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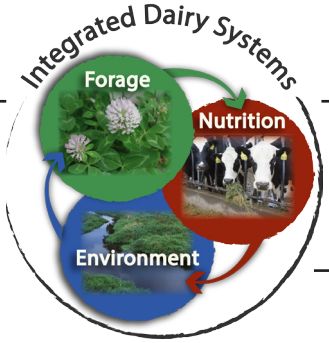
Snap-shot assessment of nutrient use efficiency on confinement dairy farms



U.S. Dairy Forage Research Center

Escalating feed and fertilizer costs, ebbing milk prices, and environmental regulations are motivating many dairy farmers to find new ways to improve nutrient use on their farms. On many farms, it may be possible to put more feed nutrients (e.g., crude protein) into milk and more fertilizer and manure nutrients (e.g., nitrogen and phosphorus) into crops and pasture (Figure 1). This would not only reduce farm input costs and enhance profits, but such improvements in *nutrient use efficiency* (NUE) could also reduce nutrient losses and the risk of environmental contamination from dairy farms (e.g., phosphorus runoff and nitrogen leaching).

But you can't manage *nutrient use efficiency* without measuring it first. How can nutrient use efficiency be determined and monitored easily on dairy farms, and what improvement in nutrient use efficiency can be realistically expected? Would the required changes in nutrient management be profitable and feasible?

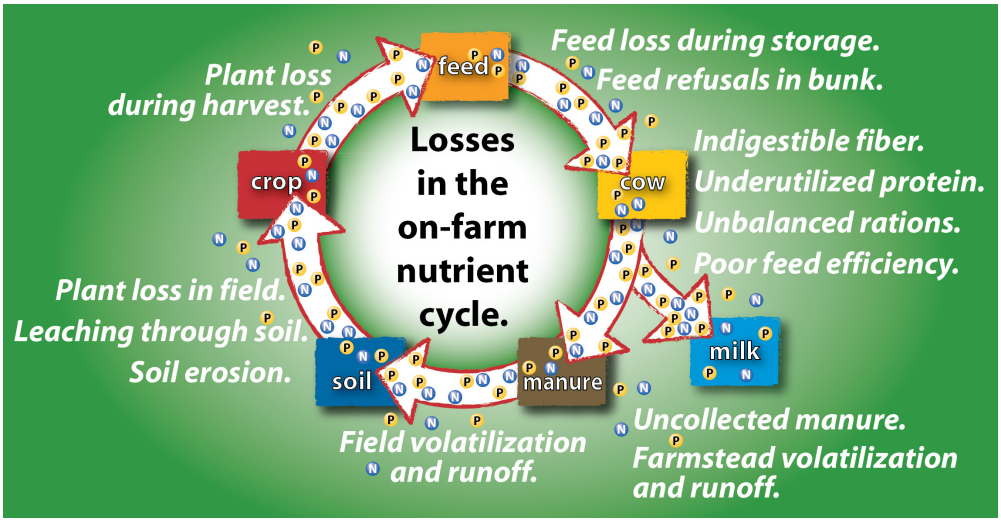


Figure 1. Nutrient losses on a dairy farm. Nutrients (this example uses phosphorus and nitrogen) are recycled through a dairy farm when the cow's manure is used to fertilize subsequent crops for feed. But many nutrients can be "lost" along the way in this continuous cycle. When more nutrients are "saved," the system becomes more economically sustainable for the dairy producer (fewer purchases of protein supplement for the herd and fertilizer for the field) and more environmentally sustainable (fewer nutrients such as nitrogen and phosphorus finding their way into surface and ground water).

Such fundamental questions are best addressed by engaging farmers directly in the process of nutrient management research and technology development.

Over the past several years researchers at the U.S. Dairy Forage Research Center and the University of Wisconsin have been developing and using rapid assessment methods to provide snap-shot assessments of feed, fertilizer, and manure use on dairy farms in various settings. The most recent work was a survey of 54 Wisconsin dairy farms known as *On Farmers' Ground*. Here we explain how the snap-shot analysis is conducted and we highlight some of the information obtained on 54 Wisconsin dairy farms using this rapid assessment technique.

