Recycling Programs: Attitudes, Costs, and Designs

By David Novak, Jeffrey Alwang, and
Leonard Shabman

Virginia's
Rural Economic Analysis Program
Department of Agricultural and Applied Economics
College of Agriculture and Life Sciences
Virginia Tech

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David Novak, Jeffrey Alwang, and Leonard Shabman

David Novak was a Graduate Research Assistant, Jeffrey Alwang is an Associate Professor, and Leonard Shabman is a Professor in the Department of Agricultural and Applied Economics, Virginia Tech

This publication was printed on recycled paper.

ACKNOWLEDGMENTS

The authors would like to thank Joe Klein, Floyd County Recycling Coordinator, for helpful information, and Drs. Waldon Kerns and J. Paxton Marshall for their review of this manuscript.

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EXECUTIVE SUMMARY

In 1990 legislation was passed mandating that by 1996 localities in Virginia recycle 25 percent of their total solid waste. Some localities, especially those in rural areas, find this mandate difficult to meet. People in rural Virginia tend to be receptive to the idea of recycling, but object to the implicit costs and inconvenience associated with it. In the counties surveyed, the difference between quantities predicted to be recycled and actual recycling data indicates that people over-estimate the amount they recycle, but that recycling might be increased by reducing its inconvenience. This REAP report investigates recycling in rural Virginia with the overall objective of providing information about how rural localities can design their recycling programs to meet the 25 percent mandate with the least total cost.

The perceived inconvenience or "psychic cost" associated with recycling, including the mess created in the home during sorting and storing, transporting separated waste to collection points, and the time required to recycle, is a strong deterrent to participation in recycling programs in rural areas. This deterrent may prevent rural localities from meeting the legislated mandate to recycle 25 percent of their total solid waste. There are several actions that rural localities might take to meet this mandate.

1. Localities need to consider ways of lowering the costs that the household must bear when recycling. Increased recycling will result from lowering these costs. These costs affect residential recycling of all materials, but have the strongest impact on the percentage of aluminum and plastics recycled. Inconvenience is a major deterrent to increased aluminum and plastic recycling in rural areas.

2. Perhaps the best way to lower perceived costs is to provide residents with the opportunity to recycle wastes (at a central collection center) without having to sort the recyclable materials and place them in separate bins. Residents would be responsible for separating recyclables from the rest of their waste, but would not be responsible for separating, for example, paper from plastics. Recycling rates are likely to increase if the locality provides a single bin where all recyclables can be deposited.

3. Accurate knowledge about the location of recycling places is strongly associated with increased recycling. Providing more information about the location of recycling places will help rural localities meet recycling targets. Paper and newspaper recycling rates are highly responsive to increased information about the availability of recycling facilities. The high weight of paper products makes them a prime candidate to help meet weight-based recycling targets.

RECYCLING MANDATE

There is interest in promoting recycling as a solid waste management option. Several factors drive this interest, including the increasing cost of solid waste disposal and the perceived environmental problems associated with landfilling or incinerating wastes. Some people hope that natural resources will be conserved through recycling and that aggressive recycling programs can boost public interest in conservation.

Recycling is now widespread in Virginia, although the percentage of total solid waste that is recycled varies by locality. The Commonwealth of Virginia, in 1990, mandated that localities recycle 10 percent of their waste by December 31, 1991. These quantities were to be increased to 15 percent in 1993 and to 25 percent by December 31, 1995 (Box 1). These uniform targets exist despite questions about the cost-effectiveness of recycling as a solid waste management strategy, and despite the fact that they are likely to be more burdensome to many rural counties than to urban areas.

Costs of instituting recycling programs vary depending on the characteristics of the location (Box 2). Rural communities, in particular, face difficulties in complying with the mandate due to the high costs of collecting, transporting, and marketing recyclable waste products. Some options exist, however, to reduce these costs or share them between communities.

Box 1: Virginia Waste Management Disposal Act

The 1990 Virginia Waste Management Disposal Act requires that every city, town, and county in Virginia develop a comprehensive solid waste management plan. As part of this plan, the localities must specify how they will meet the 10, 15, and 25 percent recycling targets.

