Hands-on Demo for Holos V4 Software Tool

Holos

A tool to estimate and reduce GHGs from farms

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Hands-on Demo for Holos V4 Software Tool

Note: *The purpose of this document is to provide an introduction on how to use the Holos model (version 4) and the required vs. optional inputs.*

For the purpose of this training, we are going to create a farm that has an annual beef production system, and a feed crop production system. The farm is located in Manitoba near Portage La Prairie.

1. Launch Holos

*** Please note that Holos 4 can be installed on a Microsoft Windows PC only. Mac OS will be supported in the next version**

Launch Holos by double-clicking on the Holos desktop icon. If there are no saved farms in the system, Holos will create a new farm and ask the user for a farm name and an optional comment (Figure 1). If there is already a saved farm in the system, Holos will ask the user to open the existing farm or to create a new farm (Figure 2).

Enter "**Holos 2021**" as a farm name and "**training version**" as the "comment". Ensure to click the "**Advanced Mode**" button so that additional features and functionality will be available. Click "Ok" to proceed to the next screen.

Ensure "Metric" is selected as the unit of measurement type and then click the "Next" button at the bottom of the screen.

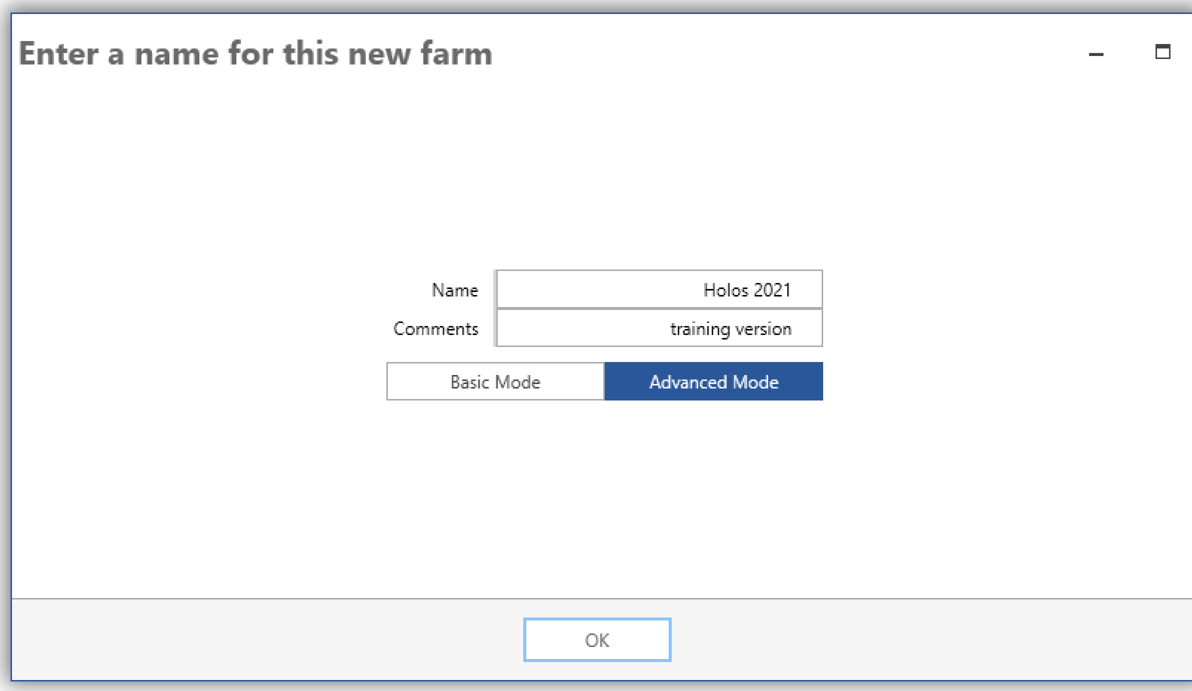


Figure 1: Entering a name for the new farm

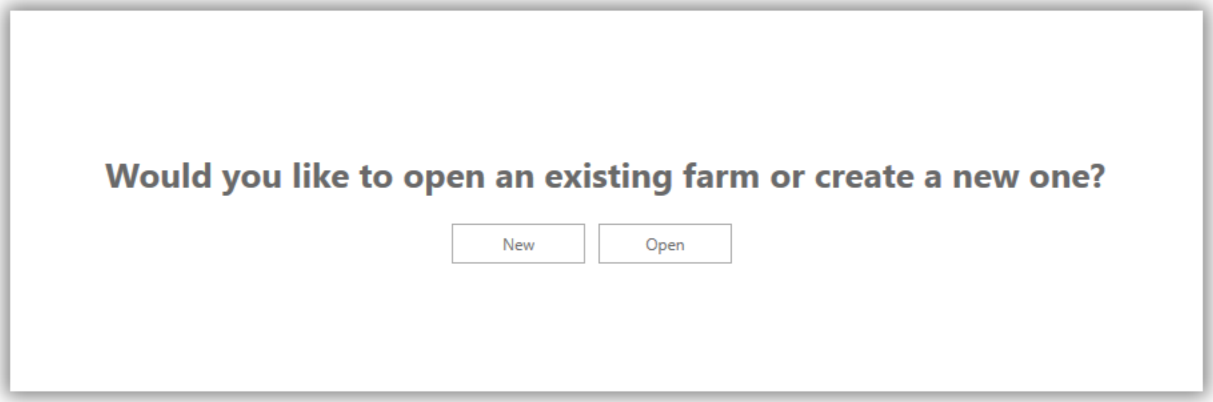


Figure 2: If a farm has been saved previously, this screen will appear

2. Creating and locating the new beef farm

The beef farm that we will create for this exercise is located in the province of Manitoba. Select "**Manitoba**" on the "Select a province" screen, and then click the "Next" button.

Holos uses Soil Landscapes of Canada (SLC), which are a series of GIS coverages that show the major characteristics of soils and land for all of Canada (compiled at a scale of 1:1 million). SLC polygons may contain one or more distinct soil landscape components.

The “Farm Location” screen brings up a map of Canada with the province of Manitoba centered on the screen (Figure 3).

The map contains red colored polygons that can be selected by moving the cursor over the region that contains the location of your farm. You can zoom in or out of the map by using the mouse wheel or by hovering the cursor over the zoom icon at the bottom of the screen.

The beef farm for this example is located between Winnipeg and Portage la Prairie (Portage) with SLC polygon number **851003**.

1. Find and right-click on this polygon to select it on the map. Note that at this point daily climate data will be downloaded from NASA.

Note: *Climate data is central to most calculations performed by Holos. For the most accurate estimation of farm emissions, measured climate data should be provided by the user which will override the default data obtained from the NASA weather API.*

Holos will use daily precipitation, temperature, and potential evapotranspiration values to model soil carbon change (climate parameter), nitrous oxide emissions, as well as ammonia volatilization.

