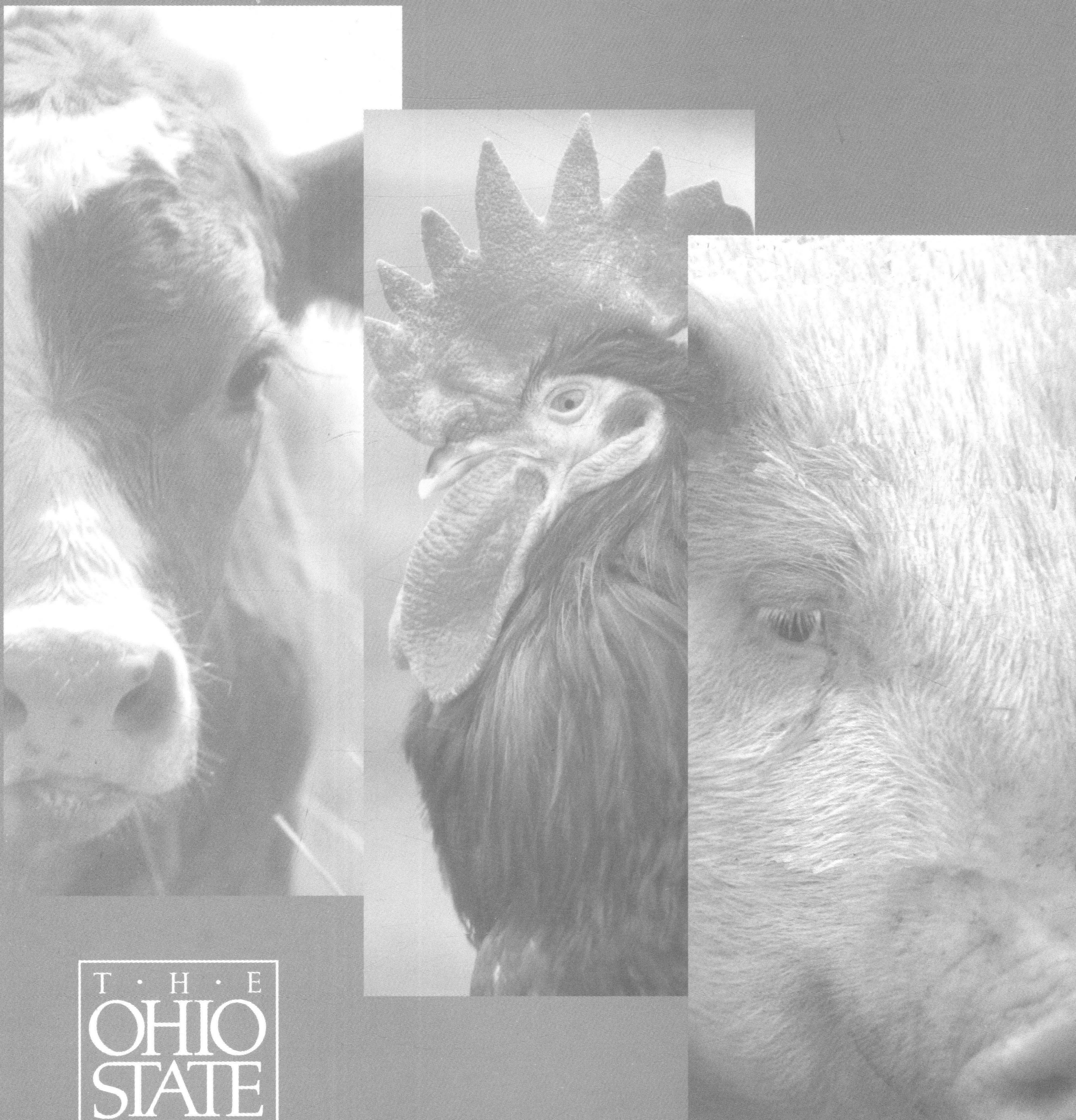
Bulletin 889

Transportation Demands of Livestock and Poultry Enterprises



THE OHIO STATE UNIVERSITY EXTENSION

Authors

Brian Roe
State Specialist, Livestock Economics
Department of Agricultural, Environmental and Development Economics
2120 Fyffe Road
Columbus, OH 43210-1067

