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Using Voluntary Approaches to Reduce Environmental Damages: Evidence from a Survey of New York Dairy Farms

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This paper presents the results from a survey of New York dairy farms that links manure management practices and farmer willingness to participate in voluntary environmental programs, focusing on those operations that are not automatically designated as Concentrated Animal Feeding Operations. A wide divergence is found between actual and recommended manure management practices on individual dairy farms, the apparent ability of farms to divert financial resources to environmental practices, and the willingness to participate in voluntary programs at various annual costs per cow. These findings have policy implications for the USDA-USEPA [30] National Strategy for Animal Feeding Operations. The findings also may help foster comparisons and enhance understanding of environmental management issues in Japan and the United States.

Key words: AFO (Animal Feeding Operation), CAFO (Concentrated Animal Feeding Operation), CNMP (Comprehensive Nutrient Management Plan), Manure Treatment, Unified National Strategy, Utilization of Livestock Manure, WTP (Willingness to Participate).

1. Introduction

Over the last decade, nutrient management on farms with livestock and crop production has emerged as a major environmental issue in many modern economies. In the United States, animal agriculture is presently at the forefront of state and federal agricultural environmental policy. According to United States Environmental Protection Agency (USEPA) documents, agriculture is the leading source of impaired river miles in New York and the United States, with animal operations recognized as a leading agricultural source of water contamination (USEPA [31]; Cook [5]). High profile spills from animal operations and the presumed linkage of animal waste practices to *Cryptosporidium and Pfiesteria piscicida* outbreaks have further elevated public concerns about agriculture and water quality (Copeland and Zinn [8]). In May 2002, the U. S. Congress reauthorized national farm legislation with passage of the Farm Security and Rural Investment Act of 2002. This act provides the Congressional authority needed to continue several important farm environmental programs for American agriculture and calls for substantial increases in federal investment in cost-sharing programs for nutrient management on U. S. livestock and poultry farms (Harl [10]).

Managing nutrients on livestock farms appears to be at least an emergent policy issue in Japan as well. A new basic *Law on Food Agriculture and Rural Areas* was adopted by the Japanese government in July 1999 (MAFF [18]). This revised law recognizes the

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importance of multifunctional agriculture and identifies the role agriculture plays in maintaining or enhancing environmental quality, preservation of landscape, and sustaining cultural traditions. In 1999, the Japanese government also enacted an entirely new *Law for Promotion on Introduction of Advanced Sustainable Farming System*; this law may set the stage for further steps to develop sustainable agriculture by harmonizing crop and livestock production with environmental concerns (United Nations [29]). Even more directly related to livestock agricultural environmental issues is a 1999 *Law Concerning the Appropriate Treatment and Promotion of Utilization of Livestock Manure*; the object of this law is to ensure and promote appropriate treatment and utilization of livestock wastes through composting and other methods (United Nations [29]).

Given these parallel policy tracks in both countries, some comparison of livestock waste management issues in the United States and Japan may be warranted and of interest to researchers and policymakers. Among these comparisons, the situation in New York State may be particularly informative for interests in Japan. Dairy production is New York State's number one farm industry, with nearly 60 percent of total farm gross receipts for New York farmers resulting from the sale of fluid milk; New York State ranks third in total U.S. milk production (NYASS [22]). In addition, New York dairy producers operate under climatic conditions that in several ways resemble those in Northern Japan, particularly on the island of Hokkaido. Hokkaido accounts for a large share of Japan's dairy industry (Kume [13]). Central New York State is approximately at the same latitude as Hokkaido and has similar mean temperatures, seasons, and levels of precipitation. In Hokkaido, Japanese dairy farms are considerably larger than the national average and often compare in size to dairy farms in upstate New York. In the early 1990s, for example, the average number of dairy cattle on a dairy farm in Hokkaido was 65 head, compared to the Japanese national average of 29 (Kume[13]). In 1992, for the state of New York as a whole, the average number of dairy animals on farms reporting milk cows was 67 head (NASS [28]). This suggests that, even though larger farms in New York receive considerable notoriety, many New York dairy farms operate on a scale that is comparable with those situated in Hokkaido.

While the physical environment and farm size for dairy farms might compare, the public policy environment for dairymen in Hokkaido and New York State is obviously quite different. This paper focuses on such policy circumstances in New York, where the evolution of public policy for livestock waste management has involved both state level initiatives and legislation/programs promulgated at the federal level. In New York, highly visible lawsuits against animal agriculture (e.g., *Concerned Area Residents for the Environment v. South View Farm*, CA 2, No. 939229, 9/2/94) and federal legislation (e.g., the 1990 Coastal Zone Management Act Reauthorization Amendments (CZARA)) motivated the New York State government to establish an Agricultural Environmental Management program in the mid-1990s. The objective of this program is to help farmers voluntarily meet environmental goals (Moore [20]). At the national level, the 1999 United States Department of Agriculture (USDA)/USEPA Unified National Strategy for Animal Feeding Operations (AFOs) prescribed that all farms designated as AFOs will need to implement Comprehensive Nutrient Management Plans (CNMPs) by 2009, relying on a blend of regulatory and voluntary programs (USDA/USEPA [30] [31]).

These regulations have received constant attention since 1999. Subsequently, the Congress has demonstrated further interest in livestock operations with discussions of new laws, and voters in individual states demanded referenda on greater regulation of large livestock operations. As a result, the USEPA developed and just finalized new regulations for large AFOs (USEPA, 2003 [32]).)

