Census of Agriculture: Agri-Environmental Spatial Data

User guide

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About this guide

This guide is intended for users of the Census of Agriculture: Agri-environmental Spatial Data (AESD) product, specifying its content and the methods used to produce it.

Introduction

Every five years, the Census of Agriculture (CeAg) provides a comprehensive and integrated profile of the physical, economic, social and environmental aspects of Canada's agriculture industry; it is the only data source that consistently provides high-quality detailed statistical information on agriculture for small geographic areas. It collects a wide range of data at the national, provincial and sub-provincial levels, such as the number of farms and farm operators, farm area, farm size, farm type, land use, crop areas, land management practices, livestock inventories, business operating arrangements, farm operating revenues, farm operating expenses, farm capital, and farm machinery.

The CeAg not only provides a snapshot in time of the agriculture industry, but is also essential for understanding changes over time, thus serving as a basis for informed public and private decision making.

The Census of Agriculture Portal is the main entry point for data and related information. The Guide to the Census of Agriculture is also useful for understanding various aspects such as determining its content, the collection process, data processing and dissemination.

Since the census methodology is to assign all data relating to a farming operation to its main location, there is some distortion in the geographic distribution of the data. Medium and large operations often operate in different municipalities. It has been proven that between 30% and 40% of operations producing field crops have plots in more than one municipality.

To counter this effect, the CeAg team produced a complementary dataset to the base data, the Agri-Environmental Spatial Data (AESD), which provides a wide selection of farm-level data to improve the distribution spatial production activities. Therefore, the AESD database offers clients the possibility to better analyze the impact of agriculture activities on the environment and produce key indicators, or for any applications where accurate location of activities matters.

Variables are offered using two types of physical boundaries: by Soil Landscape of Canada (SLC) polygons and by Sub-sub-drainage areas (SSDA), or watersheds. The focus of the redistribution of the data is on the field crops and land use variables, but the database includes all census variables related to crops, livestock, and management practices.

This frame can also be used to extract CeAg data by custom geographic areas. Also, users interested in this version of the CeAg database using administrative types of regions can request it. In both cases, please contact Statistics Canada.

Data sources

The Census of Agriculture 2021 is the main data being used to benchmark and reference the AESD.

There were two primary administrative data sources used to allocate data for agricultural commodities:

A- the Annual Crop Inventory classification map from satellite imagery produced by Agriculture and Agri-Food Canada (AAFC). This product was published at a spatial resolution of 30 metres, therefore with a geographic level much more accurate than the CeAg data, which are aggregated at the level of census consolidated subdivisions.

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B- Crop insurance datasets: these data are provided by various provincial agencies and provide the precise location and content of each individual crop plot. Again, the geographic precision far exceeds that of the CeAg data.

Given their high geographic precision, these data sources were favored in preparing the AESD, provided that their coverage and precision have been deemed acceptable (see Methodology section). However, these data sources only cover some of the agricultural commodities that were included in the CeAg, almost exclusively field crops; commodities such as livestock and other crops are currently not available in the alternative data sources, or do not have sufficient coverage or accuracy. As such, there were some commodities that were automatically distributed from the CeAg 2021 data.

Since usage of the AESD is mainly designed to analyze the impact of agriculture activities on the environment and produce key indicators, the dataset is produced using two types of physical polygon boundaries that are usually better suited for these applications:

A- Soil Landscapes of Canada (SLC), version 3.2: this dataset describes the spatial distribution of soils and associated landscapes. This is the base used to establish the various levels of the National Ecological Framework (ecodistricts, ecoregions, and ecozones). There are 3,889 soil landscape regions represented in the AESD.