Robert Moore
Extension Associate
Department of Agricultural, Environmental and Development Economics
2120 Fyffe Road
Columbus, OH 43210-1067

Acknowledgements

Forest Muir
Professor and Associate Chair
OSUE-Animal Sciences (OSU Extension)
105 Gerlaugh
OARDC-Wooster
Wooster, OH 44691

For-sale publication

Keith L. Smith, Associate Vice President for Ag. Adm. and Director, OSU Extension
TDD No. 800-589-8292 (Ohio only) or 614-292-1868
4/01—1M—189872
Visit Ohio State University Extension's web site "Ohioline" at:
http://ohioline.osu.edu

Introduction

For a variety of economic and engineering reasons, newly built livestock enterprises have a larger capacity than average, existing livestock enterprises. Large livestock enterprises may cause many types impacts in the community that houses them. One item of growing concern is the use of public roadways by livestock operations. As facilities grow larger, the sheer quantity of inputs and outputs that traverse the farm gate also grows larger. These materials often travel in large vehicles over public roads; larger vehicles can create additional congestion for local residents and can increase the local municipality's costs with respect to roadway construction and maintenance.

The purpose of this bulletin is to estimate the number of additional trips made by passenger and heavy vehicles over public roadways that are attributable to the operation of animal-confinement facilities. These figures may be useful for public officials who must estimate the increased roadway usage by new livestock facilities for use in forecasting increased roadway maintenance and construction costs. These calculations may also be of interest in calculating increases in traffic congestion that might arise from new or expanded livestock enterprises.

These calculations are made for seven different animal production enterprises: beef-cattle feedlots, dairy farms, swine farrow-to-finish operations, hog-finishing operations, sow-farrowing operations, broiler-chicken operations, and layer-chicken operations. All non-poultry calculations are made for confinement operations with an operating capacity of 1,000 animal units, while all calculation for poultry operations are made for facilities with a capacity of 10,000 animal units. The larger operating capacity for poultry operations reflects the greater relative intensity commonly found in modern poultry operations and roughly reflects common capacities of new facilities for the various species.

All calculations are made by assuming that the production technologies, transportation modes, and biological efficiencies are equivalent to those of an average Ohio operation as captured by the *Ohio State University Extension Livestock Enterprise Budgets*. Because certain assumptions, such as the technology employed to handle animal manure, can greatly influence the total number of trips generated by new operations, trip estimates are provided for several types of manure-handling systems. All trip calculations were performed using a Microsoft Excel spreadsheet program; this spreadsheet is available from the authors and allows recalculation of trip estimates for alterations of key-operation parameters.

Table 1. Capacity and Saleable Output Assumptions by Animal-Confinement Enterprise

	Hogs, Finish	Sow, Feeders	Sows, Finish	Steers	Dairy	Broilers	Layers
Animal Unit Capacity	1,000	1,000	1,000	1,000	1,000	10,000	10,000
Animals per Animal Unit	2.5	2.5	2.5	1	0.65	100	100
Capacity – Animals	2,500	2,500 sows	312.5 sows	1,000	714	1 million	1 million
Output Factor	250 lbs./ hog	14.5 pigs/sow @ 50 lbs./pig	14 hogs/sow @ 250 lbs./hog	1250 lbs./ steer	21,000 lbs. milk/ cow	5.2 lbs./ broiler	0.83 eggs/ hen/ day
# Growing Cycles/Year	2.8	1	1	1.2	1	6	1
Output	7,000 hogs	36,250 pigs; 825 cull sows	4,375 hogs; 103 cull sows	1,200 steers	15 million lbs.; 236 cull cows	6.5 million broilers	25.2 million doz. eggs; 1 million cull hens

Additional Trips Potentially Attributable to New Animal-Production Facilities

The general methodology adopted in this section is to identify the key inputs and outputs associated with the confined-animal operation of interest, calculate the typical amounts of each input and output for an operation with a capacity of 1,000 animal units (non-poultry) or 10,000 animal units (poultry), and project the annual number of round trips necessary to transport inputs and outputs to and from the operation. Note that this analysis considers only the trips generated during normal, day-to-day operations; one-time additional travel generated during the construction phase of the new facility is not considered.