Today in the United States, as in years past, much public and industry attention has been devoted to "large" farms automatically designated by operation size to be Concentrated Animal Feeding Operations (CAFOs),[1] and hence subject to the Clean Water Act's (CWA) permitting authority. However, the "vast majority of AFOs in the United States are small" with only 5% of the AFOs "expected to be regulated under existing CAFO regulations" (USDA/USEPA [30]). For the remaining 95% of operations, there is an explicit appeal to the farm sector's "ethic of land stewardship and sustainability" by relying on voluntary and educational efforts as the "principal approach to assisting owners and operators in developing and implementing site-specific CNMPs, and in reducing water pollution and public health risks associated with AFOs" (USDA/USEPA [30]). As noted above, the Unified National Strategy sets the "performance standard" objective that all AFOs, regardless of size, implement CNMPs by 2009. Despite new regulations finalized in early 2003, it is clear that policies for American livestock and poultry operations will continue to evolve with changes in information and political climate in the years ahead.

Federal farm legislation, just reauthorized in 2002, reiterates the Congress's intent to promote both agricultural production and environmental quality as being compatible national priorities as well as affirming its commitment to assist farmers in complying with all federal, state and local environmental laws and regulatory programs. As in previous American policy initiatives, the Congress prefers to provide assistance to producers for installing and maintaining conservation systems while facilitating partnerships between producers and government agencies at all levels (Harl [10]).

Despite this elevated policy interest, little is known about actual manure management practices on dairy farms—especially those that do not satisfy the large CAFO designation. To quote the Unified National Strategy, "there is insufficient data on which to base an estimate of the number of AFOs that have unacceptable conditions" (USDA/USEPA [30]). Even less is known about farmers' attitudes and their willingness to participate in voluntary programs, a component that is critical to the success of national and state policy efforts.

In an effort to address these critical information gaps, and to develop a reference point for comparative policy analysis, we conducted a statewide mail survey of New York dairy farms that focused on documenting manure management practices. We also investigated farmers' willingness to participate in voluntary agricultural environmental programs. This paper summarizes the results from this survey and discusses the policy implications of this research, with specific attention given to those dairy farms with less than 1,000 animal units (AU)—those farms that do not satisfy the "large operation" definition and, hence, are not automatically designated as CAFO point sources of water pollution.

In the next section we describe the survey. The third section documents the extent to which current practices on New York dairy farms correspond with desirable components of a CNMP—emphasizing the barnyard and wastewater handling elements that play a central role in the Unified National Strategy and focusing on farms with less than 1,000 AU.[2] Evidence presented in this section suggests that current practices on many dairy farms deviate substantially from desired manure management practices. The fourth section provides the results from a series of survey questions directed at measuring farmers' attitudes and willingness to participate in voluntary programs at varying costs. Documentation of such attitudes is essential to assessing whether voluntary AFO programs will be successful in attaining performance standards for the bulk of animal operations that do not satisfy the "large operation" CAFO definition. The willingness to participate results are also a novel application of contingent valuation to the agricultural industry, as past participation research has primarily focused on willingness to accept compensation in conservation programs (e.g., Purvis et al. [25]; Lohr and Park [14], [15]; Cooper and Keim [6]; Cooper and Osborn [7]). Here we address the more realistic policy scenario for dairy manure management in the upcoming decade—what are expected participation rates at various implementation costs facing the farm? The final section summarizes the research and addresses the question: "can voluntary and educational programs be expected to generate adequate participation to meet CNMP performance standards?" Some observations on possible implications for Japanese/US contrasts and comparisons are also mentioned.

2. Survey of Manure Management on New York Dairy Farms

The survey consisted of a 16-page booklet containing 41 questions, with sections on farm characteristics, manure management, handling manure, spreading manure, neighbor relations, and land-use issues. The survey was developed with input from agricultural economists,

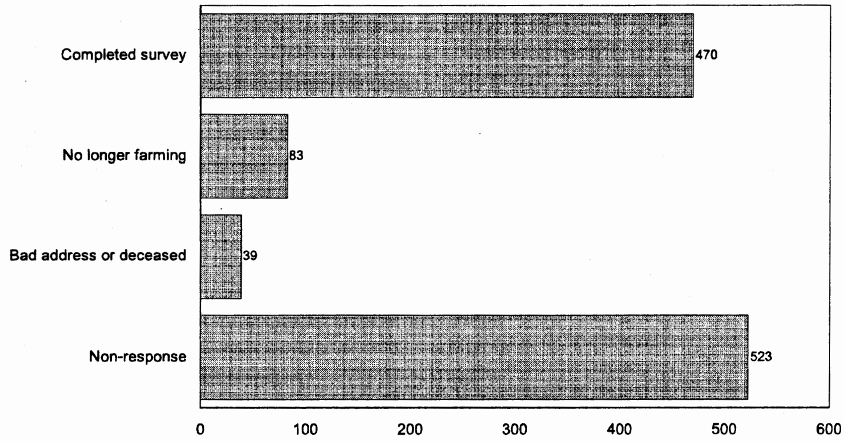

Figure 1. 1997 Survey of 1,115 dairy farms in Upstate New York

agricultural engineers, dairy specialists and soil scientists at Cornell University, and water quality specialists, extension personnel, and federal and state agency staff throughout New York State. A pretest focus group with 14 central New York farmers indicated the need for only slight modifications to the pretest instrument. Drawing a random sample of farms from a database of milk shipments in June 1995, 1,115 surveys were mailed to dairy farmers in upstate New York in summer and fall 1997.[3] Following widely used mail survey procedures, with an advance mailing, an initial survey mailing, a thank you/reminder postcard and two subsequent mailings, 470 completed surveys were returned (Fig. 1). After accounting for mail returned as "no longer in dairy farming" (83 obs.), "bad addresses" (37 obs.), and "deceased" (2 obs.), this represents a 47.5% adjusted response rate. Such a response rate is lower than the 50 to 70% standard widely adopted in contingent valuation research but is higher than might be expected for such a controversial topic from an environmentally targeted industry.