Figure 1 - Coverage of the Census of Agriculture Agri-Environmental Spatial Database using Soil Landscapes of Canada polygon boundaries
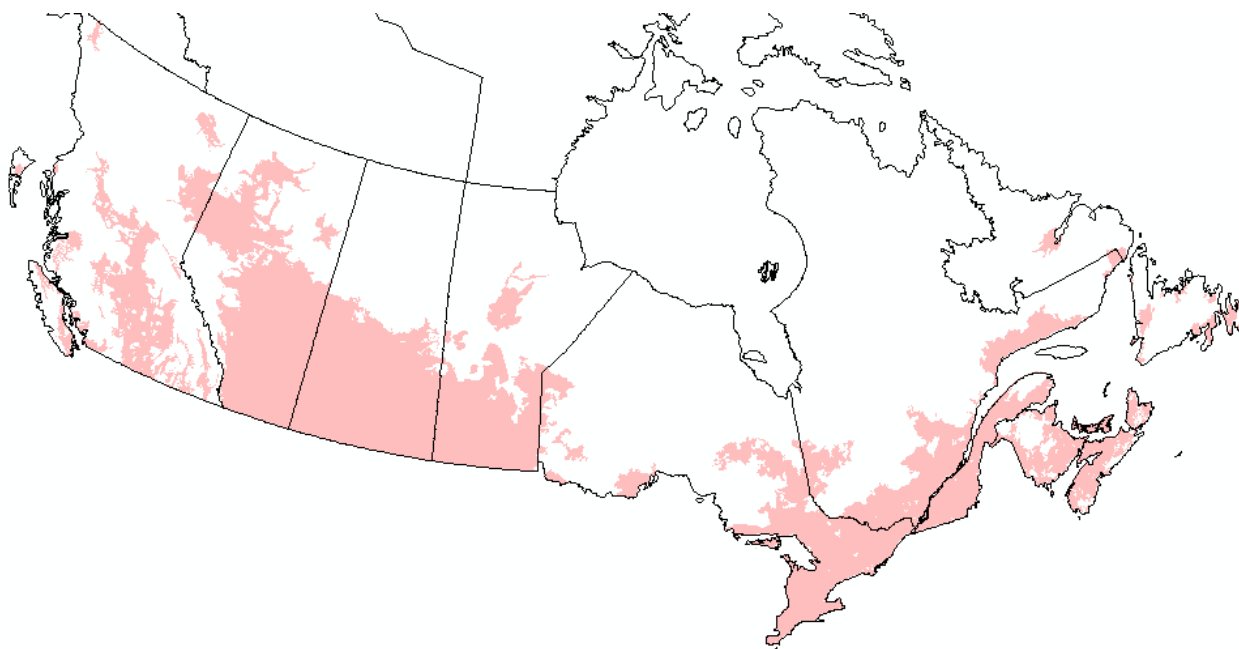
B- National Hydro Network: this dataset is using sub-sub-drainage areas (SSDA) as the base for defining regions. These regions can be amalgamated to form subdrainage areas and major drainage areas. There are 577 SSDAs represented in the AESD.

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Figure 2 - Coverage of the Census of Agriculture Agri-Environmental Spatial Database using the National Hydro Network polygon boundaries
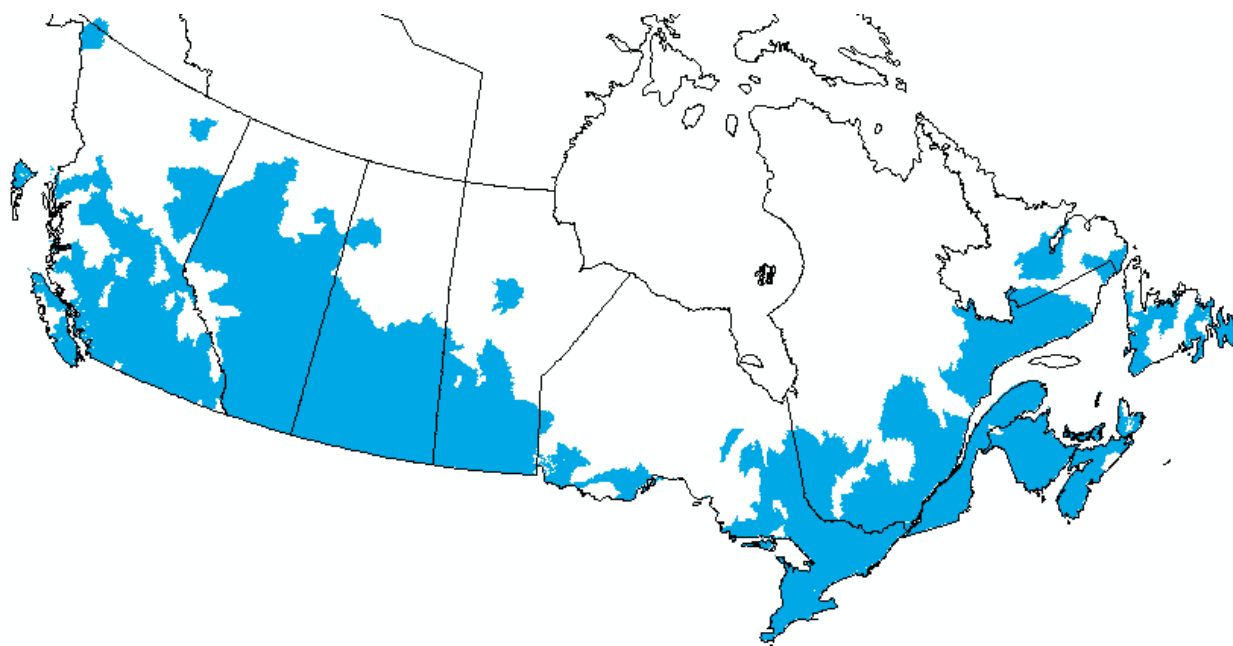
Both boundary files used the Albers conical equal area projection with the following parameters:

Central meridian: 91.867 ° West
Standard parallels: 49° and 77° North
False Easting: 6,200,000
False Northing: 3,000,000
Latitude of origin: 63.390675° N

Methodology

Selection of data source

The decision on the choice of data source between the three options (Annual Crop Inventory, crop insurance data, CeAg base data) was made at the level of each individual variable within each province. The coverage of each variable and the quality of the two alternative data sources were not equal between the provinces and so the methodology was established to take advantage of the best available data source. The data source for a given data point may vary, and is not disclosed in the release data.

The following decision criteria were established to choose the most representative source based on the availability of the variable, as well as its coverage and consistency in its geographic distribution with sub-provincial data from the CeAg. Coverage is used in this report to describe the proportion between the total area included in the alternate data source by the total area published by the Census of Agriculture for a given province.

1) If the variable is available in one of the Annual Crop Inventory or Crop insurance data, and its absolute difference in coverage is less than 30% of the published CeAg provincial total, that dataset was selected for that province. It was determined that a difference of less than 30% with

the provincial total would not cause significant bias when calibrating the data at the provincial level.

2) If the variable is available in both the Annual Crop Inventory and the Crop Insurance datasets, the Kolmogorov-Smirnov test statistic was calculated with the CeAg data at the sub-provincial scale for each province and each variable independently. This test statistic was used as a comparison metric to select which of the two data sources had a distribution which was more similar to CeAg. The dataset with the distribution closest to that of CeAg was selected, as long as its provincial total was within 30% of the provincial total published by CeAg.

3) If the provincial total of the dataset selected in step 2 had an absolute difference in coverage greater than 30% with the CeAg published total, the second dataset was selected, provided that:
   a. The Kolmogorov–Smirnov test result was within 2% of the test result with the first dataset previously rejected
   b. The provincial total had an absolute difference of less than 30% of the total published by the CeAg

4) If conditions 3a. and 3b. were not satisfied, the two alternative datasets were not used. Instead, the data from the CeAg was used in the geographic redistribution to polygons of SLCs and SSDAs.

5) A final assessment was made when data from the Annual Crop Inventory was selected for a variable and a province. Inventory data were compared with ground-truth data: if the precision for the crop being assessed was below 60% (by calculating the user and producer accuracy), this data source was rejected due to its poor reliability. Crop insurance data was then selected if its coverage was within 30% of the provincial total published by the CeAg.

Redistribution and calibration of data

Annual Crop Inventory

A geographic information system (GIS) was used to sum the pixels belonging to each crop type for each SLC and SSDA polygon, these sums being then converted into units of area (hectares). These totals were then calibrated with data from the CeAg to make them consistent. In other words, if the total area of a commodity reported in the Annual Crop Inventory was 90% of the provincial census total, the values per polygon were increased by 10% for all regions uniformly.