Animal Outputs for 1,000-Animal-Unit Capacity

Table 1 outlines the amount of the primary saleable output produced by the different animal enterprises considered in this study at their respective capacities. A simple, production-level example can be seen in the last column of Table 1, which describes the calculation for a typical layer operation. Using the definition of 100 layers per animal unit yields a capacity of one million birds. Assuming each hen yields 0.83 eggs per day implies an annual egg output of 25.2 million dozen eggs. Given an average productive life span of one year per hen yields one million culled hens that must be shipped to slaughter each year.

A slightly more difficult example, featuring a farrow-to-finish hog operation, appears in column 4 of Table 1. An operation of 1,000 animal units will be composed of 312.5 sows producing 14 surviving pigs per year:

1,000 animal units = 312.5 sows ÷ 2.5 sows/ animal unit + 14 pigs per sow x 312.5 sows ÷ 5.0 growing pigs per animal unit

where the number of growing pigs per animal unit is twice that for sows because growing pigs spend about one-half of their lives weighing less than 55 pounds, the weight threshold for counting swine as an animal unit. Total outputs include 4,375 finished hogs sold and, given a typical cull rate of 33 percent, 103 cull sows sold.

Potential New Trips Generated by Primary Inputs

One major source of roadway use is the transport of key, primary inputs to a new animal-confinement development. Feed, typically in the form of processed grains, and young animals are the non-labor inputs that require the most trips. Tables 2–8 document the raw amounts of these inputs, the modes of transportation, and the potential number of trips necessary for each of the seven enterprises considered. For each input and output there exist several different vehicles that could accomplish the transportation task. For example, feeder pigs could be moved by a 44-foot trailer with a capacity for 146 pigs per load or by a 44-foot, possum-belly truck with a capacity for 376 pigs per load. In Tables 2–8, we assume the largest vehicle is employed; the annotated spreadsheet allows for recalculation using several smaller vehicles commonly available.

Table 2. Primary Input and Trip Requirements for 1,000 AU Hog-Finishing Enterprise.

	Feeder Pigs	Corn	Supplement
Annual Need	7,000 pigs	54,625 bushels	269.5 tons
Annual Pounds (Million)	0.35	3.06	0.54
Transport Vehicle	Possum-belly truck	Semi-tractor trailer	Semi-tractor trailer
Load Capacity	376 pigs	1,000 bushels	23 tons
Annual Trips Needed	19	55	12

Table 3. Primary Input and Trip Requirements for 1,000 AU Hog-Farrowing Enterprise.

	Corn	Supplement
Annual Need	0.15 million bushels	816 tons
Annual Pounds (Million)	8.4	2.13
Transport Vehicle	Semi-tractor trailer	Semi-tractor trailer
Load Capacity	1,000 bushels	23 tons
Annual Trips Needed	150	47

Table 4. Primary Input and Trip Requirements for 1,000 AU Hog Farrow-to-Finish Enterprise.

	Corn	Supplement
Annual Need	56,250 bushels	393.8 tons
Annual Pounds (Million)	3.45	0.79
Transport Vehicle	Semi-tractor trailer	Semi-tractor trailer
Load Capacity	1,000 bushels	23 tons
Annual Trips Needed	57	18

Table 5. Primary Input and Trip Requirements for 1,000 AU Steer Feedlot.

	Feeders	Corn	Supplement	Corn Silage
Annual Need	12,000 calves	756,000 bushels	750 tons	40,800 tons
Annual Pounds (Million)	6.6	42.3	1.5	81.6
Transport Vehicle	Possum-belly truck	Semi-tractor trailer	Semi-tractor trailer	Truck
Load Capacity	56 calves	1,000 bushels	23 tons	20 tons
Annual Trips Needed	214	756	33	2,040

Table 6. Primary Input and Trip Requirements for 1,000 AU Dairy Enterprise.