Comparison of the returned surveys with data from New York Agricultural Statistics Service (NYASS [21]) indicates that the regional distribution of the returned surveys corresponds closely with the actual distribution of New York dairy herds. However, the sample distribution across herd size exhibits a slight upward bias. That is, relative to NYASS statistics, smaller herds with less than 100 cows are underrepresented in our survey responses relative to larger herds: the survey (and NYASS [21]) distribution for 99 cows or less, 100 to 199 cows, and 200 plus cows was 71% (81%), 19% (14%), and 10% (5%), respectively. Unless otherwise noted, these sample and population weights are used in all statistical tests and all aggregated results reported in this document.

This apparent bias may reflect the age of our mailing list at the time of the survey. This list consisted of farms shipping milk in mid-1995, two years before the mail survey. If one assumes that the "no longer in dairy farming" group was largely composed of farms with smaller herd sizes, this could directly affect the size distribution of survey responses. It may also reflect a potential nonresponse bias by smaller farms. Unfortunately, we do not have the data to identify the probable source of this disparity. Consistent with the tendency towards larger herds, the average milk production per cow reported in the survey was a relatively high 17,777 lbs. (8063.5 kg), which compares with the 1996 NYASS [21] statewide average of 16,423 lbs. (7449.4 kg.).[4] Using the above classification, "smallest", "small", and "medium" farms comprise 41%, 49%, and 10% of the completed surveys, respectively, as shown in Table 1.

Responses to the survey were grouped according to actual and proposed federal water

Table 1. Classification of farms with completed surveys

Category	Number of animal units (AU)	Percent of completed surveys
Smallest	Under 100	41%
Small	100-299	49%
Medium	300-999	10%
Total		**100%**

quality regulations affecting New York dairy farms. While the CAFO regulations automatically regulate large AFOs with 1,000 AU or more through permitting requirements, New York agricultural and environmental agencies are operating on the assumption that all dairy farms with more than 300 AU could appropriately be eligible for CAFO permitting as well (CAFO Information Package, http://www.dec.state.ny.us/website/dow/cafohome.html).[5] Correspondingly, for the purposes of this paper, "medium" farms are classified as those with 300 to 999 AU.[6] A second group of "small" farms with 100 to 299 AU will generally be exempt from CAFO requirements unless an individual farm is identified as a "significant contributor of pollution to the waters of the United States… [and] pollutants are discharged from a man-made device or are discharged directly into waters passing over, across, or through the facility or otherwise come into direct contact with the confined animals" (USDA/USEPA [30] [31]). However, it remains possible that farms with 100 to 299 AU in New York will still need to be in conformity with the 1990 CZARA manure management measures for storage facilities and nutrient management. The remaining "smallest" farms with less than 100 AU are presently exempt from federal water quality regulations, with the exception of the "significant contributor" clause indicated previously. As noted, however, even these smallest farms will be expected to have achieved the CZARA performance standard by 2009.

3. Components of the Comprehensive Nutrient Management Plan

While the specific practices will need to be determined at the individual farm level, the USDA/USEPA [30] National Strategy has identified several components that should be accounted for in a CNMP. Here we investigate four central components of such plans across herd sizes: manure handling, storage, land application of manure, and record keeping.

1) Manure handling

The siting and barnyard management practices are a central feature of any CNMP. Figure 2 demonstrates that for many farms, the use of barnyards and barnyard location relative to surface water would be classified as an environmental risk: 14% of farms have surface water within the "fencing of the barnyard" and an additional 33% of the barnyards are within 300 feet (91.4 meters) of the nearest downhill surface water. While CNMP barnyard location requirements have not been specified, the farms with surface water running through their barnyards clearly have a fundamental problem, and those barnyards within 300 feet (91.4 meters) are likely be scrutinized by environmental agencies. Figure 2 also demonstrates an observation that carries through the remainder of this subsection that environmental risks associated with manure management practices do vary substantially and significantly across herd sizes. Notably, medium farms tend to have lower reliance on barnyards ($p<0.001$),[7] and thus are less subject to run-on and runoff concerns.

Figures 3 and 4 similarly demonstrate that management of animal holding areas varies across farm size. Smaller farms tend to have adopted fewer run-on control practices (e.g., gutters and natural topography, $p < 0.001$). They also tend to have less investment in controlling runoff ($p<0.001$), with only 15% providing some sort of desirable runoff control. Again, a large component of this disparity in distributions across groups is attributed to the relatively limited use of barnyards on larger farms. In addition to barnyard location, animals can have direct access to surface water