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Figure 3 - Sample of Annual Crop Inventory data (colored polygons) represented with Soil Landscapes of Canada polygons (black outlines)
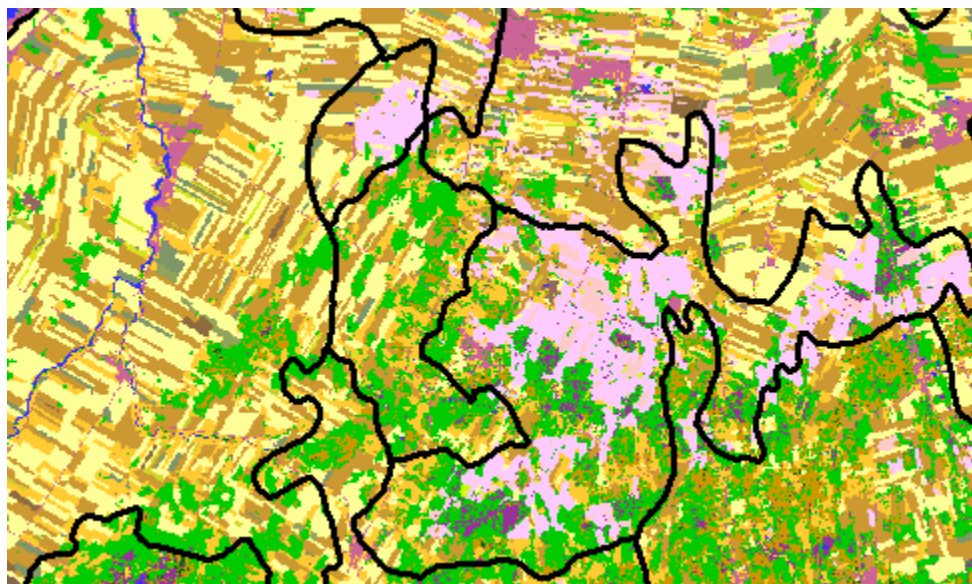
Crop insurance data

A GIS was used to assign each insured crop parcel centroid to a SLC and SSDA polygon. The areas were then aggregated by crop type for each of these polygons. Finally, these data were subsequently calibrated with data from the CeAg so that the provincial totals matched. In other words, if the total area of a commodity reported in the Annual Crop Inventory was 90% of the provincial census total, the values per polygon were increased by 10% for all regions uniformly.
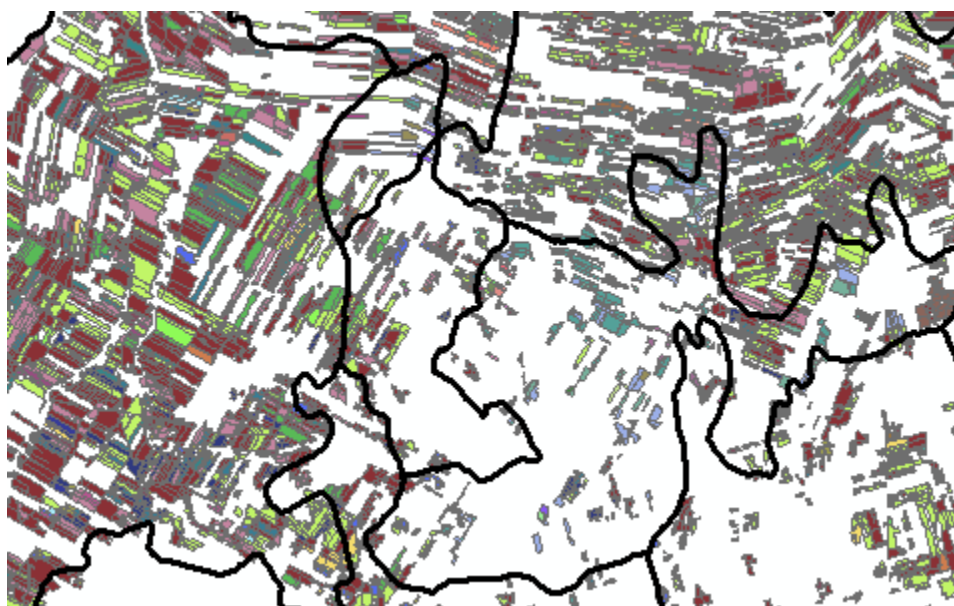
Figure 4 - Sample of crop insurance data (colored polygons) represented with Soil Landscapes of Canada polygons (black outlines)

Census of Agriculture data

In the case where the basic CeAg data were selected, the redistribution of data according to SLCs and SSDAs used a different technique than the two previous sources. Given the relatively large size of census consolidated subdivisions (the most precise level of geography used when disseminating CeAg data) a spatial intersection was performed between the two polygon layers using a GIS. In addition, to optimize data redistribution, an agricultural layer was generated from the sum of all crop and pasture classes from the 2021 Annual Crop Inventory. This layer was used to limit the redistribution of data only in agricultural areas. In the sample in Figure 4, data from census consolidated subdivision CCS2452055 was assigned to SLC polygon 540052 at 75%, polygon 540060 at 20%, and only 5% of polygon 426004 (given the near absence of agricultural zone in this last region).