	Corn	Supplement	Corn Silage	Hay
Annual Need	72,142.9 bushels	1,001.4 tons	3,985.7 tons	3,785.7 tons
Annual Pounds (Million)	4.04	2.00	7.97	7.57
Transport Vehicle	Semi-tractor trailer	Semi-tractor trailer	Truck	Truck
Load Capacity	1,000 bushels	23 tons	20 tons	20 tons
Annual Trips Needed	73	44	200	190

Table 7. Primary Input and Trip Requirements for 10,000 AU Broiler-Chicken Enterprise.

	Chicks	Corn	Supplement
Annual Need	6.5 million chicks	731,250 bushels	13,650 tons
Annual Pounds (Million)	1.3	40.95	27.30
Transport Vehicle	Truck	Semi-tractor trailer	Semi-tractor trailer
Load Capacity	20,000 chicks	1,000 bushels	23.8 tons
Annual Trips Needed	325	731	574

Table 8. Primary Input and Trip Requirements for 10,000 AU Layer-Chicken Enterprise.

	Pullets	Corn	Supplement
Annual Need	1 million pullets	0.93 million bushels	14,000 tons
Annual Pounds (Million)	3.25	52.00	28.00
Transport Vehicle	Semi-tractor truck	Semi-tractor trailer	Semi-tractor trailer
Load Capacity	6,000 pullets	1,000 bushels	23.8 tons
Annual Trips Needed	50	929	588

For example, Table 2 outlines the key inputs for a hog-finishing enterprise as feeder pigs, corn and a protein feed supplement. Operation at the 1,000-animal-unit threshold implies an output of 7,000 finished hogs per year. Therefore, 7,000 feeder pigs weighing 0.35 million pounds are necessary each year to sustain production. If transported via possum-belly truck, then total trips per year equal 19. Similar calculations yield the estimates of 55 and 12 trips per year to transport the necessary corn and supplement inputs for these animals.

Another primary input requiring transportation is labor. Table 9 outlines the labor requirements for each enterprise and the corresponding number of annual passenger-vehicle trips. Note that the labor requirements and corresponding annual passenger-vehicle trips generated are typically greater for those enterprises that produce a daily output, such as dairy and layer-egg operations, than those that produce a single end output, like broiler-chicken, beef-cattle feedlot, or swine enterprises.

The method for estimating the labor requirements was different for poultry and non-poultry enterprises. For non-poultry enterprises, we calculate labor needs from *Ohio Livestock Enterprise Budgets* (Ohio State University Extension, 1999). This per-unit coefficient was then multiplied to a scale of 1,000 animal units to arrive at the labor requirements listed in Table 9. Daily staffing needs for broiler and layer enterprises of 10,000-animal-unit capacity were determined by consulting with Professor Forest Muir of The Ohio State University's Department of Animal Sciences, a recognized poultry-production expert.

The number of passenger vehicle trips is then calculated, in the case of non-poultry enterprises, by dividing the total number of staff hours required by 10. This implicitly assumes that work is performed in 10-hour shifts and that each person travels separately by passenger vehicle to and from the site. In the case of the poultry enterprises, total passenger-vehicle trips are calculated by multiplying the number of daily workers by 365; this also assumes each worker drives separately to and from the production site.

For all enterprises, if personnel commonly share rides or if work shifts deviate from 10 hours, the number of trips should be adjusted accordingly. Also, if personnel live at the production site, they do not add vehicle trips while commuting to and from work and the total trip count should be adjusted accordingly. If the new enterprise attracts new personnel to live either on-site or anywhere in the jurisdiction, additional trips will be generated by typical shopping and pleasure trips around the jurisdiction. If the operation's personnel already live in the jurisdiction, however, such trips need not be added to the total count; this is assumption maintained for the rest of this study.

Table 9. Total Annual Passenger-Vehicle Trips Potentially Generated by Labor and Management at Various New, Animal-Confinement Operations.