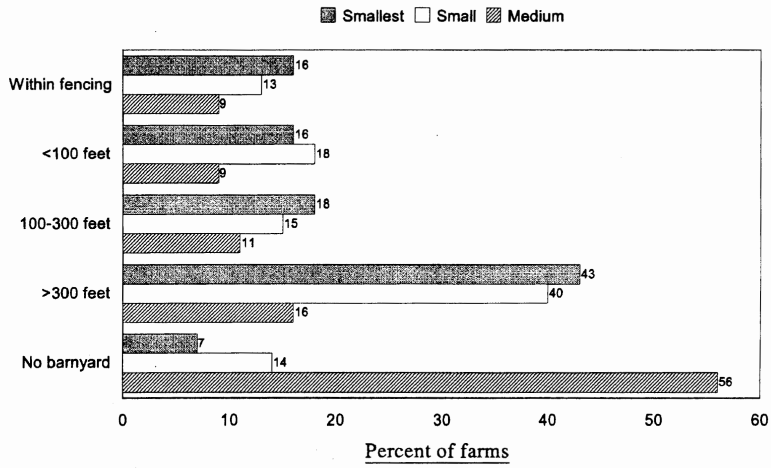

Figure 2. Percent of farms, by proximity to downhill surface water and farm size

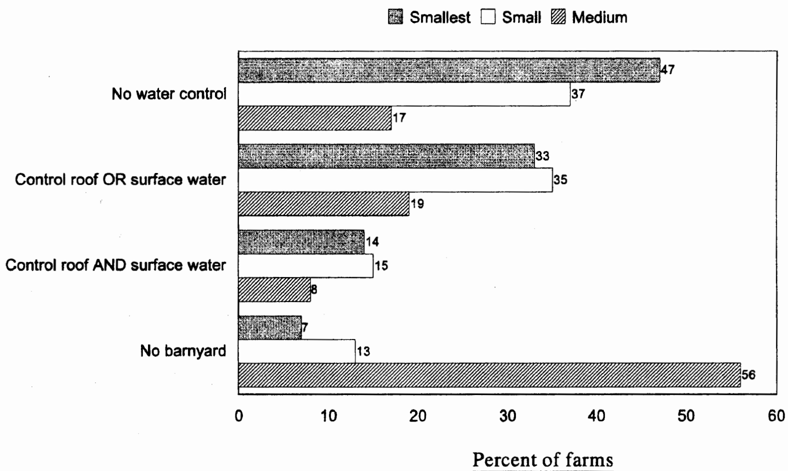

Figure 3. Percent of farms controlling roof and barnyard surface water, by farm size

while pasturing or in transit. This form of direct contact does not vary by herd size ($p=0.106$); "livestock have direct access to surface water or cross a stream to get to pasture" on an estimated 55% of all farms.

2) Storage

Adequate manure storage is a critical issue in northern states such as New York, where avoiding saturated and frozen ground is difficult without 180-day storage capacity. As demonstrated in Table 2, average storage capacity is higher on medium farms ($p=0.040$) and the average number of days in a year in which manure is spread is lower ($p<0.001$) than that for the other size groups. Yet, only 22% of medium farms have storage capacity exceeding 180 days. And reliance on daily spreading prevails in all size groups, with a mean of 263 days per year across all farm sizes. To a large extent, the observed deviation in storage and spreading across herd sizes is due to a greater reliance of larger farms on liquid manure handling systems ($p<0.001$).

3) Land application of manure

According to the USDA/USEPA National Strategy, "land application is the most

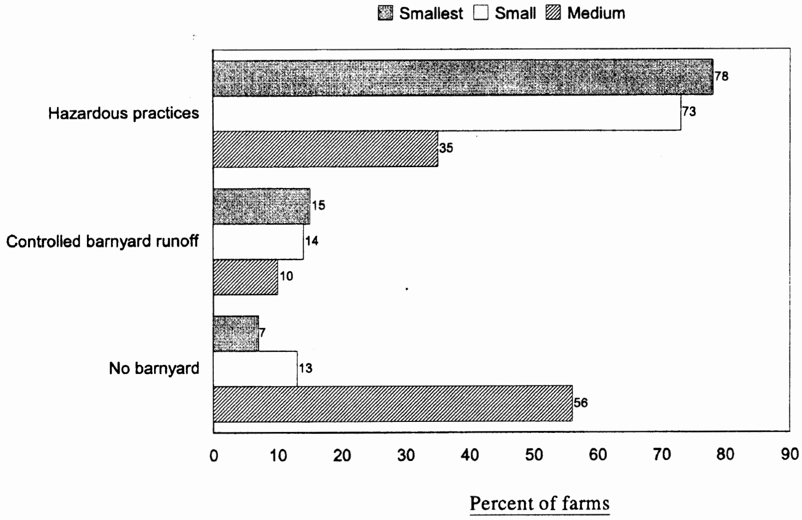

Figure 4. Percent of farms controlling barnyard runoff, by farm size

Table 2. Manure handling and storage

	Smallest	Small	Medium
Percent of farms that handle manure as a liquid or slurry	94%	74%	14%
Percent of farms by maximum days of manure storage			
No storage	58%	46%	39%
Less than 60 days	87%	77%	58%
Less than 180 days	93%	91%	78%
Average number of days manure is spread per year	274	271	185

common, and usually the most desirable method of utilizing manure" (USDA/USEPA [30]). From the perspective of potential land use, the average New York dairy farm in this survey has more than an adequate amount of land for applying manure. A commonly used threshold for land application is 0.5 acre/AU, which is greatly exceeded by all farm size groups, with medium, small, and smallest farms having 1.85 (.75 ha), 2.36 (.96 ha), and 2.77 acres (1.12)/AU ($p<0.001$).

In spite of this potential, New York dairy farms as a whole do not appear to have adopted recommended practices in terms of soil and manure testing, calibration, accounting for manure in nutrient management planning, and application practices. As demonstrated in Fig. 5, a greater proportion of medium farms have implemented recommended nutrient management practices, with significance levels across herd sizes generally less than 0.1%. The exception to this trend is the proportion of respondents who always or usually "surface broadcast manure with a spreader" ($p=0.676$). While a greater proportion of medium farms have adopted recommended practices, it is evident that there is still a wide gap between existing practices and practices likely to be required by a CNMP for all size groups.

4) Record keeping

Livestock operators should "keep records that indicate the quantity of manure produced and how the manure was utilized, including when, where, and amount of nutrients applied" (USDA/USEPA [30]). However, only 73% of medium farms, 53% of small farms and 38% of smallest farms indicated that they maintain records ($p<0.001$).