Figure 5 – Overlay of Census of Agriculture unified census subdivision boundaries (black outlines), Soil Landscapes of Canada polygons (magenta outlines) and agricultural layer (orange)
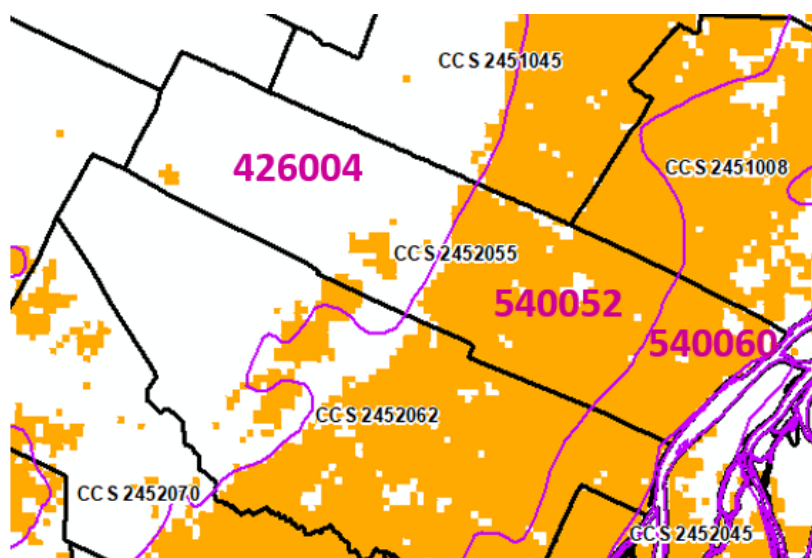
Variables of the AESD

As mentioned in the introduction, only data relevant to measuring the impact of agricultural activities on the environment and the production of key indicators were included. The complete list of included variables is provided in Appendix A. Note that no farm counts for any variable were included in this database.

This is the list of variable categories included and not included in the AESD:

Included:

- • Land use
- • Land inputs
- • Agricultural practices (partially)
- • Crops (field crops, vegetables, fruits, greenhouses and other crops)
- • Livestock, poultry, bees
- • Manure production

Not included:

- • Characteristics of agricultural operations
    - o Type of agricultural operations
    - o Size of agricultural operations
    - o Financial characteristics
    - o Operating arrangement
    - o Paid agricultural work
    - o Technologies used
    - o Renewable energy production
- • Farm operator characteristics
    - o Age and gender
    - o Working hours
- • Land tenure
- • Number of farms for any variable

Data quality

CeAg data

The quality of the CeAg data varies by commodity and by province. Since the AESD estimates were calculated based on CeAg's census consolidated subdivision (CCS) estimates using the methodology described earlier in the document, one can infer a proxy-quality level for the nearby SLC and SSDA geographies by referencing the CCS quality indicators available inside the CeAg publication tables.

Annual Crop Inventory data

The Annual Crop Inventory data covers all of Canada's agricultural land but is limited to between 40 and 50 crop classes which do not always line up directly with the CeAg themes. The quality of the classification varies by crop class and by province.

As detailed earlier in the document, coverage was assessed by comparing a commodity's provincial total calculated based on the Annual Crop Inventory to CeAg's provincial total to ensure the data was fit for use in the AESD.

Additionally, provincial commodity-level accuracies provided by Agriculture and Agri-Food Canada (the author of this publication) were evaluated to ensure that this source of data was not considered when the accuracies were deemed to be too low for use in the AESD.

Crop insurance data

Based on past field work, crop insurance data are known to have a very high accuracy. The coverage, however, varies by commodity and by province as it depends on the farmer insuring their crops, so not all crops are insured at the same rate. As previously mentioned, the provincial total calculated from crop insurance data is compared to CeAg's provincial total to assess the coverage and ensure that it is fit for use in the AESD.

Crop insurance data are only available for Alberta, Saskatchewan, Manitoba, Ontario, and Quebec.

Other points to consider

Note that provincial and national totals of the AESD may differ somewhat between calibrated datasets with CeAg totals due to adjustment factors and rounding, but these differences were less than 0.01%.