Enterprise	Animal Units	Labor Needs	Annual Labor Hours	Annual Trips*
Hog Finishing	1,000	0.4 hrs/head finished	2,800	280
Hog Farrowing	1,000	4 hrs/litter	20,000	2,000
Hog Farrow-to-Finish	1,000	6.8 hrs/litter	4,250	425
Steer Feedlot	1,000	2.0 hrs/head	2,400	240
Dairy	1,000	37 hrs/cow	26,428	2,643
Broiler	10,000	2 workers/day	7,300	730
Layer	10,000	15 workers/day	54,750	5,475

**Assumes one car trip taken for each 10 hours worked.*

Table 10. Output-Trip Requirements for 1,000 AU Hog-Finishing Operation under Four Assumptions Concerning Manure-Handling Systems.

	Finished Hogs	Manure (liquid-system A)	Manure (liquid-system B)	Manure (slurry system)	Manure (solid system)
Annual Production	7,000	7.2 million gal.	7.2 million gal.	3.21 million gal.	1.44 million gal.
Annual Lbs. Hauled (Mil.)	1.75	60.31	60.31	26.80	12.06
Transport Vehicle	Possum-belly truck	Spreader	Pumped via hose	Spreader	Spreader
Load Capacity	183 hogs	4,000 gal.	—	4,000 gal.	600 gal.
Annual Trips Needed	39	1,807	0	803	2,409

Table 11. Output-Trip Requirements for 1,000 AU Hog Farrowing Operation under Four Assumptions Concerning Manure-Handling Systems.

	Feeder Pigs	Cull Sows	Manure (liquid-system A)	Manure (liquid-system B)	Manure (slurry system)	Manure (solid system)
Annual Production	36,250 feeders	825 sows	16.92 million gal.	16.92 million gal.	7.52 million gal.	3.38 million gal.
Annual Lbs. (Million)	1.81	0.33	141.2	141.2	62.75	28.24
Transport Vehicle	Possum-belly truck	Possum-belly truck	Spreader	Pumped via hose	Spreader	Spreader
Load Capacity	376 feeders	122 sows	4,000 gal.	—	4,000 gal.	600 gal.
Annual Trips Needed	97	7	4,230	0	1,880	5,639

Table 12. Output-Trip Requirements for 1,000 AU Hog Farrow-to-Finish Operation under Four Assumptions Concerning Manure-Handling Systems.

	Finished Hogs	Cull Sows	Manure (liquid-system A)	Manure (liquid-system B)	Manure (slurry system)	Manure (solid system)
Annual Production	4,375.0 Hogs	103.1 sows	7.31 million . gal.	7.31million gal.	3.25 million gal.	1.46 million gal.
Annual Lbs. (Million)	1.09	0.041	61.0	61.0	27.1	12.2
Transport Vehicle	Possum-belly truck	Possum-belly truck	Spreader	Pumped via hose	Spreader	Spreader
Load Capacity	183 Hogs	122 sows	4,000 gal.	—	4,000 gal.	600 gal.
Annual Trips Needed	24	1	1,828	0	813	2,437

Table 13. Output-Trip Requirements for 1,000 AU Steer-Feedlot Operation under Four Assumptions Concerning Manure-Handling Systems.

	Steers	Manure (liquid-system A)	Manure (liquid-system B)	Manure (slurry system)	Manure (solid system)
Annual Production	1,200.0	7.57 million gal.	7.57 million gal.	3.36 million gal.	1.51 million gal.
Annual lbs. (Million)	1.50	63.18	63.18	28.08	12.64
Transport Vehicle	Possum-belly truck	Spreader	Pumped via hose	Spreader	Spreader
Load Capacity	31 steers	4,000 gal.	—	4,000 gal.	600 gal.
Annual Trips Needed	39	1,893	0	841	2,524

Table 14. Output-Trip Requirements for 1,000 AU Dairy Operation under Four Assumptions Concerning Manure-Handling Systems.

	Bull Calves	Milk	Cull Cows	Manure (liquid-system A)	Manure (liquid-system B)	Manure (slurry system)	Manure (solid system)
Annual Production	321.4 calves	714.0 cows	235.7 cows	11.88 million gal.	11.88 million gal.	5.28 million . gal.	2.38 million gal.
Annual Lbs. (Million)	0.03	15.00	0.33	99.18	99.18	44.08	19.84
Transport Vehicle	Livestock trailer	Tanker truck	Possum-belly truck	Spreader	Pumped via hose	Spreader	Spreader
Load Capacity	20 calves	55,000 lbs.	25 cows	4,000 gal.	—	4,000 gal.	600 gal.
Annual Trips Needed	17	365*	1	2,971	0	1,321	3,961

**Assumes daily milk removal.*

Table 15. Output-Trip Requirements for 10,000 AU Broiler-Chicken Operation.