Taken together, the above findings suggest

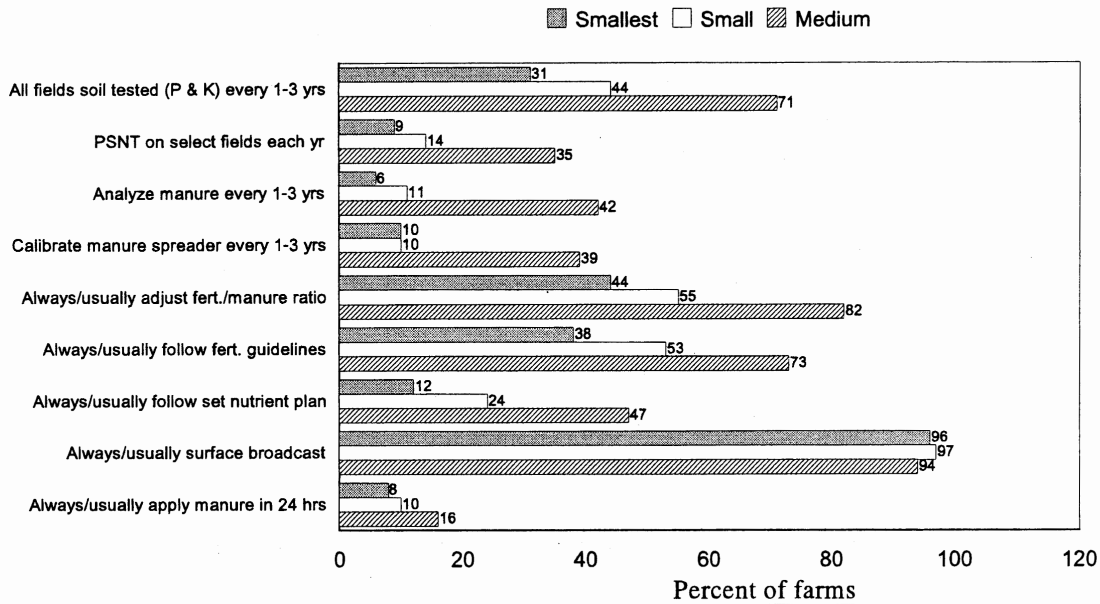

Figure 5. Percent of farms implementing selected nutrient management practices, by farm size

that the New York dairy industry will be substantially challenged by existing and proposed water quality legislation in the sense that actual practices tend to deviate from those associated with recommended components of a CNMP. Moreover, the degree of noncompliance varies significantly across herd sizes.

4. Neighbor Relations, Farmer Attitudes on Land Use, and Willingness to Participate

In addition to actual practices, a number of questions were posed pertaining to land use issues and neighbor relations. We also described a voluntary agricultural environmental program similar to those proposed in New York, and elicited responses on willingness to participate in this program using contingent valuation type questions.

1) Neighbor relations

With respect to neighbor relations, anecdotal reports would suggest that the typical livestock operation is under siege from lawsuits and neighbor complaints. This does not appear to be the case for the New York dairy industry. Over 63% of farms had not received any "complaints from neighbors or local public officials in the last five years", with significant variation across herd size: 39%, 58%, and 76% for medium, small, and smallest farms, respectively ($p<0.001$). For dairy farms that experienced complaints, the following were categories of complaints and associated percentages of total complaints: odors (42%), roadway spills (26%), water pollution (17%), farm traffic (14%), chemical use (11%), flies/insects (10%), noise (7%), dust (7%). Only odor complaints were significantly different across farm size: 66%, 42%, and 25% for medium, small, and smallest farms ($p<0.001$), respectively. This focus on odors rather than water quality is consistent with "management practices" complaints to the New York State Department of Agriculture and Markets, but deviates from the regulatory focus on water quality (Rudgers [27]; Bills and Cosgrove [1]).

2) Farmer attitudes on land use

Likert scale responses to a series of opinion questions indicate that, in contrast with popular beliefs and property rights implied by a regulatory approach to controlling agricultural pollution, farmers generally do not believe that they cause water quality problems or that they should have to pay for installing water pollution controls on current operations (see Table 3). Response patterns to these questions tend not to differ by herd size; consistent response patterns were observed for individ-

Table 3. Distribution (%) of responses to agricultural environmental opinion questions

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
Q27A. In a typical year, manure and barnyard runoff is not a water pollution problem from my farm	7	7	24	30	32
Q27B. If my net returns declined by $50 per cow per year, I would not stay in the dairy business	14	11	35	12	27
Q27C. Farmers should not have to pay for installing water pollution control practices on current operations	7	9	33	15	37
Q27D. Farmers should not have to pay for installing water pollution control practices when they expand their operation	22	23	29	11	16

ual farms' acknowledging being a source of water pollution (Q27A: $p=0.757$), whether they would be able to stay in business if they had to incur substantial environmental costs (Q27B: $p=0.499$), whether they should have to pay for enacting water pollution practices on current operations (Q27C: $p=0.166$), and whether farmers should have to pay for environmental practices when they expand operations (Q27D: $p=0.414221$). Irrespective of property rights beliefs, many farmers would be "able to pay" substantial environmental costs, with 25% indicating that they would "stay in the dairy business" at a cost of $ 50/cow/year. Participants in a 1999 New York State Bankers Association seminar suggested that at least half of the "neutral" respondents would also be able to stay in the business.

3) Willingness to participate

It is clear from the above that the manure management practices on many New York dairy farms deviate substantially from what will be expected under CNMPs. The cost of meeting these CNMPs is expected to vary widely across farms, and may be quite substantial in some instances. For example, based on extensive field experience, Cornell Cooperative Extension estimates that, in addition to per farm preparation costs, controlling barnyard runoff will cost $ 1,000 to $ 500,000 per farm. Nutrient management plans will be expected to break even. In recent years, the New York Agricultural Non-Point Source Grant Program has provided funds to individual farms to address manure management issues, with grants ranging from $ 2,155 to $ 419,050 for farms with over 300 AU (Wildeman [35]). The USDA estimated the average cost per cow per year, meeting 1990 Coastal Zone Management Act requirements, to range from $ 17.01 to $ 34.63 (Heimlich and Bernard [11]). Taken together, the evidence suggests that implementation of CNMPs would be a costly endeavor on many farms.

