NUTRIENT BALANCES AT THE TOWN AND COUNTY LEVEL

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Accumulations of excess nitrogen (N) and phosphorus (P) on agricultural landscapes are increasingly garnering attention from environmental regulators and activists. When inflows of nutrients to a geographic area appreciably exceed outflows the opportunities for water contamination are increased. The most common policy approach in Europe to avoid such accumulations is to require some minimum area of land for each animal on a farm. A more sophisticated variation is to require that farms or groups of farms maintain a nutrient balance over some period of years. We investigated the current state of the balance of nutrient inflows and outflows for civil towns in Wisconsin to learn the range of typical values and to investigate how various characteristics of the local farm industry affected the nutrient balance.

Town Data

The town is an appropriate scale at which to estimate nutrient balances because it is about the dimension of a town (about 6 mi. on a side) that a farmer is willing or able to haul manure. Most farmers do not move manure this far, but some do, and few if any haul greater distances. The challenge of estimating the nutrient balance of a town is that necessary information on local agriculture is not available at this small geographic scale. The Wisconsin Agricultural Statistics Service (WASS) of the Department of Agriculture, Trade and Consumer Protection provides annual statistics on livestock and crop production. The most complete data are made available for the state as a whole, and somewhat fewer parameters are supplied at the county level.

Town level estimates of agricultural activity were created by combining several sources of data, primarily the WASS county values, the zip code-based federal Census of Agriculture, and the WISCLAND database of land use across the state. This resulted in estimates of the following values for 1225 Wisconsin towns:

- Cropland area
- Number of cattle and calves
- Number of dairy cows
- Milk production rate
- Number of hogs and pigs
- Acres and yields of alfalfa, other hay, corn for grain, corn silage, oats, and soybeans

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Nutrient Balance Model

We created a spreadsheet to account for the major nutrient flows into and out of a region (state, county, town) using the data typically available at the county level, and in this study, estimated for towns. We developed a set of rules for taking the commonly reported "Cattle and Calves, " "Dairy Cows," and "Hogs and Pigs" census values to create estimates of the numbers and annual exports of all associated animal types, such as replacement heifers and steers on feed (Bland, 2002). With typical weights of the animals we could then estimate manure production and feed requirements. Representative diets for all livestock types were created from consultation with experts and industry publications.

Estimated feed requirements were first supplied from the locally grown crops. Crops in excess of the local requirements were considered exported and deficiencies were imported. Nutrient applications to town cropland were calculated in three steps. A small (20-40 lbs/acre depending on crop) base application of N and P was assumed for all acres. Next additions from legumes (land assumed to be going from soybean or alfalfa to corn) and manure were estimated. We assumed that the available manure is uniformly spread over the corn, soybean, and oat acreage (this is not how any one year works, but over several years it is possible), and that only 50% of excreted N and 80% of excreted P becomes available for crop uptake. Finally, crop removal of N and P based on yield is compared to the nutrients from the base fertilizer and manure. Calculations can be made assuming a range of crediting of manure and legume credits, to evaluate the importance of this farmer behavior on the town-level nutrient balance. If after manure crediting there is a deficiency, a supplemental fertilizer application is assumed to make the total nutrient addition equal the removal. Thus the manure from a town's livestock may contain nutrients in excess of crop requirements, leading to accumulation, or be inadequate to meet the need and so invoke supplemental fertilizer applications.

Results

Cropland area among the 1225 towns ranged from 0 to 30,747 acres (a 6 x 6 mi square is 23,040 acres), and corn for grain area averaged 2640 acres, with a maximum of 10710. The number of cattle and calves averaged 2770 with a maximum of 11410.

The number of livestock and area of cropland led to a range of estimated P accumulation (or depletion) rates, as shown in Table 1. Only the P results are reported here. Annual rates of change in P stored in the cropland soil ranged from –7, indicating a drawdown of soil P, to +23, indicating continuing large accumulation. A clear relationship was evident between the size and sign of the P change and the number of crop acres per dairy cow. The town with the most dairy cows was estimated to have the largest rate of P accumulation.

Table 1. Selected results from town-level nutrient balance calculations. Numbers in bold type are the largest values out of 1225 towns.

Town →	Oneida	Dodgeville	Springfield	Clinton
Crop area (ac)	**30474**	23603	17743	20901
Grain corn (ac)	9561	3512	5181	**10709**
Cattle & Calves	6862	**11410**	8800	2209
Dairy Cows	3272	3653	**5695**	929
Crop area/dairy cow (ac/cow)	9.3	6.5	3.1	22.5
Annual change in #P2O5/ac	+7	-7	+23	0

Conclusions

The civil town is an appropriate scale at which to calculate soil nutrient budgets on agricultural land because the dimension of a typical town is about the distance farmers are willing to transport manure. The data needed to do these calculations are not publicly available at this small geographic scale, but approximate estimates were derived by combining several data sources. These estimates were combined with a nutrient balance model of fertilizer, feed, and animal product imports and exports to predict annual change soil nutrients. The ratio of the cropland area to the number of dairy cows was closely related to the size of the annual nutrient accumulation.

Literature Cited

Bland, W. L. 2002. Estimating spatial cattle and swine inventories from limited data. Agricultural Systems (in press).