Note also that there are inconsistencies regarding some area variables: existing distortions in the CeAg data sometimes had to be transferred to the AESD due to the non-availability of the variable in the alternative data sources or due to the lack of coverage or precision of these variables for certain provinces. However, these distortions have been reduced.

Other types of inconsistencies exist in some variables of the "Land inputs" category – the data for these variables have not been redistributed using the alternative data, unlike the field crop area variables, because it was not possible to know to which type of crop the inputs referred.

In all cases, aggregating these data at higher geographic levels gradually eliminates these inconsistencies.

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Appendix A – Complete list of variables included in the Agri-Environmental Spatial Data

The variables are presented in alphabetical order of variable code by category.

Category « Land use » - area in hectares

Variable code	Definition
CRPLND	Land in crops (excluding Christmas tree area)
IMPAST	Tame or seeded pasture
OTHLAND	All other land
SUMMRF	Summerfallow land
TFAREA	Total farm area
UNIMPAST	Natural land for pasture
WOODWET	Woodlands and wetlands

Category « Management practices » - area in hectares

Variable code	Definition
CHEMSF	Weed control on summerfallow land: chemical only
COMBSF	Weed control on summerfallow land: tillage and chemical combination on the same land
CROPRES	Baled crop residue in the calendar year prior to the census
IRRIG	Total use of irrigation in the calendar year prior to the census
TILARS	Total land prepared for seeding
TILCONS	Tillage retaining most crop residue on the surface
TILCONV	Tillage incorporating most crop residue into soil
TILLNO	No-till seeding or zero-till seeding
TILLSF	Weed control on summerfallow land: tillage only

Category « Land inputs » - area in hectares

Variable code	Definition
FERTIL	Use of commercial fertilizer (including lime) in the calendar year prior to the census
FUNGIC	Use of fungicides in the calendar year prior to the census
HERBCI	Use of herbicides in the calendar year prior to the census
INSECTI	Use of insecticides in the calendar year prior to the census
LIME	Use of lime in the calendar year prior to the census
MINRAL	Use of trace minerals and nutrients (copper, manganese, etc.) in the calendar year prior to the census
MLIQINJ	Liquid manure injected or incorporated into soil in the calendar year prior to the census
MLIQSUR	Liquid manure not incorporated into soil in the calendar year prior to the census
MSCOMPIN	Solid or composted manure, incorporated into soil in the calendar year prior to the census

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MSCOMPNO	Solid or composted manure, not incorporated into soil in the calendar year prior to the census
TRTSEED	Treated seed, prior to planting

Category « Hay and field crops »- area in hectares

Variable code	Definition
ALFALFA	Alfalfa and alfalfa mixtures
BARLEY	Barley
BUCWHT	Buckwheat
CANARY	Canary seed
CANOLA	Canola (rapeseed)
CHICPEA	Chick peas
CORNGR	Corn for grain
CORNSI	Corn for silage
DFPEAS	Dry field peas
FABABN	Faba beans
FLAXSD	Flaxseed
FORAGE	Forage seed for seed
GINSENG	Ginseng
HEMP	Hemp
LENTIL	Lentils
MUSTSD	Mustard seed
MXDGRN	Mixed grains
OATS	Oats
ODFBNS	Other dry beans
OFIELD	Other field crops
OTTAME	All other tame hay and fodder crops
POTATS	Potatoes
RYEFAL	Fall rye
RYESPG	Spring rye
SOYBNS	Soybeans
SUGARB	Sugar beets
SUNFLS	Sunflowers
TOFDCP	Total field crops
TOTCORN	Total corn
TOTRYE	Total rye
TOTWHT	Wheat (total)
TRITCL	Triticale
WHITBN	Dry white beans
WHTDUR	Durum wheat
WHTSPG	Spring wheat (excluding durum)
WHTWIN	Winter wheat

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Category « Vegetables (excluding greenhouse vegetables) »- area in hectares

Variable code	Definition
ASPNPRD	Asparagus, non-producing
ASPPROD	Asparagus, producing
BEANS	Green and wax beans
BEETS	Beets
BROCLI	Broccoli
BRSPRT	Brussels sprouts
CABAGE	Cabbage
CARROT	Carrots
CELERY	Celery
CHINCABG	Chinese cabbage
CLFLWR	Cauliflower
CUCUMB	Cucumbers
GARLIC	Garlic
GRPEAS	Green peas
KALE	Kale
LETUCE	Lettuce
ONIONS	Dry onions, yellow, Spanish, cooking, etc.
OTHVEG	Other vegetables
PEPPER	Peppers
PUMPKIN	Pumpkins
RADISH	Radishes
RHUBARB	Rhubarb
RTBAGA	Rutabagas and turnips
SHALOT	Shallots and green onions
SPNACH	Spinach
SQUAZUC	Squash and zucchini
SWCORN	Sweet corn
TOMATO	Tomatoes
TOTVEG	Total vegetables