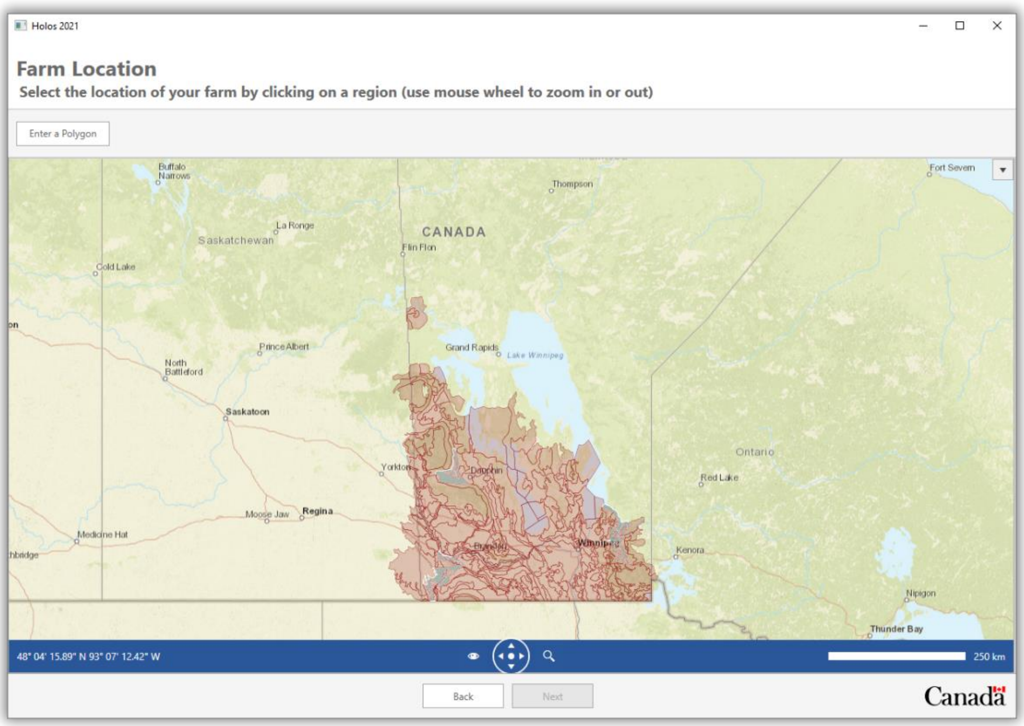


Figure 3: SLC polygons and farm location

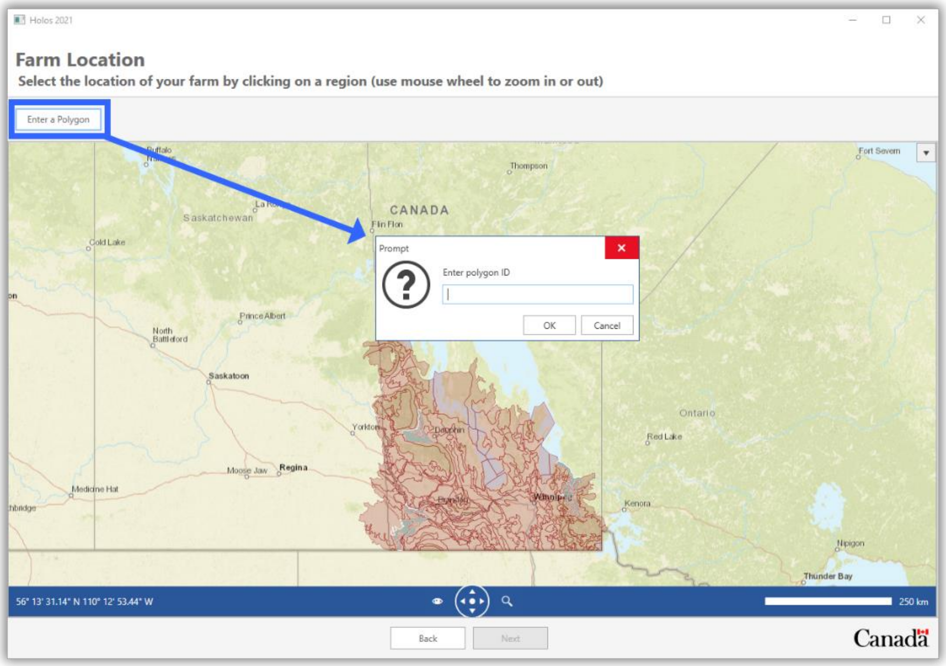


Figure 4: Enter the polygon ID

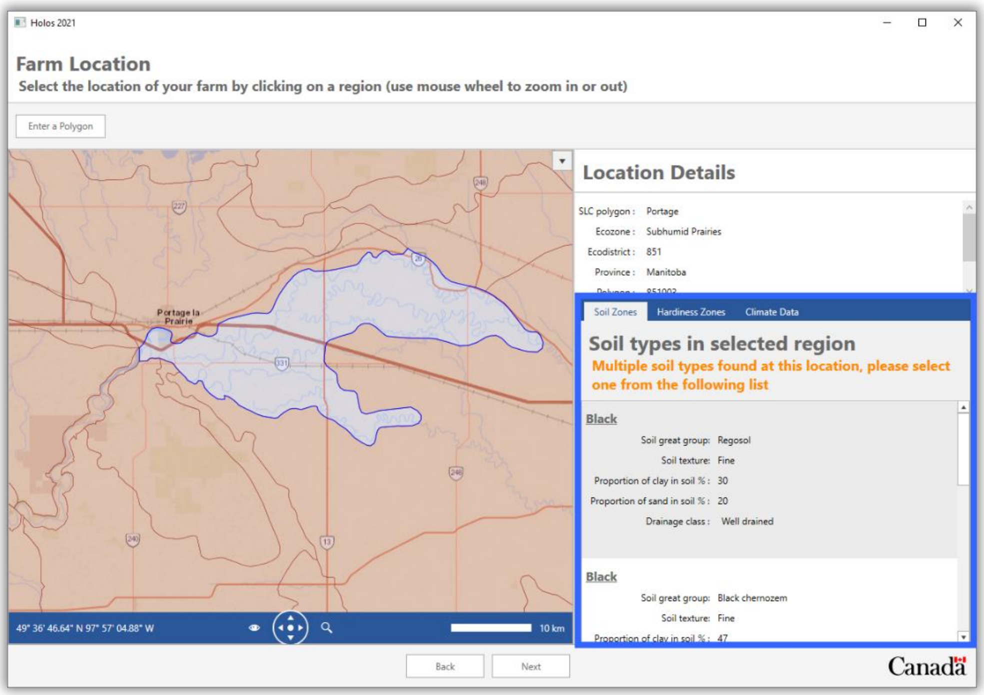


Figure 5: Multiple soil types will be displayed for the selected region

Once the farm location is selected, soil information (texture, sand, and clay proportions) for the types of soils found in this region are displayed on the right side of the screen (Figure 5). It's possible that more than one soil type per region will be found and the user is expected to select their soil type from this list or use the default selection.

Keep the first selected soil type, and keep the default "Hardiness zone".

Note: *Soil data obtained from the user's selected location will be used in the calculation of location-specific N2O emission factors. Properties such as soil texture, top layer thickness, and soil pH are required for these calculations, and can be overwritten.*

Click the "Next" button to proceed to the next step.

3. Selecting farm components

Now that the farm location has been selected, we move on to the "Component Selection" screen. This is where the user can select different components for their farm. Holos will display all available components on the left side of the screen under the "Available Components" column (Figure 6). These components are grouped into categories such as "Land management", "Beef production", "Dairy Cattle", etc.. If we click on the drop-down button on one of the categories we can then see the available components. For this portion of the training, we will be working with the "Land management" and "Beef production" categories. The model is designed to define the land management before livestock. This is because we are going to allow be placing livestock onto a specific pasture (field) for grazing, and that is easier done when a pasture field has been defined already (otherwise the user would have to interrupt the livestock setup to setup a field).

3.1. Crop and hay production

*** In order to calculate soil carbon change for fields and crop rotations, click on the "Settings" menu and select the "Multi-year" option.**

Now we can add our first component to the farm. Drag a "Field" component from the left side of the screen and drop it on the "My Farm" area on the right side (Figure 6). The screen now updates to reflect the component you have added to your farm. Holos has labelled the field as "Field #1". At this point, we can now enter production information related to the crop being grown on this field.