	Broilers	Manure
Annual Production	6.5 million broilers	22.2 million lbs.
Annual Lbs. (Million)	33.8	22.2
Transport Vehicle	Semi-truck	Semi-truck
Load Capacity	28,080 lbs.	44,000 lbs.
Annual Trips Needed	1,204	506

Table 16. Output-Trip Requirements for 10,000 AU Layer-Chicken Operation.

	Eggs	Cull Hens	Manure
Annual Production	25.2 million dozen eggs	1 million hens	26.1 million lbs.
Annual lbs. (million)	3.4	4.5	26.1
Transport Vehicle	Semi-truck	Semi-truck	Semi-truck
Load Capacity	51,750 lbs.	6,250 hens	44,000 lbs.
Annual Trips Needed	732	160	593

Potential New Trips Generated by Outputs

Tables 10–16 provide estimates of the number of trips needed to transport all major enterprise outputs off site, including the number of trips necessary to move all animal manure. Because the number of trips needed to handle manure is highly sensitive to the manure-handling technology, we provide a trip estimate for four different technologies commonly employed in non-poultry enterprises.

Consider the output trips generated by a hog-finishing operation (Table 10). Column 2 calculates an annual trip estimate for finished hog outputs of 39 by dividing annual production of 7,000 head of finished hogs by a load capacity of 183 animals per truck. The trips needed for transporting manure varies from zero (column 4, liquid-manure system B) to 2,409 trips (column 6, solid-manure system). The liquid-manure system B moves all manure in liquid form via hose or other conveyance that does not use public roadways. The solid-manure system allows manure to dry before transporting it via large-scale spreader to its eventual location in a crop field. If the confinement operation also owns adjoining cropland, some of the manure may be transported to fields on private roadways; in such a case the number of trips should be prorated accordingly.

Note that trip estimates for poultry operations, listed in Tables 15–16, provide only an estimate for one type of manure-handling system. The variability of manure-handling systems for poultry operations is less than that for hogs and cattle, because poultry manure has a low percentage of liquid content; hence, liquid-manure systems are typically not used for such operations and are not considered here.

Calculating Total Trips

Transport of most inputs and outputs takes place by some type of heavy vehicle: semi-truck; large-scale, tractor-drawn spreader; or possum-belly truck. However, the transport of labor and management to the production site normally occurs via some type of passenger vehicle. These different vehicles have differential impacts on the roadway congestion and roadway wear-and-tear. Therefore, Table 17 lists total trips broken down into total annual passenger-vehicle trips and total annual heavy-vehicle trips by manure system. In all cases featuring heavy vehicles, however, it is assumed that the largest feasible vehicle was used. In the case of manure, it is assumed that poultry manure is handled in semi-trucks while for non-poultry manures it is assumed that manure is handled in large, tractor-drawn spreaders.

The number of passenger-vehicle trip totals ranges from 240 (beef feedlot) to 5,472 (layer operation). Generally, solid-manure systems require more trips. On a per-animal-unit basis, dairy and hog-farrowing operations typically have the highest heavy-vehicle requirement while broilers and layers (calculated in the tables at 10,000 animal units vs. 1,000 animal units for other enterprises) have the smallest requirement.

Circumstances That May Alter Total-Trip Count

The previous example and Tables 2–8 make several assumptions concerning the use of public roadways during the transport of certain inputs. First, it is assumed that all feed is purchased in bulk and transported to the confined animal facilities via the jurisdiction's roadways. Some operations may grow some or all the necessary feed inputs on land adjoining the new development, however. If so, some or all of the trips needed to move the feed may occur on private roads or pathways hence reducing the number of trips on public roadways. On the other hand, if feed inputs are harvested on adjoining lands and transported over public roadways, this will often occur in trucks or wagons that are smaller than those used to transport bulk purchased feed. If this is the case, the total number of trips must be increased to reflect the smaller vehicles used.