Initial questionnaire and interview

The assessment begins with a two- or three-hour initial interview with the farm operator(s). First, a questionnaire is used to compile an overall picture of each farm, including herd size and composition, livestock facilities, land use, management practices, and motivations and goals related to feed, fertilizer, and manure management. The questionnaire is designed to provide a snap-shot of nutrient management for the period "yesterday-today-tomorrow." Second, questions are posed to define broad, seasonal differences in nutrient management. For example, time lines are

established for when dairy cow diets may change, for when manure is spread, for crop rotations, etc. The information obtained during the first interview is used to establish initial nutrient use efficiencies and to develop additional survey tools for subsequent farm visits and nutrient management monitoring.

Subsequent farm visits (usually monthly or quarterly) are set up to collect additional data along with feed and manure samples, and to discuss survey results with farmers. Data collection over 12 to 18 months on representative dairy farms can provide a 'snap-shot' of nutrient management for the dairy industry, as well as information on the range of feed and manure management practices on individual farms.

Focus on feed management

During each farm visit, farmers are asked the number of lactating cows, dry cows, and heifers they have. Questions are asked related to feed management, such as:

- whether the lactating herd is divided into different feeding groups, and the basis for herd grouping;
- how often rations are balanced;
- the use of milk production technologies such as bST;
- milking frequencies and average milk production per cow (usually the previous day's bulk tank volume divided by number of cows milked).

Types and amounts of feed being offered are recorded for each feeding group, and samples of each feed component and/or the TMR are taken for analysis. This information is used to estimate the feed nutrients going into the cow which is then divided into the amount of nutrients coming out in the cow's milk to calculate *feed nutrient use efficiencies* (FNUE) as follows:

Our studies of *feed nutrient use efficiency* have focused on nitrogen (or crude protein) and phosphorus because putting more feed nitrogen and phosphorus

$$\text{FNUE} = 100 \times \frac{\text{nutrients in milk (lb/cow/day)}}{\text{nutrients consumed in feed (lb/cow/day)}}$$

into milk (and less into manure) has both cost reduction and environmental benefits. Excess feed nitrogen is a wasted cost. It is simply excreted as urea in urine, which is lost rapidly as ammonia gas or leached through the soil as nitrates in groundwater (and may be re-emitted as nitrous oxide, a greenhouse gas).

Table 1. Milk production, apparent feed nitrogen (N) intake, milk N secretion, and feed N use efficiency (FNUE) on 54 Wisconsin dairy farms determined by rapid assessment methods.

	Milk production	Feed N intake	Milk N secretion	FNUE
	---------- lbs./cow/day ----------			percent
Average	65	1.44	0.34	24.9
Range	32 to 96	0.78 to 2.28	0.17 to 0.50	12.5 to 45.7

Excess dietary phosphorus is also a wasted cost and is excreted in feces which, after land application, can run off from fields and pastures into lakes and streams and promote algae growth and declines in water quality.

Table 1 provides an example of snap-shot estimates of apparent feed nitrogen consumption, milk nitrogen secretion, manure nitrogen excretion, and feed nitrogen use efficiency. Our on-farm studies using these survey techniques reveal that dairy farmers who offer total mixed rations, balance rations, use bST, and milk three times per day obtain much higher levels of milk production and feed nutrient use efficiency than farms that do not implement these practices.

Focus on manure management

To determine the relative amount of manure that farmers collect, and that is available for application to cropland, the snap-shot survey contains a series of questions related to herd management, barn cleaning and manure storage practices. To determine the amount of manure that goes uncollected (wasted resource), the questionnaire asks where and for how long livestock are outside. Time spent outside is delineated by animal type (e.g., lactating cows, dry cows, heifers), season (spring, summer, fall, and winter), and location. Farmers are asked to define the approximate date each

Table 2. Snap-shot assessment of manure collection on 54 Wisconsin dairy farms.