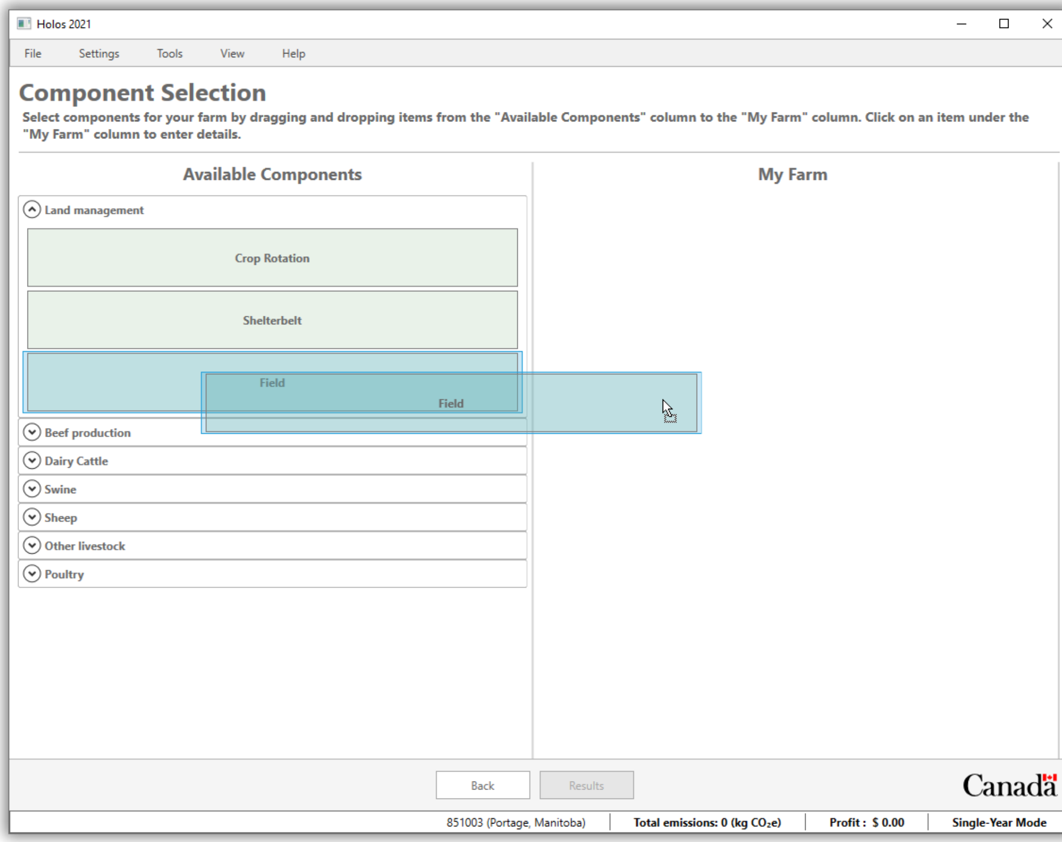


Figure 6: Model components

3.1.1. Wheat with Cover Crop

Our first field on the farm will grow continuous wheat with a cover crop of hairy vetch.

1. Rename the field to "**Wheat & hairy vetch**" in the "**Step 1**" section of the screen. Change the area of the field to **18** ha.
2. Select "**Wheat**" from the crop list under the 'Crop' column, and "**Hairy Vetch**" as the cover crop in "**Step 2**".
3. Click the 'General' tab and then select "**Reduced tillage**" as the tillage type.
   Enter a yield of **3,000** kg/ha (wet weight), ensure "**Cash crop**" is selected as the 'Harvest method', enter **200** mm as the amount of irrigation.
4. There is no pesticide used on this field.
5. Select the 'Fertilizer' tab and click the "**Add Fertilizer Application**" button. Holos has now added a new fertilizer application for this field and will suggest Urea as the fertilizer blend. A default application rate is calculated based on the yield value entered for this field. Details of this fertilizer application can be changed by clicking the "**Show Additional Information**" button (e.g., season of application, different fertilizer blend, etc.).

Note: *At a minimum, Holos requires the area of the field, type of crop grown, and a field-specific fertilizer application rate to calculate direct and indirect nitrous oxide emissions.*

Residue management of each crop (and cover crop) can be adjusted in Holos (see 'Residue' tab). Holos provides default values depending on the type of crop being grown and will set a value for percentage of product returned to soil, percentage of straw returned to soil, etc. These residue input settings will have an impact on the final soil carbon change estimates.

Furthermore, biomass fractions and N concentrations can be overwritten by the user, and in this way 'custom' crops can be added that are currently not available.

3.1.2. Pasture (native)/grasslands information

The cow-calf operation (defined later on) relies on native pasture for the summer months (**May through October**).

1. Drag a new "Field" to your list of components.
2. Enter the name "**Native grassland**" in the 'Field name' input box.
3. Enter **100** ha for the total area of the field.
4. Select "**Pasture**" from the crop list under the 'Crop' column in "**Step 2**".
5. Note that Holos auto populates the 'Winter/Cover/Undersown Crop' column when a perennial crop type is selected
6. This grassland is not irrigated (**0** mm.) and no fertilizer is used.

3.1.3 Barley grain and mixed hay rotation

To demonstrate the crop rotation component (as opposed to using individual field components), we will assume that barley grain and mixed hay are grown in rotation, with the mixed hay under seeded to the barley so that it can be harvested in both main years (example derived from U of Alberta's Breton plots, Figure 7).

When using the "Crop Rotation" component, any sequence of crops that are input into this component will be applied to each individual field that is part of the rotation setup. This means one field is added for each rotation phase, and the rotation shifts so that each rotation phase is present on one field. Since each field can have a different historical management, soil carbon algorithms will run for each field.

For this example, we assume that the farm requires 70 ha of barley grain and mixed hay, which are grown in rotation. We will need to setup three fields where barley grain is rotated in each field every two years (Figure 7). When using the crop rotation component, the crop management input of a specific crop is repeated on each field in the rotation where the crop is grown.

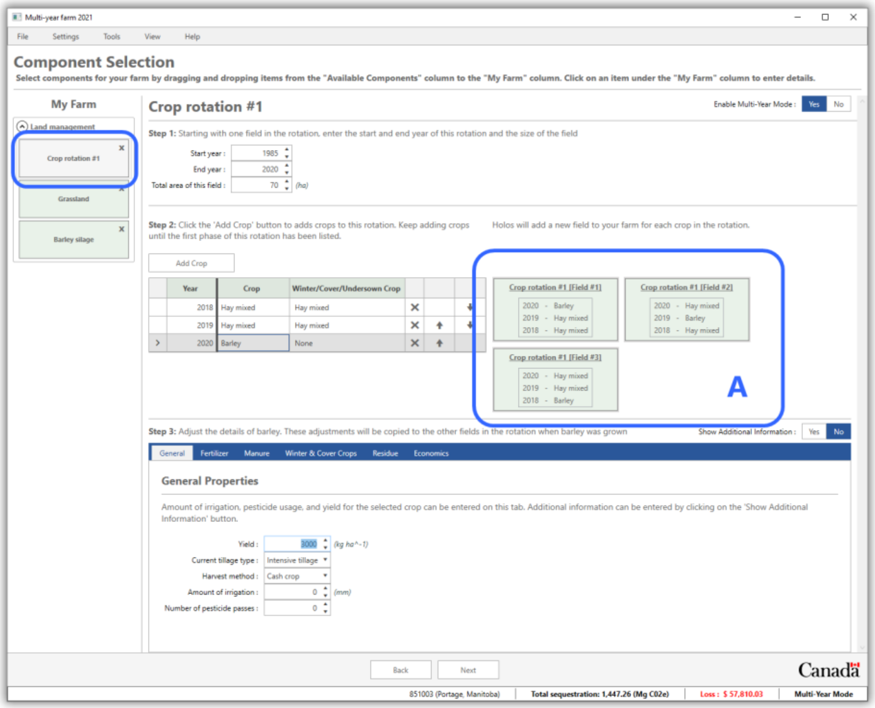


Figure 7: Barley grain and mixed hay fields using a crop rotation component

To setup the rotation:

1. Add one “Crop Rotation” component to our farm.
2. Click the “**View**” menu and select “**Hide List of Available Components**” to reduce the amount of horizontal scrolling needed when entering data.
3. The rotation for this field began in **1985** and ends in **2021**. Ensure these two values for the ‘Start year’ and ‘End year’ under ‘**Step 1**’.
4. Enter **70** ha for the ‘Total area of this field’
5. Under “**Step 2**”, change the “Crop” to “**Barley**” for the first row (2021).
6. The farm is practicing reduced tillage on the barley grain field. Change the tillage type to “Reduced tillage”
7. Enter a yield of **3,000** kg/ha (wet weight) for the barley crop. There is no irrigation and we will add one fertilizer application of urea to this crop (use the suggested application rate).
8. Click on “**Add Crop**” button under **‘Step 2’** to add a second crop to the rotation. Note that Holos sets the year for this new crop to **2020**. This means that Holos is expecting the user to enter crops that have been grown in reverse order back to 1985. Note that it is not necessary to enter a crop for each individual year going back to 1985, only enough crops to describe a single phase of the rotation will need to be entered by the user. Holos will then copy the phase information and back-populate the field history (e.g., Holos will copy the rotation back to 1985 on behalf of the user).
9. Under the “Crop” column for this 2nd crop (grown in 2020), select “**Hay mixed**” as the crop type.
10. Click on “**Add Crop**” button a final time to add another field and select “**Hay mixed**” as before.

11. To add harvest data for the two mixed hay fields:
    - Select the row for 2020 growing hay mixed.
    - Under the "Harvest" tab, click the "Add Harvest Date" button to create a new harvest, select a harvest date of "**August 31, 2020"** (assuming the harvest is done on the same day every year), select "**Mid**" for the 'Forage growth stage'. This harvest yielded **5** total bales with a bale weight of **500** kg per bale.
    - Repeat the last two steps above for the other mixed hay crop grown in 2019.

