (tier1), >70- 85% (tier 2) and >85 – 100% (tier 3). If farmer’s production return is below a protection level of average level of return payment to the farmer is triggered.
2. Average level of return is an Olympic 5-year average margin for income and expenses (excluding drainage related cost).
3. Payment is at protection return share of 20% : 80% (tier 3), 30%:70% (tier 2) and 50%: 50% (tier 1) for farmer : government, respectively.
4. Payments are zero for negative returns

Decision variable:

1. Dummy variable denoting 1 if the farmer decides to join the program and zero otherwise.
2. Protection level.

Payment:

1. **Cost**

The cost component are negative expenditures that takes away money from the farm. The main components are crop production input cost (cpc), machinery cost (mc), drainage cost (dc), nuisance cost (nc), input wastage cost (iwc), and CAIS deposits (cd).

1. *Input costs*

They are the costs associated with inputs that are used to produce the crops.

Assumptions:

1. The inputs costs are seed, pest control, and fertilizing.
2. Farmer applies all pesticides himself except fungicides which is applied by high clearance sprayer because fungicides are applied at later crop production stage.
3. Default levels of input use and unit prices are taken from representative farm enterprise budgets from the Canadian Prairies.

Decision Variable:

1. Dummy variables for seed, pest control and fertilizer which for each variable will equal 1 if the farmer will use that input and zero otherwise.
2. Levels of inputs that will be used.
3. *Machinery Costs*

Assumption: Producers practice no tillage farming.

1. *Drainage Cost*

The cost of drainage are ditch construction, drainage rehabilitation, and drainage maintenance.

1. Drainage Construction Cost

This is the cost of constructing wetland drainage.

Assumption:

1. Contour surface drainage
2. Complete drainage of all wetlands in a quarter-section

Dl = ditch lengh, hr=hours used for installing, imc = installation machin cost./hr

The default values of the variables are taken from ……..

Decision variable:

1. Ditch length, installation machinery cost
2. Rehabilitation Cost

Cost incurred for preparing drained wetland areas for seeding. It is assumed to be …..

1. Maintenance Cost

It is 1.5% of wetland drainage cost.

Assumption:

1. Producers use 1.5% of the time spent in constructing ditches to conduct maintenance.
2. Since drainage are maintained, its usefulness horizon could be infinite.
3. **Time Available for Drainage**

The time available for drainage is the residual time after the time for all other operations (crop harvesting, existing drainage maintenance, fall weed spraying, summer fallow operations) are taken from the total working days during the period August 1st to Nov 11th.

Assumptions on workdays:

1. Workdays are from ripe to freeze-up (August 1st to Nov 11th)
2. Workdays and non-workdays are calculated from workday and non-workday probabilities, respectively, (Cortus 2015).

Calculation:

For August 1st, if a draw from a uniform dist is less than the unconditional workday probability then that day is a workday. Subsequently, …..

1. Harvest

The start date of harvest is based on crop maturity date which is also determined by the growing degree days. Different crop maturity dates given GDD for different crops are provided in Cortus (2015). The number of days for harvesting will be the sum of the number of days for swathing and combining.

1. Fall weed spraying
2. Maintaining existing drainage infrastructure
3. Summer fallow operations
4. **Wetland Drainage Decision Criteria**
5. If there is sufficient time (which takes three years when started and mist finish) for drainage then go ahead to drain no…don’t even drain..assess next time
6. And if yes, is the npv drainage positive. If yes then drain.