Category	Sub-category	Manure collection (% of annual excretion)
Housing type	Stanchion	66 (±18.9)
	Free-stall	89 (±16.5)
Herd size (cows/farm)	<50	57 (±12.6)
	50-99	76 (±18.2)
	100-199	95 (±5.1)
	>200	100 (±0)

season starts and ends and the type(s) of outside locations where livestock are kept. Information on relative time spent in outside areas is combined with manure nutrient excretions to determine loading rates in areas where manure is not collected.

The difference between total herd excretion and uncollected manure is the amount of manure collected and available for application to cropland. Table 2 provides the type of information obtained using snap-shot assessment of manure collection practices. Relatively less manure is collected 1) on dairy farms that have stanchion barns than on those that have free-stall barns, and 2) on farms having small herd size than on farms having large herds.

The section of the survey related to manure collection can be followed by an exercise using farm maps and information on crop rotations to assess when, where, and how collected manure is land-applied. This information can be used to calculate approximate manure application rates to cropland (Figure 2). The information also provides the basis for developing manure spreading logs which can be used by farmers to track actual spreading practices. Using these logs, farmers record information on the type of manure spread (semi-solid, liquid, bedded pack), the type of spreading equipment used, when and which fields receive manure, etc. Manufacturer information on manure spreader holding capacities and relative fullness of each load are used to estimate manure amounts (tons) spread. Manure samples taken by farmers are analyzed to estimate the amount of manure nutrients spread on a per field basis.

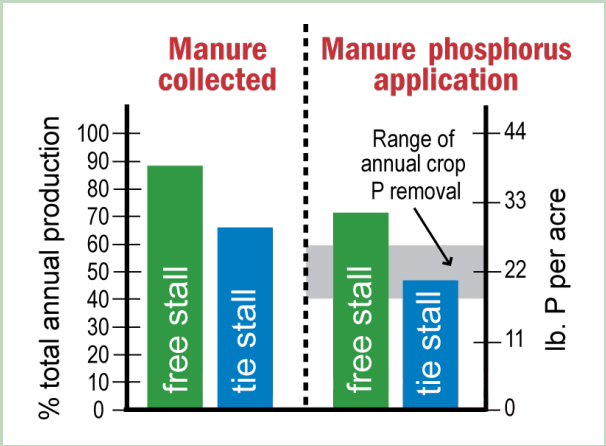


Figure 2. Comparison of manure collection and spreading on dairy farms with free stall or tie stall barns, based on survey of 54 Wisconsin farms.

Validate data and share it with farmers

We have used various methods to validate the snap-shot estimates of apparent feed intake, milk production, and manure nutrient excretions (as depicted in Table 1) and of the manure collection and manure spreading practices (as shown in Table 2 and depicted in Figure 2). For example, cow nutrient balances and associated feed requirements can be used to calculate the errors associated with data on apparent feed nutrient intake; and calculated feed nutrient use efficiencies and manure nutrient excretions can be compared to published values of relationships between feed-milk-manure.

Once a farm's information has been compiled and analyzed, a report can be compiled to depict various nutrient use efficiencies for individual farms, how each farm's nutrient use efficiency compares to other study farms, and where improvements in nutrient use efficiency can be made. For example, a farmer report may contain a graphic depicting feed nutrient use efficiency, such as the one shown in Figure 3. We've found that this type of information provides for interesting discussion with producers (and dairy nutrition consultants) on how the farm's feed nutrient use efficiency compares to other farms, and what may be needed for the herd to attain the potential feed nutrient use efficiency established under experimental conditions.