If the hay field is harvested more than once, the "Add Harvest/Grazing Date" button can be used to add subsequent harvests.

3.3. Cow-calf operation

1. Click the "**View**" menu and uncheck the "**Hide List of Available Components**" option so that we can see all of the available components again.

Adding animal components follows the exact same approach that was used for land management components. Under the 'Beef production' category, drag and drop one 'Beef Cow-Calf' component to the 'My Farm' area. Replacement heifers will not used in this example so we can remove this group from the component by clicking the "**X**" icon to the right of this animal group.

3.3.1 Entering Beef Cows, calves, and Bulls Information

3.3.1.1 Beef Cows

Following the annual feeding cycle, the beef farm we are working with is divided into three management (production) periods. We can now enter production and management data corresponding to these three management periods.

a) Our first management period will be for winter feeding (January through April)

1. Under the animal groups section in '**Step 1**', make sure that the "**Cows**" row is selected in order to enter the associated management information for that group.
2. Click the management period named "**Winter Feeding**" in '**Step 2'** to activate that management period (Figure 9b).
3. Ensure "**January 1, 2020"** is set as the 'Start date' and that "**April 30, 2020"** is set as the 'End date' (121 days). Note that the 'Number of days' being shown will be inclusive of the start and end dates.

Next, we can enter data related to the number of animals, housing type, manure system, and diet (Figure c).

1. Click on the 'General' tab and enter **150** for 'Number of animals'.

Note: *The number of animals, average daily gain, and feed quality are the minimum required inputs for calculating methane and nitrous oxide emissions. Length of management periods (i.e., duration of grazing) also will be needed. Housing and manure management information are also important inputs but are relatively more impactful on the emissions of monogastrics.*

1. We are going to create a custom diet for our group of cows during the "**Winter feeding**" management period. *(Holos incorporates feed ingredient information from the recently published Nutrient Requirements of Beef Cattle book (2016)*.
2. Click on the 'Diet' tab. Note that Holos provides a default set of animal diets that can be used. Since we are going to create our own custom diet, we will click on the '**Custom Diet Creator**' button.

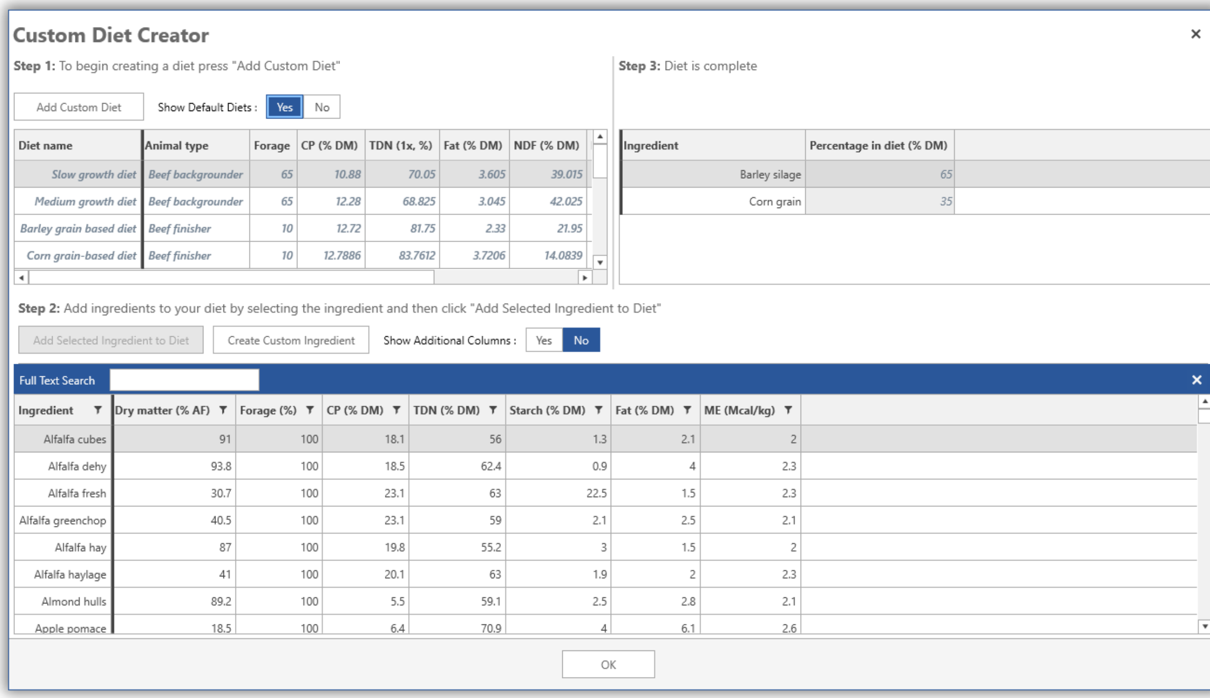


Figure 8: Custom diet creator screen

3. Click the "**Add Custom Diet**" button in the "**Step 1**" section of the screen to create a new custom diet.
4. Rename this diet to "**My Custom Cow Diet**" then press the Enter key to save the name.
5. To add ingredients to our new diet, select "**Alfalfa hay**" from the ingredient list, and then click the "**Add Selected Ingredient to Diet**" button.
6. We will add one more ingredient to our diet. Select **'Barley Hay**' from the ingredient list, and then click the "**Add Selected Ingredient to Diet**" button.
7. Enter **50**% for 'Barley Hay' and **50**% for 'Alfalfa Hay' in "**Step 3**". Note that Holos now reports the diet being complete since all ingredients total up to 100%

8. Click the “OK” button to save the new custom diet
9. Select the “My Custom Cow Diet” diet from the diet drop down-down menu.

> ***Note:*** *Diet quality information such as crude protein, total digestible nutrient, and fat are required inputs so that Holos can estimate enteric methane emissions from an animal group.*

10. Click on the ‘Housing’ tab and select “**Confined no barn**”.
11. Click on the ‘Manure’ tab and select “**Deep bedding**” from the list.

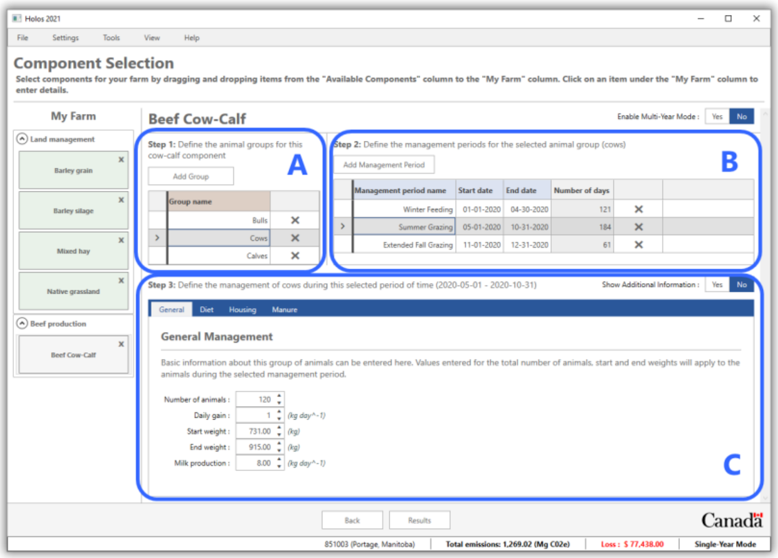


Figure 9: Beef cow-calf operation screen

b) Our second management period will be for pasture grazing during the summer months

1. Click on the management period named “**Summer Grazing**”.
2. Ensure “**May 1, 2020**” is set at as the ‘Start date’ and that “**October 31, 2020”** as the ‘End date’ column (184 days).
3. Click on the ‘General’ tab to confirm that we have **150** animals during this period
4. Select “**High energy protein**” as a default diet under the ‘Diet’ tab.
5. Select “**Pasture**” as the housing type under the ‘Housing’ tab, and then locate the pasture field (“**Native Grassland**”) that the animals will be grazing on from the ‘Pasture location’ input box. Select “**Continuous / mob grazing**” as the type of grazing. Holos will adjust carbon inputs from pastures according to the selected grazing system.
6. Select “**Pasture**” as the default manure management system under the ‘Manure’ tab.

c) Our third management period will be for extended fall grazing

1. Select the management period named “**Extended fall grazing**”.
2. Select “**November 1, 2020”** as the ‘Start date’ and “**December 31, 2020”** as the ‘End date’ for the period (61 days).
3. Click on the ‘General’ tab and enter **150** animals during this period.