The Act leaves some leeway as to how localities measure whether they achieve these targets, but guidelines promulgated by the Department of Environmental Quality discuss how to compute the percentages recycled. The guidelines define principal recyclable materials (PRMs) to be those materials (glass, aluminum, plastic, and paper) that are targeted directly for the recycling effort. Supplemental recyclable materials (SRMs) are materials, such as tires, sludge, and concrete, that can be recycled, but a process, (for example, pulverizing concrete and processing it into new concrete) must be employed to recycle the material according to guidelines. The *percentage recycled* equals the weight of PRMs plus SRMs separated from the solid waste and collected, divided by the total weight of household solid waste plus the total weight of PRMs from industrial and commercial sources. Non-PRM industrial and commercial solid waste does not enter the denominator of the calculation.

A REAP policy paper (Stedge and Shabman) provided evidence that recycling may be a relatively costly means of managing solid waste. The authors compared data from a number of studies to show that, even with stringent environmental protection standards that drive up the cost of landfilling, recycling is an expensive means of dealing with waste. With the current prices for recycled materials (Box 3), landfilling is relatively cheap. It is also environmentally safe as a result of newly established Environmental Protection Agency (EPA) restrictions on landfills.

Despite arguments about the cost effectiveness of recycling, the recycling mandate remains a part of the Code of Virginia, and the question localities should ask is how their residents can achieve the mandated rate at the least total cost. In order to answer this question, some of the determinants of household participation in recycling programs were analyzed and evidence provided on how recycling rates can be raised.

Box 2: Recycling Programs

Separation and sorting

Recycling programs are distinguished by the types of materials that are included in the recycling effort. All known programs require separation of recyclables from the rest of the waste by the resident, known as "source separation," and most programs require the resident to sort the different types of recyclables and place them in separate containers. An alternative to separation, practiced in some cities, is *post-collection sorting*. This system allows the resident to place all recyclables (paper, aluminum, etc.) in a single container (either at the roadside or at the point of collection), and someone sorts the waste after collection.

Curbside

In a *curbside program*, public or private workers collect recyclables directly from the home or business. Residents are responsible for separating their recyclables from the rest of their waste, sorting the recyclable materials, placing them in appropriate containers, and placing the containers near the curb.

Drop-off

In a *drop-off program*, instead of placing the containers near the curb, the resident transports the recyclables to a convenience center or a collection site.

A *convenience center* is a publicly or privately managed collection facility with specially labeled bins and is usually enclosed by a fence. Residents must place their recyclables in the proper collection bins. Some centers charge a fee for disposal of non-recyclables.

A *collection site* (usually referred to as a "green-box collection site" because of the ubiquitous green boxes that characterize them) consists of dumpsters or other waste disposal or recycling containers. Residents are left on their honor to separate recyclables from the rest of their garbage and place the recyclables in the correct bins.

Box 3: Financial viability of recycling

The amount that the public must pay (through taxes or fees) to subsidize recycling depends on costs of operation minus revenues received from sales of recycled materials. Dramatic fluctuations in the price of recycled materials (such as scrap aluminum or newsprint) may create conditions where recycling is more cost effective or less cost effective.

DETERMINANTS OF RECYCLING RATES

Information on the determinants of recycling by households in rural areas will assist rural recycling coordinators in designing their programs to meet the state targets. With such information, the coordinator might increase the rate of recycling by targeting certain demographic groups to receive information, or he/she might design a program that lowers the cost of participating. The resulting information will also help citizens make better choices about how to improve recycling services in their localities.

Overall rates of recycling in a locality are determined by a number of factors. Among these factors are the size of the commercial and industrial solid waste (Box 1), the design of the residential recycling program (Box 2), and people's decisions about how much to participate in the program (Box 4). These factors tend to vary by locality, leading to relatively large differences in recycling rates across rural areas.

Box 4: Rates of participation in recycling programs

The level or rate of residential participation in a recycling program is the percentage of residents who recycle and the proportion of their solid waste that they recycle. The total amount recycled can be increased by inducing people who formerly did not recycle to do so, or by increasing the rate of recycling by existing recyclers, or both.

Commercial and industrial wastes are normally more cheaply recycled than residential wastes because they are usually concentrated geographically so that collection costs are lower. In addition, commercial and industrial recyclable wastes tend to be more easily separated and graded and tend to be "cleaner" than residential recyclables. The relative size of the commercial and residential sectors in the local economy helps determine the overall potential for recycling wastes. In urban areas, commercial and industrial wastes represent a high proportion of total solid waste; urban localities can focus their recycling efforts on encouraging these producers to recycle. Such efforts tend to lead to high overall rates of recycling at relatively low costs.