**Appendix 1**

**![Map

Description automatically generated]()**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Paper** | **Journal** | **Studied**  **Crops** | **Time Period** | **Region** | **Estimation Method**  **& Functional Form** | **Weather** | **Price** | **Technology** | **Land Quality & Characteristics** |
| Qui et al (2015) | Nature | Corn, Soybeans | 1950-2013 | Ontario, Canada | Ordinary Least Squares (OLS)  Method; Quadratic functional form | Precipitation before GS, precipitation after GS, GDD | Lag Output price, Fertilizer price index | Trend term |  |
| Houck & Gallagher (1976) | American Journal of Ag. Econs | Corn | 1951-1971 | US | OLS method, Quadratic functional form for weather | Weather: proxy variable by USDA to capture moisture conditions for pasture in selected states during growing season | Ratio of fertilizer price index to price of corn | Trend term |  |
| Kaufmann & Snell (1997) | American Journal of Ag. Econs | Corn | 1889-1995 | Ontario, Canada | OLS method Log-linear functional, form Quadratic functional form | Rainfall and temperature | Lag of corn prices, and change in input (derived from value of marginal product = input price) | Time trend, real value of machinery per acre | % change in acres planted from one observation to another |
| Schlenker & Roberts (2009) | PNAS | Corn | 1950-2005 | US | Nonparametric method Step functional form for heat 8th degree Polynomial for heat Piecewise linear functional form for heat Quadratic functional form for time trend | Temperature withing growing season, precipitation | None | Quadratic time trend | None |
| Cabas et al. (2010) | Climate Change | Corn, Soybeans | 1981-2006 | Ontario, Canada | Feasible Generalize Least Square Method Just and Pope production function | Length of growing season (GS), GS temperature, GS precipitation, coefficient of variation of GS precipitation, coefficient of variation of GS temperature; and quadratic terms of weather variables | change in input (derived from value of marginal product = input price) | trend | Change in cultivated area |
| Tolhurst & Alan  (2015) | American Journal of Ag. Econs | Corn, Soybeans | 1955-2011 | US | Nonparametric method, Quadratic functional form for precipitation | Precipitation, growing degree days, extreme temperature degree days, vapor pressure deficit |  | trend |  |
| Miao et al. (2016) | American Journal of Ag. Econs | Corn, Soybeans | 1977-2007 | US | Instrumental Variable method, Quadratic functional form | Degree days, overheat days, temperature deviations, | Output price, lag fertilizer price index, Federal Ag. Improvement Act dummy | Trend |  |
| Cortus et al (2015) | Canadian Journal of Ag Econs | Canola, Barley, Flax, Spring Wheat |  | Saskatchewan | Systems of equations, quadratic functional form | GS precipitation, GDD |  |  |  |
| Jiangui et al (2020) | IEEE Journal of Selected Topics in Applied Earth Observations And Remote Sensing | barley, canola,  and spring wheat | 2000 - 2016 | Canadian Prairies (Census of Agriculture Regions) | Ordinary least squares, linear functional form | MODIS metrics |  | Trend term |  |

**CAI**

1. Farmer also deposits a certain amount of money based on the protection level in a CAIS approved financial institution.

Deposit:

## [Sub-Process or Workflow Step 1] Example: Configure Connect to manage your work

[Provide a concise description of the context for this sub-process or workflow, including any requirements or conditions that are relevant.]

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam at porta est, et lobortis sem. Duis imperdiet in nisl sed luctus.

### [Procedures for Step 1] Example: To Log in to Connect:

1. Do something.
2. Complete an action.
3. Select a value.

Screen capture

1. Enter some text.
2. Drag and drop a value.
3. Click or press something to complete the procedure.

[NOTES, CAUTIONS, and WARNINGS provide any relevant or supplemental information about consequences of performing a step incorrectly. Place warnings before the step to be taken. Notes may be placed either before or after the corresponding step.]

NOTE: Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam at porta est, et lobortis sem. Duis imperdiet in nisl sed luctus..

### [Procedures for Step 2]:

1. Do something fairly complex that needs substeps:
2. Do the first thing
3. When something happens, do the next thing.
4. Click a button or a link.
5. Enter some data.
6. Complete the action.
7. Complete an action using one of the following options:

* Option 1

1. Click somewhere.
2. Enter something.

* Option 2

1. Click somewhere.
2. Enter something.
3. Select a value.

Screen capture

1. Enter some text.
2. Click or press something to complete the procedure.

## [Sub-Process or Workflow Step 2] Example: Asset Record Statuses

[If a sub-process or workflow step requires additional context and detailed information to properly prepare the user, you can expand a context section to include tables (such as definitions of the values available in a dropdown) or graphics such as flow diagrams. You should add captions to identify tables and graphics, and consider including a table of figures following the TOC if the number of graphics and tables is significant.]