4. Select "**Medium energy protein**" as the default diet.
5. Select "**Pasture**" as the housing type under the 'Housing' tab, and then locate the pasture field that the animals are grazing on ("**Native grassland**") in the 'Pasture location' input box. Select "**Switchback grazing**" as the type of grazing.
6. Select "**Pasture**" as the default manure management system under the 'Manure' tab.

3.3.1.2 Bulls

Click on the "**Bulls**" row in the animal group section "**Step 1**". Information related to diet, housing and manure management is identical to the cows group.

- Right click on the "**Bulls**" animal group. A menu will appear allowing you to select the option to copy management periods from another animal group. Since the management for the bulls is similar to the management for the cows, click the "Copy Management From" -> "Cows" sub-menu item.
- Adjust the number of bulls for each of the three management periods to **4**.

3.3.1.3 Beef Calves

Calves on our farm are born on March 1 and weaned on September 30 at the age of seven months. Using a final weaning rate of 85%, we will have 110 calves from March to September. Following the cows, calves will be in confinement for the months of March and April and will be grazing on pasture from May to September. This will result in two separate management periods.

Click on the "**Calves**" row in the animal group section "**Step 1**" to activate the calf group.

- The first management period will span from "**March 1, 2020"** to "**April 30, 2020"** (61 days), there will be a total of 110 animals, calves will be fed a "Medium energy protein" diet, in a "Confined no barn" housing type with a "**Deep bedding**" manure handling system. We will rename this management period to: "**Confinement**".
- Grazing in this second management period will span from "**May 1, 2020"** to "**September 30, 2020".** We will rename this management period to "**Grazing**".
- On the 'General' tab, change the 'Number of animals' to **110**.
- Calves will consume a "**High energy protein**" diet.
- Change the housing to "**Pasture**" where the animals will graze on the "Native grassland" field. The grazing type will be "**Continuous / mob grazing**".
- On the 'Manure' tab, ensure "**Pasture**" is set as the manure handling system.

3.4. Beef stocker & backgrounder operation

To enter information on backgrounder and stocker animals, we will add a new "Beef Stockers & Backgrounders" component to our farm.

1. Drag and drop a new "Beef Stockers & Backgrounders" component.

The beef farm manages 200 backgrounders (100 steers and 100 heifers).

1. Click on the "**Heifers**" group to activate it and to enter management data to this group.

2. For “**Management period #1**”, enter “**October 1, 2020”** as the ‘Start date’ and “**January 18, 2021”** as the ‘End date’ (110 days).
3. Click on the ‘General’ tab and enter **100** for number of animals, **1.1** kg/day for daily gain, 240 for ‘Start weight’.
4. The 100 heifers are fed a “**Medium Growth**” diet and managed in a “**Confined no barn**” housing type with a “**Deep bedding**” manure handling system.

Right-click on the “**Steers**” group to activate the context menu. In the menu that appears, select “Copy Management From” -> “Heifers”

3.5. Finishing feedlot operation

We will now repeat the steps used for “Beef Stockers & Backgrounders” to enter the beef feedlot management data. Drag a new “Beef Finisher” component from “All components” to your list of components.

The beef farm manages 200 feedlot animals (100 steers and 100 heifers) in a feedlot operation for **170 days**.

1. Select the “**Heifers**” group
2. For “**Management period #1**”, enter “**January 19, 2021”** as the ‘Start date’ and “**July 7, 2021”** as an ‘End date”.
3. Enter **100** for number of animals, an average daily gain of **1.2** kg/day, and **350** kg as the ‘Start weight’.
4. Feedlot animals are fed a “**Barley grain-based diet**”, housing type will be “**Confined no barn**”.
5. The manure management system will be “**Deep bedding**”.

Click on “**Steers**” group to activate the group. Management data for this group of animals is the same as for the “**Heifers**” group.

1. Right-click on the “Steers” group to activate the context menu. In this menu we can then select “Copy Management From” -> “Heifers”

3.5.1. Adding a Manure Application to the Wheat Field

Holos has the ability to add manure applications from manure that is sourced from livestock on the current farm or from imported manure (off-site). Since we have now defined our animal components, we can apply manure to any field on our farm.

1. Select the “**Wheat & hairy vetch**” field from the list of components added to our farm.
2. Click on the ‘Manure’ tab and then click the “**Add Manure Application**” button. Select “**Beef cattle”** as the ‘Manure type’, select ‘**Livestock**’ as the “Origin of manure”, **‘Solid storage’** as the ‘Manure handling system’, and enter **1,000** kg/ha as the amount of manure applied to this field.
3. Note that both chemical fertilizers and manure applications can be made on the same field.

3.5.2. Adding supplemental hay/forage for grazing animals

We can also add additional hay/forage for animals that are grazing on a particular field. Since we have now placed a group of animals on the “Native Grassland” field component, and we have also provided harvest information for our mixed hay crops on the crop rotation component, we can then add an additional forage supplement for these grazing animals.

1. Select the “**Native Grassland**” field component we created earlier.
2. Click on the ‘Grazing’ tab.
3. Click the “**Add Supplemental Hay**” button to add additional forage for the animals on this field.
4. Change the ‘Number of bales” to **1**, change the wet bale weight to **500** kg.

3.6 Pullet farm operation

We will add one last animal component to our farm. In addition to the beef cattle operations of this farm, we will also be adding a “Chicken Meat Production” component to our farm. If you hover your mouse cursor over the “Chicken Meat Production” component under the “Poultry” category, Holos will display a tooltip that gives a brief description of a chicken meat production operation:

“Chicks arriving in the operation from a multiplier hatchery are raised to market weight (1-4 kg)”

1. Drag one “Chicken Meat Production” component to the farm.
2. This operation has 400 pullets and 400 cockerels.
3. Click the “**Pullets**” group to select it.
4. Adjust the 3 management periods for this group so that there are 400 animals during each of these periods.
5. The group of cockerels has the same management as the pullets. Right click on the “**Cockerels**” group and copy the management from the “**Pullets**” group.

4. Timeline Screen

We are now finishing defining our farm. Click the “Next” button to go forward to the timeline screen.

The timeline screen (Figure 10) provides a visual layout of all the fields from 1985 to the specified end year for each field. This screen also allows the user to add historical and projected production systems. The “**Add Historical Production System**” button enables the user to add a different cropping history to individual fields whereas the “**Add Projected Production System**” button enables the user to add a future (projected) cropping system to individual fields.

Adding a historical production system

We will assume that the barley grain and mixed hay rotation fields were previously in a continuous wheat cropping system between 1985 and 2000.

1. To add a new historical cropping system, select one of the fields that are in the barley grain and mixed hay rotation. To select an item, click on the timeline bar to activate that field. We will select the first field in this rotation (i.e., the field with the name of "**Crop rotation #1 [Field #1]**")
2. Click on the "**Add Historical Production System**" button which will add a new row to the table under the "**Step 1**" section in the upper left section of the screen. Notice that this new entry has the words "Historical management practice" added.
3. We will set the end year of this historical management practice to the year **2000**. To adjust the we use the numeric up/down buttons within the cell (Figure 11).
4. We then click the "**Edit Selected**" button. This will open a new screen (Figure 12) that allows us to adjust the crops grown and the management during this period.
5. Click on the "**Barley**" crop under the "**Step 2**" section. Change the crop type to 'Wheat' and on the 'General' tab change the yield to **3,500** kg/ha. We will keep the other settings unchanged.
6. We also need to remove the "Hay mixed" crops from this historical period. Click the '**x**' icon beside each of the "Hay mixed" crops under the "**Step 2**" section. Clicking the '**x**' icon will remove these crops from the rotation for this period of time.
7. Click "Ok" to save adjustments we just made to this field.
8. Repeat these same steps so that the other fields in this rotation also have continuous wheat from 1985 to 2000 using the same steps we used for the first field.