By contrast, in rural areas commercial and industrial wastes represent a much lower percentage of the total solid waste generated, and residential waste represents a higher proportion. Thus, rural localities must turn to residents as their major source of recycled materials. At the same time, many of the recycling programs for residents in rural areas can be substantially more costly than in urban areas.

Costs of recycling

An important element of the discussion of the costs of recycling in rural areas is the fact that the residential recycling program design and the level of participation by residents go hand-in-hand. Participation rates depend critically on the design of the program. This link helps define the problem that a recycling coordinator in Virginia faces: how to design a recycling program to achieve the 25 percent target rate at the least possible cost. More expensive programs, such as curbside pickup of

unseparated recyclables, can induce more participation than less expensive options. The planner must balance these costs and outcomes when designing the program.

Frequently overlooked in the recycling coordinator's decision process is the fact that removing recyclables from other solid waste and sorting, storing, and transporting them require time and effort. The costs of such work have to be borne by someone. Recycling coordinators try to minimize their program's costs while ignoring the implicit and sometimes explicit costs borne by the households. That is, by requiring that households separate, sort, and transport recyclables, the recycling coordinator is shifting the costs from the program to the individual.

The issue of *how* the costs should be borne (ultimately, citizens bear all the costs through collection fees or taxes, or through the implicit costs of sorting and transporting[1]) is one that should be decided in the public arena as are similar decisions related to publicly provided or regulated goods. Society should decide how to achieve the 25 percent recycling mandate at least total cost.

An example of such a decision is delivery of water into the home. At some point in time, individuals decided that they would commit to pay the up-front costs of having water piped into their homes. Prior to that time, the costs of bringing water from the ground (or other source) into the home was divided into costs of pumping and of carrying water from a source into the house. Eventually, the implicit cost of carrying water by bucket (including the inconvenience and value of time spent hauling) became so high that the majority of people paid the up-front costs and installed piped water systems.

In the case of solid waste, the government has become involved since society decided that such waste should be handled in a centralized manner in order to meet such social goals as a healthy and clean environment. The analogy to water is appropriate since the distribution of program costs (collection and disposal) and private costs (time and effort) depends on the design of the program. Society should decide how to distribute the private and public costs to achieve the social goal at the minimum total cost.

The discussion of who bears the costs of recycling should occupy a central place in the design of these programs, especially for rural areas. Because rural populations are widely dispersed, the average cost of providing collection services to each residence is higher than it would be in urban areas. For this reason, curbside collection of wastes and recyclables is rare in rural areas, and costs are shifted to the residents who generate the wastes. Drop-off green boxes for residential wastes are common in rural areas, as are drop-off recycling centers. There are often fewer recycling centers than green-box systems, making the implicit cost of recycling (mostly embodied in the transport of the item) higher than the cost for normal waste disposal. In each case, the total social cost of the program equals the public cost plus the private costs.

By using drop-off systems, solid waste coordinators have shifted part of the costs of waste disposal services from the public entity to the individual. This cost shift is desirable from the perspective of the coordinator as people are acutely aware of taxes or fees being spent for waste disposal. On the other hand, shifting costs to the individual ensures lower rates of participation and reduces the likelihood of meeting the legislated target level.

[1] Businesses can be made to bear the costs, but in rural counties shifting costs to businesses is usually not viable.

Citizens should be aware that, regardless of how the program is structured, they will pay its costs, through taxes or fees or implicit costs. Implicit costs are less easily identified, and most citizens tend to ignore them. They are, however, real costs and high implicit costs reduce participation.

Individual decision processes and the design of recycling programs

Several factors combine to determine how much a household will recycle. These factors include people's attitudes toward recycling, information the household has about recycling, the implicit and explicit costs associated with the recycling program, and the materials targeted by the program for recycling. Since recycling rates are affected by these variables, information about the magnitude of their impact will help in designing a program to meet the mandated levels.

Implicit costs of recycling depend on the value people put on their time, the value they associate with the clutter in their home and car, and the inconvenience caused by recycling. The value of time is important, as people spend time separating and transporting recyclable materials. Messiness and inconvenience are costs that lower participation. Explicit costs are the travel expenses associated with making trips to recycling centers.

