

Summary of Revisions of the LCA Digital Commons Unit Process Data: field crop production

For Version 2 (April 2015)



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Summary of Revisions

Starting from the work described in Cooper et al. (2012) and Cooper (2013), the goals for the release of Version 2 of the field crop data were:

- **Rework the data to link up with the tier 2 field operations/ work process datasets** recently added to the Commons (described in Cooper (2015)).
- **Eliminate the use of service processes.** In Versions 1 and 1.1 of the field crop data, cases where the ARMS data are incomplete, such as when ARMS data has been omitted for privacy or specific ARMS variables do not represent 100% of the planted area, data were included in the field crop production unit processes as under the subcategory "services." This was intended to ensure that missing data are represented as such and that ultimately data representing the range of possibly applicable practices are accessed in the related tier 2 dataset.
- **Rework balance parameters using a simpler formula.** In Versions 1 and 1.1 of the field crop data, upwards of 20% of the data had 95% confidence intervals less than or exceeding actual limits, e.g., suggesting that the pdf at its tails includes a negative irrigation area or a fractional use of an irrigation method exceeding a total irrigated area. To account for these phenomena in the parameterized data, bounds were set on the parameterized ARMS variable value as applicable: physical values are set at a minimum of zero (such that the minimum area or application mass is treated as zero in an uncertainty analysis) and fractions are bounded by 0% and 100%. Further, when fractions were used together (e.g., to estimate the irrigated area using pressure systems and the irrigated area using gravity systems) balance relationships were parameterized using successive if statements to convert percentages (with in the field crop unit process data the parameter name starting with per_) to balance parameters (with the parameter name starting with Bal_) as described by Cooper et al. (Cooper, Noon, and Kahn 2012). Specifically, successive if statements balance the set of percentages to ensure the total does not exceed 100% as each data point is varied over its Student's t distribution. The balance parameters were then combined with the raw data to represent the final value of interest.

These 3 goals were met as follows:

- **Version 2 aggregates all years of data, creating crop-state instead of crop-state-year datasets.** The multi-year aggregations not only facilitate the link to field operations datasets but is also the basis for the elimination of missing data. First, the field operations datasets are intended to represent operations in 2014 because datasets representing equipment (i.e., tractors, combines, etc.) described in Cooper et

al. (2014) are only available in the Commons for 2014 fleets. Therefore, it is assumed here that the aggregation of data for all years provides the most appropriate representation of state operations in 2014. Current work by the USDA on the development of fleet data by year may mean that a subsequent version of the field crop data might again be prepared by production year.

Second, aggregation of the data for multiple years reduces the instances of missing data. To accomplish this, raw data parameter values in the Version 2 data represent the sum of all years for which there were data in Versions 1 and 1.1 (e.g., the sum of kg produced or applied over all years, the sum of the planted area over all years, etc.). For example, if 100 kg of grain were produced on 1,000 ha in year 1 and 300 kg of grain were produced on 3,200 ha in year 2, production is 400 kg and the planted area is 4200 ha and the yield is $(100+300)/(1000+3200) = 0.095$ kg/ha. Further, to be included, Version 2 datasets require values for the TOTAL areas and amounts of N, P, and K fertilizers and pesticides be available, either in Versions 1 and 1.1 or supplemented as:

- Missing ARMS fertilizer data were obtained from QuickStats, with RSE values taken as the maximum for each parameter.
- Missing ARMS manure transport distances were assumed to be the average for all data, with an RSE at the maximum for all data.

This means that zero values for previous areas, use of tillage methods, seed use, irrigation, and manure applications are assumed to be valid. Given this definition of a complete dataset, 105 Version 2 crop-state combinations were prepared.

- **Version 2 uses simpler balance equations, using the max formula and keying the balance to the fractional values within each group of parameters.** Instead of bounding individual parameters with if statements, the max formula (e.g., $\max(0, -7) = 0$) is used to ensure parameter values do not fall below zero. Also, instead of the use of successive if statements, each fractional value (e.g., the fraction of nitrogen fertilizers applied with or without incorporation) is reestimated as a fraction of all fractional values in the group. Any balance is listed as unspecified.

Noting that Version 2 maintains the parameter names to the extent possible for p0801 through p5338, other Version 2 updates are:

1. **Elimination of lagoon storage for beef manure.** Preliminary development of manure datasets gas revealed that lagoon storage of beef manure is not used in practice. Thus, in Version 2 it is assumed that none of the beef manure is stored in a lagoon.
2. **Fixed parameter value errors** for p1978: seed transport, regional truck (miles) and p1998: limestone, dolomite, and gypsum transport, regional truck (miles).

3. **Modified annual manure type fractions.** The annual fractions of the types of synthetic fertilizers is assumed to be the average of the values in Versions 1 and 1.1 in the years include in the crop-state combination, over a range from the minimum to maximum of these same values.
4. **The area for pesticide applications** is assumed to be the maximum of the total pesticide area and the sum of the herbicide and insecticide areas.
5. **The field burning fraction** is assumed to be the average of the values in Versions 1 and 1.1 in the years include in the crop-state combination, over a range from zero to the maximum of these same values.
6. **Data representing manure after planting were removed**, as all the values were zero
7. **Reduced tillage systems are assumed to use mulch till equipment.** Reduced-till systems are somewhat similar to mulch till in that they involve full-width tillage, use the same implements and may use one to three tillage trips. Reduced-till, however, leaves 15-30 percent residue on the soil surface after planting¹.
8. **"Average ratio of the mass of dolomite to the mass of limestone" data** with a sample size of 1 is assumed to have an RSE of 49% (the largest among the data with larger sample sizes).
9. **Temporal coverage data quality for Version 2 is reduced from A to B**, as the data are aggregated over multiple production years but assigned to the year 2014.

Works cited

Cooper, J.S., E. Kahn, M. Noon (2012) LCA Digital Commons Unit Process Data: field crop production, Version 1, prepared for the United States Department of Agriculture National Agricultural Library under specific cooperative agreement 58-8201-0-149

Cooper, J.S. (2013) Summary of Revisions of the LCA Digital Commons Unit Process Data: field crop production, prepared for the United States Department of Agriculture National Agricultural Library under specific cooperative agreement 58-8201-0-149

Cooper, J.S, M. Noon, E. Kahn, R. Johnson (2014) LCA Digital Commons Unit Process Data: agricultural self-propelled equipment, prepared for the United States Department of Agriculture National Agricultural Library under cooperative agreement Univ_Washington_SCA 6-29-10

Cooper, J.S. (2015) LCA Digital Commons Unit Process Data: field operations/ work processes and farm implements, prepared for the United States Department of Agriculture National Agricultural Library under cooperative agreement Univ_Washington_SCA 6-29-10

¹ See <http://extension.psu.edu/agronomy-guide/cm/sec1/sec11g0>