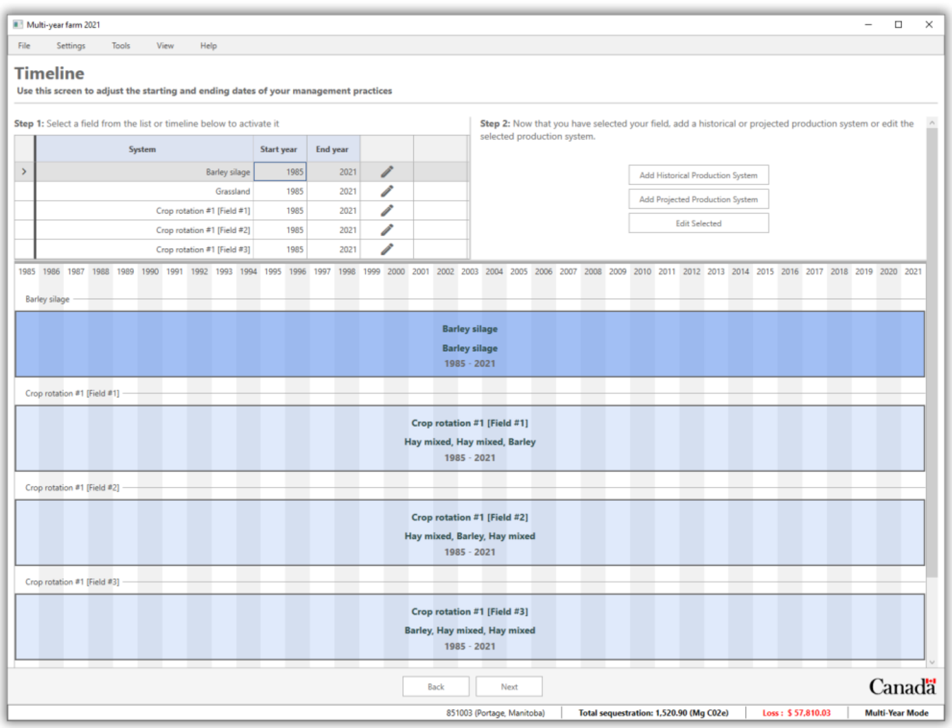


Figure 10: Customized timeline screen

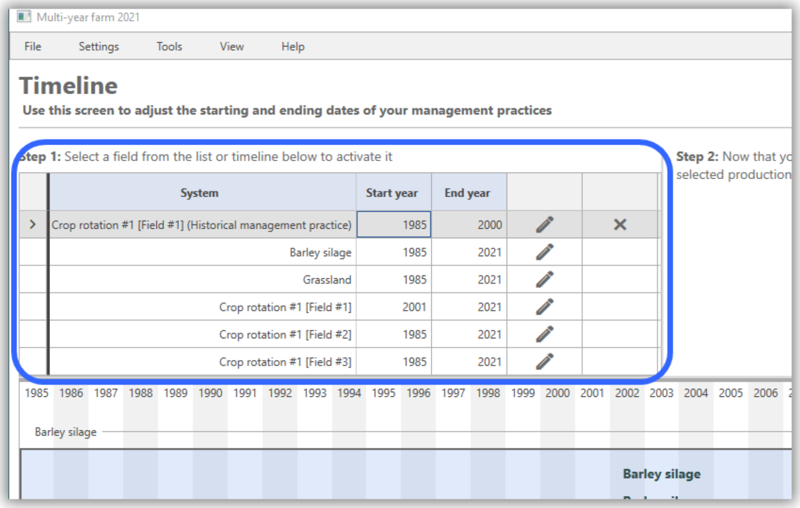


Figure 11: Adjusting the start and end year for productions systems on the timeline screen