Proin euismod lectus sed dui accumsan lobortis. Donec iaculis sed magna ac aliquam. Donec sagittis mi at enim gravida, vitae pharetra nunc sollicitudin. Suspendisse mollis turpis in odio lobortis tincidunt. Nullam ut augue eget massa eleifend consequat. Praesent ac vestibulum leo, sit amet tempor urna. Praesent eu quam diam. Morbi tincidunt nec urna at vehicula. Vestibulum tincidunt sit amet urna eget auctor. Nulla faucibus nulla vitae pretium rutrum. Nulla nibh sapien, ultricies eu pellentesque fermentum, molestie et purus.

|  |  |
| --- | --- |
| Indicator | Definition |
| **Value 1** | Lorem ipsum dolor sit amet, consectetur adipiscing elit. |
| **Value 2** | Sed id neque auctor, pellentesque quam vel, pulvinar lorem. |
| **Value 3** | Morbi in odio vitae dui dictum ultricies eu vel nisi.  Phasellus eu dui vitae nisl viverra vulputate ac sit amet turpis. |
| **Value 4** | Vivamus tristique augue ornare lorem lobortis, a pellentesque felis blandit. |
| **Value 5** | Duis at nisi eget ligula fermentum pretium at et felis.  Integer consectetur nibh a condimentum rhoncus. |

Figure X-X: Lorem ipsum dolor sit amet

If you encounter issues not addressed by this user guide, please contact your account manager for additional support.

# Appendices

[Appendices are optional, and are used to provide additional detailed information that may help the end user manage the overall application. Examples could include references to standards (such as W3C standards), technical specifications required for regulatory compliance, checklists, or other information of a technical nature.]

# Index

[Depending on the size or complexity of the final document, consider pulling together an index to assist the using in location specific information. Index entries correspond to tags or categories, and are useful in navigating long books.]

## Style Sheet Information

The following styles have been set up in this template. Avoid applying manual character formatting to the document. Applying these styles will assist in the conversion process if the document is to be laid out in a structured authoring tool, content management tool, or an HTML editor.

| Style Name | Apply to |
| --- | --- |
| Title | Title as listed on the cover page of the document |
| Subtitle | Subtitle as listed on the cover page of the document |
| Heading 1 | Chapter Name or Process or Workflow |
| Heading 2 | Subsection or SubProcess or Workflow step |
| Heading 3 | Subsection 2 or Procedure |
| Callout Block Copy Note | Notes, cautions or warnings, use arrow graphic on the left margin |
| Chapter Body Copy | Generic text following a heading |
| * Chapter Body Copy – Bullet | Unordered list within a section or subsection, sometimes within a Step to indicate alternative ways to do something. |
| * + Chapter Body Copy – Bullet 2 | A secondary unordered list, within a higher level ordered or unordered list |
| 1. Chapter Body Copy – Step | An ordered list (sequential) used in a procedure to indicate the order of actions to be taken |
| 1. Chapter Body Copy – Step a | A secondary ordered list, e.g. substeps in a procedure |
| Chapter Body Copy – Indent | Sets additional text inward so that it aligns with either Chapter Body Copy – Bullet or Chapter Body Copy – Step |
| Chart Body Copy | Text within a table |
| Chart Header Information | The first row of a table. |
| Caption | Descriptive text for a table or graphic. |
| Header | Text that appears at the top of each page. |
| Footer | Text that appears at the bottom of each page. |
| Chart Title and Footer Info | Copyright and other front matter preceding the Table of Contents; additional information used to footnote or provide a legend for a table. |
| TOC Heading | Heading used for Table of Contents, Table of Figures (if applicable), and the Document Revisions pages of the front matter to the document. |
| TOC 1 | TOC display information for a chapter. Generated automatically from Heading 1. |
| TOC 2 | TOC display information for a sub-section. Generated automatically from Heading 2. |
| TOC 3 | TOC display information for a subsection 2. Generated automatically from Heading 3. |
| [Template Instructions] | Guidance on building out the user guide. Should be deleted prior to publishing. |