New York's efforts to pursue a voluntary program and the voluntary/regulatory mix proposed in the USDA/USEPA National Strategy raises the critical question of how many farmers would actually participate in voluntary programs. Here we use a "contingent valuation" survey method to estimate participation levels at different costs to the farmer. This technique has been widely used in the last three decades to place economic values on environmental goods (Loomis [16]). Several studies have also applied this technique to valuing positive (open-space) and negative (water contamination) agricultural externalities (Poe [23]). Recently economists have adapted this survey method to estimate the

Farmers are increasingly the target of environmental policies to protect water quality. Federal laws such as the Coastal Zone Management Act and Clean Water Act may require specific best management practices to be implemented on all dairy farms in New York. At the same time other Federal and State programs may provide some cost-sharing assistance to farmers adopting best management practices.

New York is introducing an agricultural enviromental management program that would involve:

1) individual assessments of farm pollution risk, and
2) Voluntary management plans tailored to the needs and pollution risks of each individual farm.

The implementation of improved manure management practices may increase the returns on some farms, but on others they may decrease net returns.

In order for the voluntary program to be successful, enough farms have to participate in this or similar local voluntary programs. If participation levels are not high enough, then it is likely that a regulatory program requiring specific management practices on all farms will be adopted.

Figure 6. Contingent valuation scenario

likelihood of participation in conservation programs at various payments to the farmer (e.g., Purvis et al. [25]; Lohr and Park [14], [15]; Cooper and Keim [6]; Cooper and Osborn [7]). A "willingness to accept" framing is not consistent with present water quality efforts. Rather, given limited funding and the large number of operations, a "willingness to participate at various costs" format is more appropriate to the current AFO and water quality situation.

Figure 6 provides the text of the contingent participation scenario corresponding with the current policy situation. In creating this question, effort was taken to develop a concise half-page scenario that closely resembles New York's voluntary Agricultural Environmental Management (AEM) program. Two central features of the AEM and CNMP programs—individual assessments of farm pollution risk and voluntary management plans tailored to the needs and pollution risks of each individual farm—were explicitly mentioned. Corresponding to policy expectations that some minimum level of participation would be required for the program to be classified as a success, the need for "high" participation levels was emphasized.

Given this scenario, farmers were asked: "If you determined that the cost to implement manure management practices on your farm would be one of the following amounts each year, would you participate in the voluntary program?" Using a multiple bounded format described in Welsh and Poe [34], the dollar amounts that each respondent was asked to consider included 0 cents, 10 cents, 25 cents, 50 cents, \$1.00, \$2.00, \$5.00, \$10.00, \$25.00, \$50.00, \$100.00, and \$200.00 per cow per year. For each dollar amount, respondents indicated their likelihood of participation in the program, with response options including "I would definitely participate", "I would probably participate", "not sure", "I would probably not participate", and "I would definitely not participate".

The range of "cost per cow" dollar values was determined by first estimating an upper bound of \$100 on possible costs and then doubling this value to avoid any truncation effects on willingness to participate (WTP).[8] A lower bound of zero was used to capture "no net loss in farm returns" programs like that used in the New York City watershed (McGuire [17]).

Our analysis focuses on the "probably participate" (or higher) responses (Poe et al. [24]; Vossler et al. [33], Blumenschein et al. [2]). As indicated in Table 4, responses at this level or higher are approximately 77% at \$0, a proportion which is only slightly exceeded by participation rates in the complete cost-sharing program in the New York City watershed. However, the "probably participate" responses fall

Table 4. Distribution of participation responses across selected dollar values-percent (cumulative percent)

	Definitely participate	Probably participate	Not sure	Probably not participate	Definitely not participate
$0.00	57	20	15	4	4
		(77)	(92)	(96)	(100)
$0.50	35	19	18	10	18
		(54)	(72)	(82)	(100)
$5.00	12	13	24	16	35
		(25)	(49)	(65)	(100)
$50.00	2	2	13	16	68
		(3)	(16)	(32)	(100)

below the median by $5 per cow, and approach 3% at $50. This latter figure contrasts substantially with the 27% of respondents who indicated that they would be likely to stay in business if they had to pay $50 per cow per year; thus there appears to be a broad discrepancy between "ability to pay" and "willingness to participate". Such a discrepancy is consistent with the general economic notion of free-riding and the more specific sequence of producer denial that has characterized past agricultural environmental issues and the economic notion of free-riding (Daily [9]).

WTP is likely to be associated with many factors, including the cost of participation, herd size, farmer attitudes, and socioeconomic characteristics. Due to the large dimensions of the response matrix (12×5) and the need to control for various factors simultaneously, contingency table analyses, as used in the rest of this article, are neither appropriate nor informative. Instead, a multiple bounded approach analogous to the maximum likelihood interval modeling approach used for payment card data was used to model the "probably participate" response function (Welsh and Poe [34]). In the Welsh and Poe (1998) framework, the respondent's choices define a WTP interval. Defining X_{iL} as the maximum amount that the ith individual would vote for, and X_{iU} as the lowest amount that the ith individual would not vote for, WTP_i lies somewhere in the switching interval $[X_{iL}, X_{iU}]$. Assuming WTP is distributed logistic, let $\Lambda(X_i; \beta)$ denote the distribution function for WTP_i with parameter vector β. The probability WTP_i falls between the two price thresholds, X_{iL} and X_{iU}, is $\Lambda(X_{iU}; \beta) - \Lambda(X_{iL}; \beta)$, resulting in the following log-likelihood function:

$$\ln(L) = \sum_{i=l}^{n} w_i \ln[\Lambda(X_{iU};\beta) - \Lambda(X_{iL};\beta)] \quad (1)$$

where w_i is the sampling weight on the ith observation. When the respondent says "yes" to every amount, $X_{iU} = \infty$. Likewise, when the respondent says "no" to every amount, $X_{iL} = -\infty$. These estimates were then converted to WTP functions following methods detailed in Cameron ([3], [4]). Combined, these statistical analyses allow us to present a "regression" function relating WTP to other variables reported in the questionnaire.