Category « Fruits, berries and nuts »- area in hectares

Variable code	Definition
APCTTA	Apricots total area
APPLETA	Apples total area
BLUEBTA	Blueberries total area
CRANBTA	Cranberries total area
CURRANT	Blackcurrants, redcurrants and whitecurrants
GRAPETA	Grapes total area
HASKAPTA	Haskaps
HBLUEBTA	Blueberries, highbush
LBLUEBTA	Blueberries, lowbush
OTFRTTA	Other fruits, berries and nuts total area

PEARTA	Pears total area
PECHTA	Peaches total area
PLUMTA	Plums and prunes total area
RASPBTA	Raspberries total area
SASKBTA	Saskatoon berries total area
SRCHTA	Cherries (sour) total area
STRWBTA	Strawberries total area
SWCHTA	Cherries (sweet) total area
TOTFRT	Total area of fruits, berries and nuts (producing and non-producing)

Category « Greenhouse products » - area in square metres

GRNCUCUMB	Greenhouse cucumbers
GRNFLOWER	Cut flowers
GRNHERB	Greenhouse herbs
GRNOTHER	Other greenhouse products
GRNOTHVEG	Other greenhouse fruits and vegetables
GRNPEPPER	Greenhouse peppers
GRNPLANTS	Potted plants, indoor or outdoor
GRNTOMATO	Greenhouse tomatoes
TGRNFRTVEG	Total greenhouse fruits and vegetables
TOTGRN	Total area of greenhouses in use
TUNDGLAS	Total area under glass, plastic or other protection

Category « Other crops » - units specified for each variable

AGMUSHRM	Agaricus mushrooms – area in square metres
MAPLET	Taps on maple trees in the spring of the census year – Number
MUSHRM	Total growing area for mushrooms – area in square metres
NURSERY	Total area of nursery products – area in hectares
OTHSPMUSH	Specialty mushrooms, other methods of production – area in square metres
SOD	Total area of sod under cultivation for sale – area in hectares
SPMUSHBAG	Specialty mushroom, bags – area in square metres
SPMUSHLOG	Specialty mushroom, logs – area in square metres
TOTSPMUSH	Specialty mushrooms, total – area in square metres
XMASAREA	Total area of Christmas trees grown for sale – area in hectares

Category « Livestock » - number of animals

Variable code	Definition
BFCOWS	Beef cows
BFHEIF	Heifers for beef herd replacement
BISON	Bison (buffalo)
BOARS	Boars
BULLS	Bulls, 1 year and over

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CALFU1	Calves, under 1 year
DEER	Deer (excluding wild deer)
DONKEYS	Donkeys and mules
ELK	Elk
EWES	Ewes
FDHEIF	Heifers for slaughter or feeding
GOATS	Goats
GRWPIG	Grower and finishing pigs
HORSES	Horses and ponies
LAMAS	Llamas and alpacas
LAMBS	Lambs
MINK	Mink
MKTLAMBS	Markel lambs
MLKCOW	Dairy cows
MLKHEIF	Heifers for dairy herd replacement
NRSPIG	Nursing pigs
RABBIT	Rabbits
RAMS	Rams
REPLAMBS	Replacement lambs
SOWS	Sows and gilts for breeding
STEERS	Steers, 1 year and over
TCATTL	Total cattle and calves
TOPIGS	Total pigs
TOTCOW	Total cows
TOTHEIF	Total heifers, 1 year and over
TSHEEP	Total sheep and lambs
WEANPIG	Weaner pigs