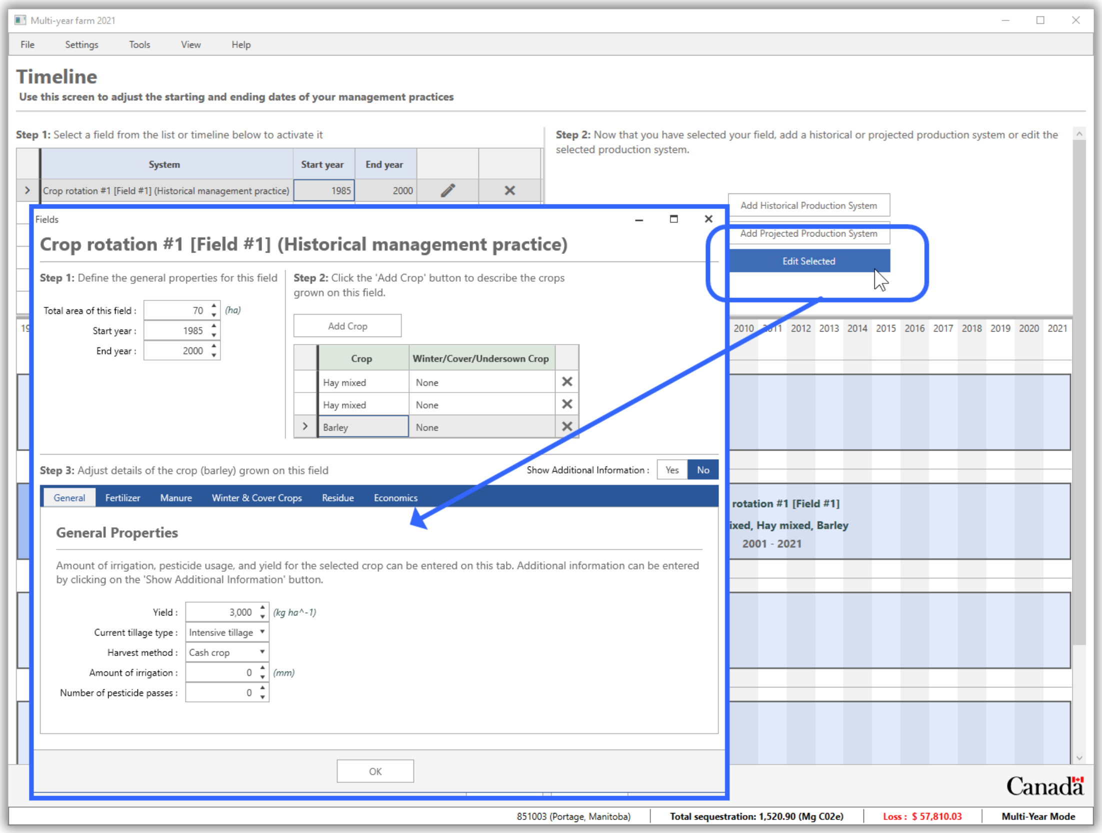


Figure 12: Editing crops in a historical period of the rotation

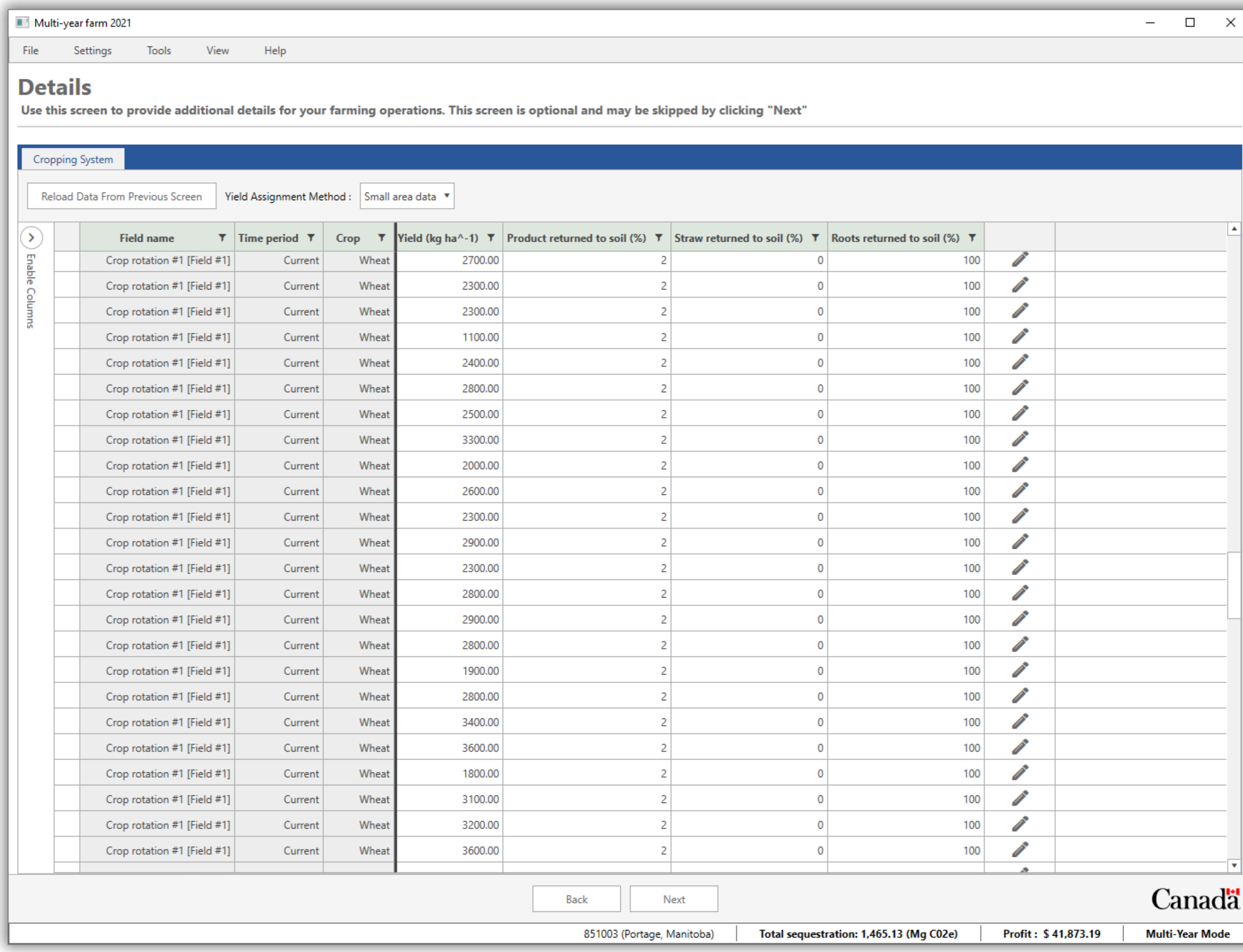
5. Details Screen

Click the “Next” button to go forward to the details screen.

To avoid the requirement that a user needs to provide crop yields going back to 1985 for each field on the farm, the model will use Stats Canada reported crop yields as defaults (where available). The model allows the user to calculate how changes in crop type, yield, tillage, residue management, manure, irrigation or fallow will result in changes to soil carbon.

We will adjust this grid so that we can view the above ground and below ground carbon inputs for our wheat field and then we will adjust the crop yield for one specific year.

1. We will set a filter on the first column named ‘Field name’ so that we only display information for our wheat and hairy vetch field. Beside the column heading, click the ‘funnel’ icon to set a filter. Check the box beside “**Wheat & hairy vetch**”.
2. On the far left of this screen, click the “**Enable Columns**” sidebar (located near the “Field name” column).
3. Place a check beside “**Above ground carbon input**” to show the column and remove the check beside the “**Notes**” column to hide it.
4. Click the “**Enable Columns**” sidebar again to collapse it.
5. We can now (optionally) adjust the yields for our wheat field for any given year if actual measured yields are available.
6. Adjust the yield for **1987** to be **4,100** kg/ha.
7. Note that Holos has updated the above ground carbon inputs for this.



Field name	Time period	Crop	Yield (kg ha^-1)	Product returned to soil (%)	Straw returned to soil (%)	Roots returned to soil (%)
Crop rotation #1 [Field #1]	Current	Wheat	2700.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2300.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2300.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	1100.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2400.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2800.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2500.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	3300.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2000.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2600.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2300.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2900.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2300.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2800.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2900.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2800.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	1900.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	2800.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	3400.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	3600.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	1800.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	3100.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	3200.00	2	0	100
Crop rotation #1 [Field #1]	Current	Wheat	3600.00	2	0	100

Figure 13: Details screen

6. Discover results

Click the “Next” button to move to the final results report. Results will now be displayed in a variety of reports and charts.

1. Click on the tab named “Emissions Pie Chart”

Starting with the “Emissions pie chart” we can see an overall breakdown of the enteric CH_4, manure CH_4, direct and indirect N_2O. We are also able to see a detailed breakdown of the sources of these emissions.

2. Click the “Yes” button beside ‘Show details’

We can see that the biggest source of emissions from our farm is the cow-calf component. If you hover your mouse pointer over any slice of this chart you can get an isolated look at the different emission sources.

3. Click on the tab named “Detailed Emission Report”

The “Detailed Emission Report” (Figure 14) will display a monthly or annual GHG emission report.

The detailed emission report will report on enteric methane, manure methane, direct & indirect N_2O, and CO_2 emissions from the farm.

Click the “Report Format (Monthly)” button (Figure 14a) to switch to a monthly report. Now we can see a monthly breakdown of all emissions from the farm and the emission source.

In the “Unit of measurements” drop-down menu (Figure 14b), you can choose to have the results displayed as CO_2 equivalents (CO_2e) or as unconverted greenhouse gas (GHG), and you can also choose the unit of measurement as either tonnes or kilograms.

The “Estimate of Production” report (Figure 15) provides total harvest yields, amount of land applied manure, and estimates of milk production for dairy components.

The “Feed Estimate” report provides an estimate of dry matter intake based on energy requirements of the animal and the energy in the feed.