Table 17. Heavy Vehicle and Passenger Vehicle Trips Generated by New Animal Confinement Operations.

Enterprise	Passenger Vehicle Trips	Heavy Vehicle Trips by Manure System			
		Liquid Manure System A	*Liquid Manure System B*	*Slurry Manure System*	*Solid Manure System*
Hog Finishing (1,000 AU)	280	1,932	125	928	2,534
Hog Farrowing (1,000 AU)	2,000	4,531	301	2181	5,940
Hog Farrow-to-Finish (1,000 AU)	425	1,928	100	913	2,537
Steer Feedlot (1,000 AU)	240	2,238	345	1,186	2,869
Dairy (1,000 AU)	2,643	3,861	890	2,211	4,851
Broiler (10,000 AU)	730	NA*	NA*	NA*	3,340
Layer (10,000 AU)	5,472	NA*	NA*	NA*	3,052

** Because of the low liquid content of poultry manure, it is assumed the manure is handled only by solid-manure handling systems and only in semi-trucks; non-poultry livestock manure is assumed to move in large spreaders.*

Also, the number of total trips calculated should be decreased if the new enterprise merely involves relocation of animals or inputs that would have traversed the jurisdiction's roadways even if the facility were not built. Two examples are particularly pertinent. Suppose the new enterprise was merely a consolidation of several enterprises currently housed in the jurisdiction, and the distances traveled per trip were basically the same. For example, suppose 10, 100-animal-unit operations in a given jurisdiction merged into one, centrally located operation of 1,000 animal units. In this case, the new operation mimics the activity of the old operations, and no additional trips are generated by the new enterprise. If part of the new operation merely replaces existing operations already in the jurisdiction, trip counts should be adjusted accordingly.

Also, consider an example with respect to feed inputs. Suppose a new enterprise were constructed in the jurisdiction and used feed grains raised in the jurisdiction. If, in the absence of the new enterprise, the grain would have traversed the jurisdiction's roadways to reach final market, and that distance traveled on jurisdiction roadways was similar to the distance to reach the new enterprise, no new trips have been generated by the enterprise with respect to the transport of grains. To calculate such credits one must assess how many of the grain inputs are being trucked in from other jurisdictions and prorate the input trips accordingly. In the absence of direct data concerning the location of the feed inputs, this can be ascertained from estimates of the jurisdiction's animal population needs and grain production. The residual would typically traverse the roadways to some other market and hence, would not require additional trips though the total mileage may differ.

Extending the previous example, consider another situation that might occur in which a new livestock development may decrease roadway usage by feed-grain transport. Consider a case where, before the construction of a new livestock development, grain traveled across the entire jurisdiction en route to its final destination. With the presence of the new livestock operation, the grains might only travel half way across the jurisdiction on public roadways to reach the operation. Total jurisdiction roadway usage for moving feed grains decreased by 50 percent and this reduction could be used as a credit against the new trips generated by moving additional manure and animal outputs. Such credits against the base-trip calculation must be made on a case-by-case basis, however, and must use the facts relevant to local situation.

Finally, consider a case where a vehicle that delivers inputs to the operation also transports outputs to market. For example, a possum-belly truck that delivers feeder pigs to the production site might also transport finished hogs to the slaughter plant as part of the same trip. If so, the round trip mileage traveled in the jurisdiction for both the inputs and outputs involved in such a complementary transportation arrangement should be divided in half. Otherwise, it is assumed in all trip calculations that all input trucks leave the operation empty and that all output trucks arrive at the operation empty.

Summary

This report has estimated the annual number of heavy-vehicle trips, passenger-vehicle trips, and passenger-vehicle trip equivalents potentially generated by the introduction of seven different types of confinement livestock operations. This was done for new enterprises of a capacity of 1,000 animal units for non-poultry enterprises and 10,000 animal units for poultry enterprises that operate under production parameters typical to Ohio producer of such a scale.

Literature Cited

The Ohio State University Extension, 1999. *1999 Ohio Livestock Enterprise Budgets*, Deptartment of Agricultural, Environmental and Development Economics, 2120 Fyffe Road, Columbus, OH.