Category « Poultry » - units specified for each variable

Variable code	Definition
BREEDCHK	Layer and broiler breeders (pullets and hens) – Number
BROILER	Broilers, roasters and Cornish – Number
BROILPRD	Broilers, roasters and Cornish production in the calendar year prior to the census – Kilograms
DUCK	Ducks – Number
EGGHATCH	Hatching egg production in the calendar year prior to the census – Dozens
EGGTABL	Table egg production in the calendar year prior to the census – Dozens
GEESE	Geese – Number
HATCHNUM	Chicks or other poultry hatched in the calendar year prior to the census – Number
LAYHEN	Laying hens, 19 weeks and over – Number
OTHPLT	Other poultry – Number
PULETS	Pullets under 19 weeks, intended for laying – Number
TCHICK	Total hens and chickens – Number
TURKEY	Turkeys – Number

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TURKPRD	Turkey production in the calendar year prior to the census – Kilograms

Category « Bees » - units specified for each variable

BEEHON	Honeybees – Number of colonies
BEEPOLL	Other pollinating bees – Number of gallons

Category « Manure Production » - production in kilograms

LVKGMAN	Annual manure production for all livestock
LVKGNI	Annual nitrogen (N) production in manure for all livestock
LVKGP	Annual phosphorus (P) production in manure for all livestock
LVKGK	Annual potassium (K) production in manure for all livestock

(refer to Appendix B for the methodology for calculating manure production values)

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Appendix B - Livestock Manure Calculations

Estimates for the following variables have been calculated for geographic units:

- Annual kilograms of manure production from all livestock (LVKGMAN)
- Annual kilograms of nitrogen (N) in manure from all livestock (LVKGNI)
- Annual kilograms of phosphorus (P) in manure from all livestock (LVKGP)
- Annual kilograms of potassium (K) in manure from all livestock (LVKGK)

Values for each geographic unit were calculated by multiplying the number of each livestock type by the following coefficients and summing the total for all livestock included in the calculation.

Variable	Description	Average animal weight (kg)	Manure (kg/year)	Nitrogen (N) (kg/year)	Phosphorus (P) (kg/year)	Potassium (K) (kg/year)
BFCOW[14]	Number of beef cows.	635.04	13443.80	78.81	21.32	48.68
HORSES[1]	Number of horses and ponies of all ages.	450.00	8376.75	49.28	11.66	41.06
LVLRG[2]	Number of various large livestock; includes wild boars, bison, llamas and deer.	201.85	4273.16	25.05	6.78	15.47
LVMRF[2]	Number of various small livestock; includes mink, rabbits and/or fox.	4.01	58.55	0.61	0.13	0.47
TSHEEP[14]	Total number of sheep and lambs.	45.36	662.26	6.95	1.44	5.30
GOATS[1]	Number of goats of all ages.	64.00	957.76	10.51	2.57	7.24
BULLS[14]	Number of bulls 1 year and over.	725.76	15364.34	90.07	24.37	55.63
CALFU1[12]	Number of all cattle under 1 year.	204.12	4321.22	25.33	6.85	15.65
HEIFER[14]	Number of heifers, 1 year and over. For slaughter, feeding, beef or dairy herd replacement.	420.59	8903.83	52.19	14.12	32.24

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MLKCOW[2]	Number of cows mainly for dairy purposes.	612.35	22706.36	121.97	26.80	61.75
PIGBRS[3]	Number of boars.	158.76	1357.62	9.93	3.31	6.62
PIGHOG[3]	Number of market hogs (grower and finishing pigs).	61.24	1287.26	8.53	3.25	4.51
PIGNW[3]	Number of nursing and weaner pigs.	11.34	612.59	3.48	1.44	1.99
PIGSOW[3]	Number of sows and gifts for breeding.	124.74	1357.62	9.60	3.15	6.13
STEERS[14]	Number of steers, 1 year and over.	453.60	9602.71	56.29	15.23	34.77
PLTBRC[1]	Number of broilers, roasters and cornish poultry.	0.90	27.92	0.36	0.10	0.13
PLTLAYH[1]	Number of laying hens.	1.80	42.05	0.55	0.20	0.20
PLTPUL[1]	Number of pullets intended for laying.	0.90	27.92	0.36	0.10	0.13
PLTTRKY[1]	Number of turkeys of all ages.	6.80	116.65	1.54	0.57	0.60

Sources:
[1]American Society of Agriculture Engineers, ASAE D384.1 FEB03.
[2]Midwest Plan Service publication, no. MWPS-18 "Manure Characteristics," quoted on the Michigan State University Extension website.
[3]Oklahoma State University, "Production and Characteristics of Swine Manure," F-1735.
[4]Agriculture Canada and Agri-Food Canada. Discussions among experts.