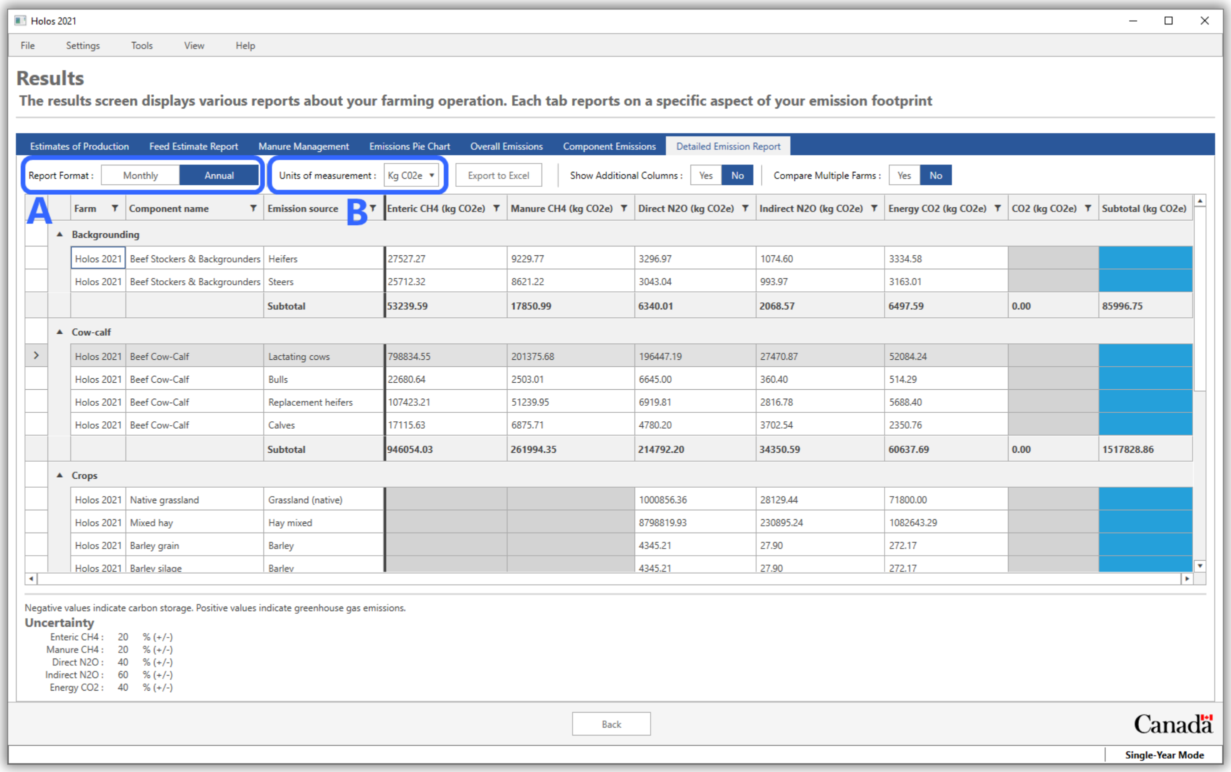


Figure 14: Detailed emission report

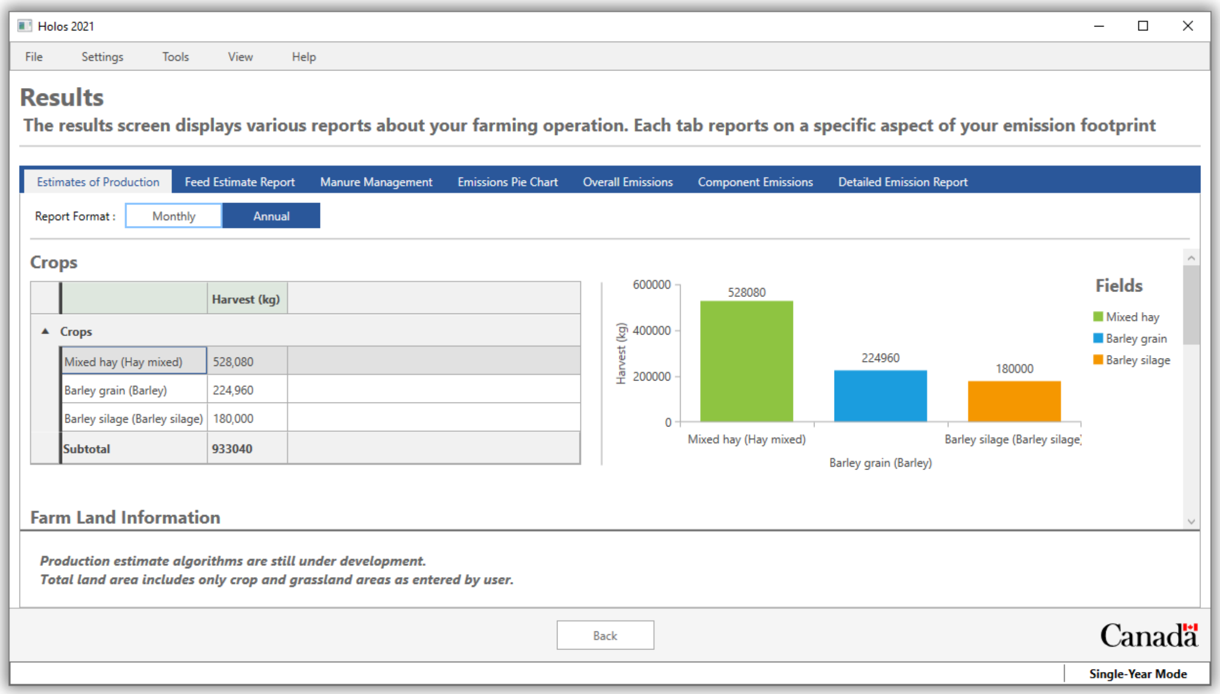


Figure 8: Estimates of production report

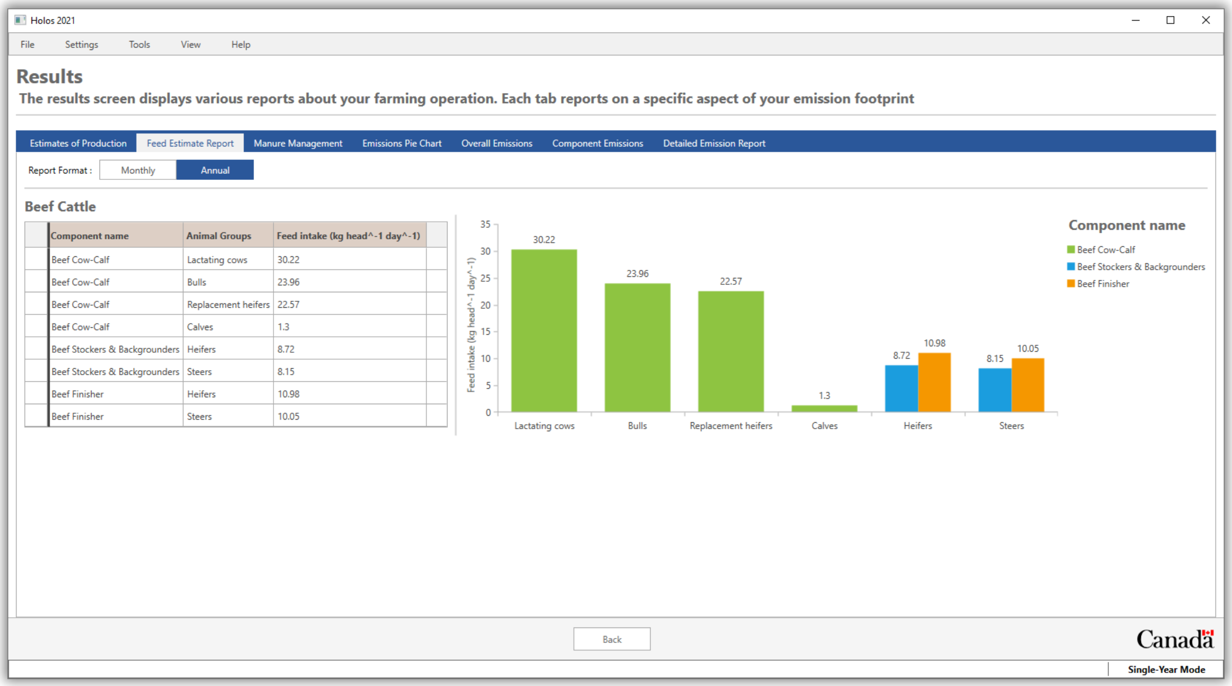


Figure 16: Feed estimate report

6.1 Soil carbon modelling results

On the results screen we can see the change in soil carbon over time by clicking the "**Multiyear Carbon Modelling**" tab. This tab displays a graph showing the change in soil carbon over time for each one of our fields.

For each field on the graph, you can hover your mouse over the series to get more information for each historical year of the field.

If we click on one of these points, we can then view a more detailed breakdown of these results. We can also export this data by clicking the "Export to Excel" button.

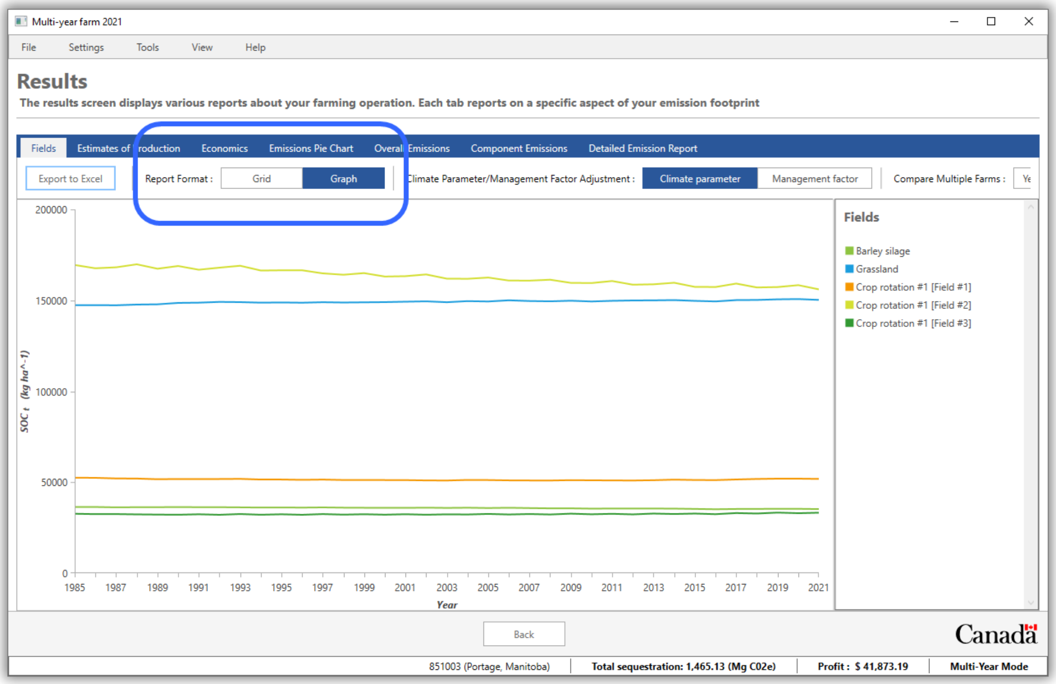


Figure 9: changing the report format in multi-year mode

7. Finally…

Whole-systems approach

An ecosystem consists of not only the organisms and the environment they live in but also the interactions within and between. A whole systems approach seeks to describe and understand the entire system as an integrated whole, rather than as individual components. This holistic approach can be very complex and describing the process can be difficult. One method to conceptualize a whole system is with a mathematical model. The whole-systems approach ensures the effects of management changes are transferred throughout the entire system to the resulting net farm emissions. In some cases, reducing one GHG will actually increase the emissions of another. The whole-systems approach avoids potentially ill-advised practices based on preoccupation with one individual GHG.

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