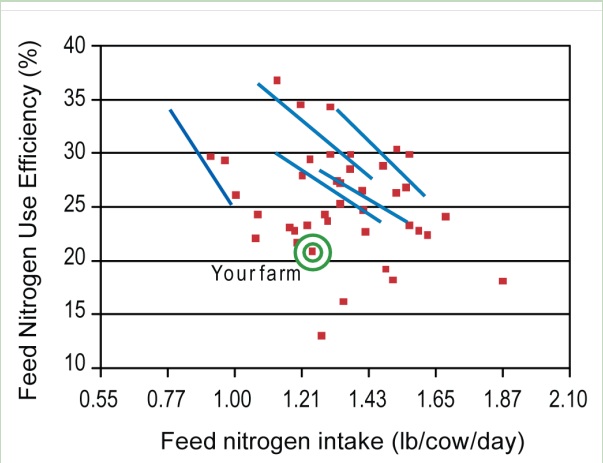


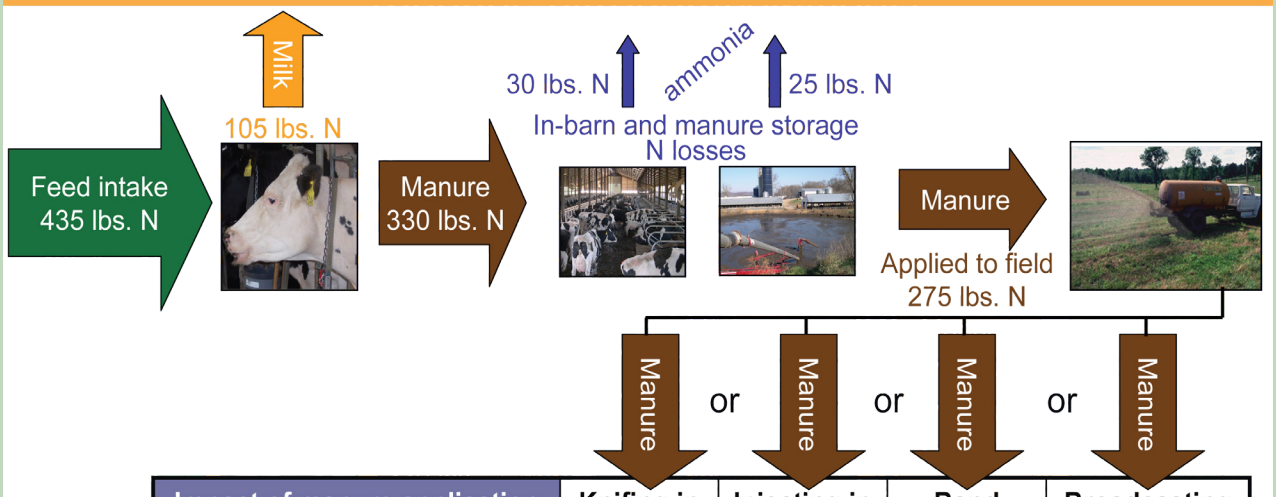
Figure 3. Relationship between feed nitrogen intake and Feed Nitrogen Use Efficiency. Solid lines correspond to experimental trials, to depict potential NUE; rectangles correspond to individual Wisconsin dairy farms, to depict the array of actual, industry NUE; and 'Your farm' designates the individual farm NUE for comparison to the NUE on other farms and to the potential NUE.

Conclusions

Relatively short, face-to-face interviews with dairy farmers can provide accurate, general snap-shot assessments of feed and manure management. Pre-testing the questionnaire, interview forms, and other survey tools on two to three farms is highly desirable before a full study is undertaken. Successful interviews require that the interviewer be knowledgeable of dairy farming practices, including cropping systems, dairy feeding practices, manure storage and spreading norms, and expected nutrient values of feed and manure. Studies that rely on farmers filling out daily manure-spreading logs are most effective when consistent contact is kept with the farmers, including fielding questions, addressing concerns, and encouraging ongoing farmer participation. Such snap-shot studies represent a valuable source of information about actual and potential nutrient management practices on dairy farms.

From feed to field: Nitrogen flow on a typical confinement dairy operation

(pounds nitrogen/cow/year)



Impact of manure application on nitrogen cycling	Knifing in	Injecting in open slots	Band spreading	Broadcasting
Ammonia N loss	5	15	24	70
N going to soil	270	260	251	205

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