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| **Paper** | **Journal** | **Studied**  **Crops** | **Time Period** | **Region** | **Estimation Method**  **& Functional Form** | **weather** | **Price** | **Technology** | **Land Quality** | **Ground Water Level** |  |
| Qui et al (2015) | Nature | Corn, Soybeans | 1950-2013 | Ontario,  Canada | Ordinary Least Squares (OLS)  Method; Quadratic functional form | Precipitation before GS, precipitation after GS, GDD | Lag Output price, Fertilizer price index | Trend term |  |  |  |
| Houck &  Gallagher (1976) |  | Corn | 1951-1971 | US | OLS method , Quadratic functional  form for weather |  |  |  |  |  |  |
| Kaufmann &  Snell (1997) |  | Corn | 1889-1995 | Ontario,  Canada | OLS method Log-linear functional,  form Quadratic functional form |  |  |  |  |  |  |
| Schlenker &  Roberts (2009) |  | Corn | 1950-2005 | US | Nonparametric method  Step functional form for heat  8th degree Polynomial for heat  Piecewise linear functional form  for heat  Quadratic functional form for time  trend |  |  |  |  |  |  |
| Cabas et al.  (2010) |  | Corn, Soybeans | 1981-2006 | Ontario,  Canada | Feasible Generalize Least Square  method Just and Pope production  function |  |  |  |  |  |  |
| Tolhurst & Alan  (2015) |  | Corn, Soybeans | 1955-2011 | US | Nonparametric method, Quadratic  functional form for precipitation |  |  |  |  |  |  |
| Miao et al. (2016) |  | Corn, Soybeans | 1977-2007 | US | nstrumental Variable method,  Quadratic functional form |  |  |  |  |  |  |
| Cortus et al (2015) | Canadian Journal of Ag Econs |  |  | Saskatchewan | Systems of equations, quadratic functional form | GS precipitation, GDD |  |  |  |  |  |
| Cabas et al (2009) |  |  |  |  | Just and Post production function |  |  | Trend term |  |  |  |
| Jiangui et al (2020) |  |  |  |  | Ordinary least squares, linear functional form | MODIS metrics |  | Trend term |  |  |  |

**Applied Crop Production Functions Yield in Canada**

Crop yield production functions establish technical relationships between crop inputs and outputs. These functions must satisfy some minimum assumptions:

Cortus et al. (2015)

GS : Growing season (May 15 to August 13) precipitation

GDD : Growing degree days in growing season

Qui et al (2020)

PBGS : precipitation before growing season

PRECI : precipitation after growing season

DD : growing degree days

: output price last year

: fertilizer price index

T : trend term

: mean of PRECI for all the data subgroups

: mean of DD for all data subgroups

Cabas et al (2009)

Based on Just and Post (1978, 1979) production function: Production is decomposed into a deterministic part related to production inputs and stochastic part related to output.

The mathematics of input variables in applied production function based on Kaufmann and Snell (1997):

Profit maximization posits that the value of marginal product of an input must be equal price of the input:

: Crop output price

index of crop input prices paid by farmers

Model:

Jiangui et al (2020)

Utility of Terra/MODIS derived crop metrics for yield estimation. The idea behind this is that, the factors such as soil condition, temperature, soil moisture could be obtained from Satellite data such as crop vegetation cover fraction, green leaf area index and fraction of absorbed cover. Such metrics are then used to predict yield:

X: MODIS metrics, T: trend term