In estimating these WTP regressions, the dollar per cow value was multiplied by the number of milking and dry cows reported in the survey in order to directly estimate WTP as a function of total, as opposed to per cow, farm costs. As such, each respondent faces a unique set of dollar values in considering his WTP. In the simplest case, we estimated WTP as a function of the dollar value and the herd size. The resulting regression coefficients were[9]

$$WTP = 26.32 + 153.07\ D100199 + 957.09\ D300999 \quad (2)$$

in which the intercept and coefficient on the small herd size dummy were not significantly different from zero but the coefficient for the middle herd size was significant at the 1% level (see Model 1 in Table 5). Holding everything else constant, this estimated function indicates that the average smallest farms would not be willing to participate in this type of voluntary program even if it only had a nominal effect on their net returns. In contrast, the average small farm would probably participate

Table 5. Estimated multiple bounded coefficients, "probably yes" models

Variable	Description	Mean value [n]	Sign Exp.	Model 1	Model 2	Model 3
Constant	1	1	n.a.	26.32 (71.32)	−144.46 (421.28)	−388.09 (334.10)
D100299	Binary: 100 to 299 AU = 1	0.52 [325]	?	153.07 (96.48)	77.68 (96.98)	
D300999	Binary: 300 to 1,000 AU = 1	0.06 [325]	?	957.09 (212.02)***	693.43 (209.72)***	631.35 (199.48)**
Q27A	1-5 scale: Farm is not a water pollution problem	3.77 [325]	−		−72.54 (40.64)*	−78.62 (40.16)*
Q27B	1-5 scale: Not able to pay $50 per cow	3.21 [325]	−		−52.54 (36.10)	−56.63 (35.49)
Q27C	1-5 scale: Farmers should not have to pay for installing practices, current operations	3.65 [325]	−		−18.43 (40.25)	
No-complain	Binary: no complaints from neighbors or local officials in last five years = 0	0.35 [325]	+		135.84 (98.09)	150.79 (97.29)
Inoper10	Binary: farmer, family or partner expects to be in operation in 10 years =1	0.58 [325]	+		130.06 (100.74)	149.10 (97.54)
Age	Age in years	47.96 [325]	−		−3.76 (4.30)	
Milk	Lbs. (kg.) milk per cow per year, actual or estimated from daily milk production	17,582 (7975.1 kg) [325]	?		0.05 (0.02)***	0.05 (0.01)***
k	Scale parameter as defined in Cameron (1988 [3])	n.a.		516.55 (31.63)***	498.41 (30.41)***	499.17 (30.47)***
n				325	325	325
Wald Stat.				266.82***	268.44***	268.43***

Note: *, **, *** denote 10, 5, and 1% significance levels, respectively. Sampling weights were adjusted to the smaller sample size used in these models, with sample proportions being 0.68 (smallest), 0.21 (small), and 0.11 (medium). Numbers in ( ) indicate asymptotic standard errors.

at a cost of $179.39 (=26.32+153.07) per annum. Similarly, these estimates indicate that the average medium dairy farm would participate at a cost of $983.41 (=26.32+957.09) per annum. Accounting for the size distribution across farms, the overall average willingness to participate is $162.

Other covariates were introduced into the model in an effort to account for farmer and farm characteristics that are correlated with WTP and to examine the construct validity of farmer responses. These additional variables are evaluated in Models 2 and 3 in Table 5. Model 2 includes the most complete set of covariates; and Model 3 excludes those Model 2 covariates (D100299, Q27C, and age) that were not significant at the 20% level. Of particular interest amongst these excluded variables, from a property rights perspective, is whether or not farmers believed that they should have to pay for installing water pollution control practices on current operations. Interestingly, the coefficient for Q27C was not statistically significant, a finding that seems to contradict the widespread "property rights" belief that farmers should not have to pay to install environmental practices on their farms.

Notably, as expected, WTP is positively correlated with the belief that one's farm is not a water pollution problem. This finding is important because it suggests some potential for an educational role in agricultural environmental policy in the sense that WTP would be expected to rise if farmers could be convinced that their farm contributes to water pollution problems. WTP was also significantly and positively correlated with production per cow, suggesting that more intense milk production management may carry over to willingness to invest in manure management. Although not quite significant at the 10% level, community pressures also appear to exert an influence on WTP, as farms that had received complaints from neighbors or local officials in the last five years had a higher WTP. In addition, expectations of being in operation in 10 years has some positive correlation with WTP, as does ability to pay, as measured by the response to Q27B concerning the farmer's assessment of staying in business if additional environmental costs were $50 per cow. Overall, the weighted models strongly conform to prior expectations, indicating that WTP does vary systematically across farmers, suggesting that these contingent participation measures demonstrate construct validity.

5. Summary and Discussion

This research provides useful insights into US policies for managing nutrients on American dairy farms. Our study of the New York dairy industry, the Nation's third largest milk producing region, demonstrates the degree of nonconformance with recommended best management practices for handling livestock wastes and examines the likelihood that farmers will voluntarily implement the practices needed to meet stated agricultural environmental objectives. Such research is important because the great majority of livestock operations in New York, and the rest of the country, are smaller farms that fall below the regulatory threshold established in federal clean water laws. Compliance with recommended manure management practices on those smaller farms will rely on voluntary and educational activities. Because of limits on government budgets, we doubt that all farmers will have access to public funds to help offset any investment or operating costs that might come with new management practices. These funding shortfalls make questions about farmers' voluntary behavior an absolutely critical element in the ongoing debate over water quality in rural communities.

The results from our statewide survey indicate that there is a substantial gap between actual and recommended nutrient management practices for all dairy farm size groups. Many of these gaps are fundamental. For example, 14% of New York dairy farms have surface water running through a barnyard—an open surface area where cattle congregate for feeding and exercise. Further, less than 10% of all dairy farms have capacity to store manure for at least 180 days; this means that too many farms are dependent on dairy land application of manure during winter months when nutrients can more easily reach surface water. It is clear from these data that farms will have to incur a range of costs to meet performance objectives stated in the national water strategy. On some farms these added costs will be negligible. But on others, particularly on those farms which will need to relocate a barnyard or install manure storage facilities, these costs may be substantial.

Instead of reliance on storage and subsequent land application of manure, more New York farms may follow the Japanese example and implement a composting operation. To date, only a handful of New York farmers have decided to experiment with compost production (Jordan [12]). Composting does not alleviate the financial concerns that farmers have regarding manure management in the short run because new capital and labor inputs are needed to move into compost production. However, preliminary case study results indicate that composting may produce net income benefits for those farmers who are able to find a viable off-farm market for the compost product. Because many New York farms are located in reasonably close proximity to metropolitan areas and along major transportation corridors, some dairy producers might have some opportunity to develop a viable, local market outlet for compost products.

As with the case of adequate storage and land application, the composting option raises the same critical question: can voluntary and educational programs be expected to generate adequate participation to meet nutrient management performance standards? The answer to this question is strongly in the affirmative if adequate cost sharing is provided. Over 78% of the farmers in our survey indicated that they would participate in such a program if it were 100% cost shared. Yet, once even nominal costs are imposed, participation levels drop dramatically, suggesting that attaining the needed performance standard will be difficult at best.

We doubt that these findings should be interpreted to mean that farmers have a low environmental ethic. Many farmers may simply have reached their own environmental equilibrium, in which they are undertaking practices commensurate with their level of understanding of environmental issues/needs. As such, they may be reluctant to make additional investments in nutrient management or sacrifice any farm income to meet such environmental targets. Such a conclusion may be supported by our survey results which show that a relatively small proportion of New York dairy farmers believe that they are presently contributing to water pollution. Conversely, our analysis indicates that the willingness to participate in a voluntary public program increases with greater understanding that runoff from the farm contributes to water pollution. However, predicted participation levels fall short of the expected costs on many farms.

Given these data and estimated participation functions, we believe that our results raise a considerable challenge to present efforts that rely on educational programs and voluntary participation in order to meet stated performance standards on the majority of smaller dairy farms not directly subject to CWA regulations. Based on our analysis, it appears that agricultural environmental policy in New York and elsewhere will need to extend or move beyond the present voluntary program approach to meet water quality objectives. Either substantial additional resources or an expansion of regulations will be needed to accomplish CNMP performance standards by 2009.

1) The CWA gives the USEPA the authority to regulate point source discharges, including CAFOs, into the waters of the United States through the National Pollution Discharge Elimination System (NPDES) permitting program. In order for an AFO to be considered a CAFO, a facility must meet the NPDES definition [40 CFR 122.23 (b) (1)] of an AFO: a lot or facility where animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period and where crops, vegetation, forage growth, or post harvest residues are not sustained over a growing season. Under the NPDES program, an AFO is automatically a CAFO if more than 1,000 animal units are confined at the facility [40 CFR Part 122 Appendix BJ]. For dairy, this is approximately equal to 700 mature cows. An AFO may also be designated as a CAFO if there are 300-999 animal units confined in the facility, and it meets special criteria as defined by the NPDES-permitting authority. In addition, any AFO can be classified as a CAFO on a case-by-case basis if the NPDES-permitting authority determines that it is a significant contributor of pollution to the waters of the United States [http://www.epa.gov/owm/afo.htm#cafo]. Following EPA terminology [http://www.epa.gov./owm/afoguide.htm] we refer to "large operations" as those with 1,000 AU or greater and automatically subject to the NPDES permitting program.

2) According to the Unified National Strategy (USDA/USEPA [30]), a CNMP contains the following components: feed management, manure handling and storage, land application of manure, record keeping, and other utilization options such as off-farm sales of manure and power generation. Our survey does not address the feed management or other options categories.

3) For the purposes of this research, "upstate" excludes the New York State counties of Nassau, Putnam, Orange, Suffolk, and Westchester and the five boroughs of New York City.

4) 1996 data were used for milk production com-

parisons because the survey asked farmers to report their annual production for the previous year.

5) The broad extension of permits to cover operations with 300-999 AU is motivated by the general proximity of New York dairy farms to surface water and the *Concerned Area Residents for the Environment v. Southview Farm* ruling (CA 2, No. 93-9229, 9/2/94).

6) Consistent with federal water quality legislation, the AU data used here account for all animals on the farm, including those beyond the main milking herd (e.g., calves, heifers, other livestock). The 300 and 100 AU thresholds correspond to 210 and 70 milking cows, respectively. There were five responses to this survey from farms with 1,000 or more AU. These are deleted from the subsequent analyses, allowing us to focus on those farms presently outside the regulatory realm and only subject to voluntary programs.

7) Throughout, chi-square statistics associated with contingency table analyses are used for discrete variables, and F-test statistics from ANOVA analyses are used for continuous variables unless otherwise indicated. A p level of less than 0.10 indicates that the response patterns across herd size groups are significantly different at the 10% level, and so on.

8) The upper bound of $100 comes from early estimated costs associated with sequencing batch reactors designed to treat manure (personal communication with Carlo Montemagno [19], Agricultural and Biological Engineering School). Rowe, Schulze, and Breffle [26] demonstrate that truncation effects are not a problem in payment cards if the upper end of the distribution is set at a sufficiently high level.

9) Because of the Cameron [3], [4] transformation, the bid value does not appear in the final regression. An indicator of the responsiveness of WTP to changes in this variable is provided in the coefficient on the k variable in Table 5. In all cases, this coefficient was found to be highly significant, and thus, there is statistical evidence that farmers were responding to the variations in the costs of participation.

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