Clearly, the total volume of materials recycled depends directly on the types of materials that the program includes. By including high-weight materials such as glass and paper, the recycling authority can meet a weight-based target more easily than with metal cans and plastic. Newspapers, for example, are heavy and are also relatively low-mess items for which the implicit costs of recycling may be lower. By expanding the list of recyclable materials to include metal cans and plastics, the potential to meet mandated targets rises, but the implicit costs also rise as messiness and inconvenience may be more pronounced for these materials.

As recycling is introduced and expanded, the availability of information about the program can be a critical determinant of participation. Rates of participation might be increased relatively cheaply by providing information about the program and the types of materials that can be recycled.

Finally, attitudes toward recycling can have a major influence on the degree to which people participate. While attitudes are hard to change, information about the impact of attitudes on recycling rates can help in the design of information campaigns and can provide guidance as to the types of materials that should be targeted for recycling.

PRECEIVED AND ACTUAL RECYCLING RATES

The study was conducted in three predominantly rural counties located in Southwestern Virginia: Floyd, Pulaski, and Washington. These counties were selected because they operate slightly different waste management and recycling systems, and the recycling coordinators and county administrators expressed interest in cooperating in the study.

The data were generated through a mail survey of a randomly selected sample of residents. Questionnaires were mailed to 300 addresses in each county. A total of 206 usable responses were obtained, which, when adjusted for incomplete addresses, represents an overall response rate of

about 25 percent, somewhat lower than anticipated. In order to assess the representativeness of the survey, the survey data were compared with census data for the three counties. The comparison of income, age, education, and labor force participation showed an acceptably close match between the census and the survey. Thus, the respondents adequately represent the counties' populations as a whole (see Novak for more details on these comparisons).

The survey asked respondents a variety of questions concerning their waste disposal and recycling behavior, general views on the environment, distances traveled to recycling and waste disposal sites, and the demographic characteristics of the household (Appendix A contains a facsimile of the survey instrument). Data on the composition and quantity of local solid waste, estimated tons of waste landfilled, estimated tons diverted through recycling, and annual expenditures on solid waste management were obtained from the county recycling coordinators.

Reported recycling rates

The reported recycling rates from the survey vary for each material by county (Table 1). These materials were included in the study because they form the bulk of the residential PRMs defined by the Department of Environmental Quality (Box 1). The reported rate of recycling in Floyd County is below the rates for the other two counties for all materials except glass. Residents of Floyd County recycle about 40 percent less newspaper and 18 percent less plastic than do residents of nearby Pulaski County.

Residents of Pulaski County report that they recycle newspaper at a higher rate than residents of the other two counties, while rates of recycling of aluminum, glass, and plastic are virtually identical for both Pulaski and Washington counties.

There is not much difference in the average distance traveled to the nearest recycling center by county, but the reported distances are highest for Floyd County and lowest for Washington County.

Differences in recycling rates by county are not explained by recycling facilities being available for each material. Of those residents of the 3 counties who do not recycle, only about 5 percent reported that facilities for recycling that material are not available in their county. Floyd County residents were much more likely than residents of other counties to state that recycling facilities existed, yet they still reported lower recycling rates for most of the materials.

About 10 percent of the households in Washington County that reported not recycling specific materials stated that there were no facilities available to recycle that material. This result, combined with the already relatively high rates of recycling in the county, provides evidence that increased recycling will occur in Washington County if more information about recycling opportunities is provided, or if better access to recycling facilities for each material exists, or both.

Table 1. Summary of recycling behavior and opportunities by county.

	Floyd	Pulaski	Washington	Three county average
Material	----------Percent recycled----------			
Aluminum	46	52	51	49
Glass	32	33	30	32
Newspaper	27	45	36	34
Plastic	28	34	36	32
Average rate[a]	28	42	35	34
	----------Miles----------			
Average distance to recycling facility	16	14	11	14

[a] Average rate is computed using the reported rates for each material times the percent of total recyclable waste accounted for by each material. According to estimates, aluminum represents 2.1 percent, glass 13.7 percent, paper 66.4 percent, and plastic 17.8 percent of recyclable waste.

Estimated recycling rates from other sources

The self-reported rates indicate that the three counties should be close to meeting the legislated mandates, even within the existing programs. The four recyclables covered in the survey represent about 70 percent of total solid waste.[2] Using average rates of recycling from Table 1, Floyd County residents claim to recycle about 20 percent (28 percent times 70 percent) of their total solid waste. Residents of Pulaski and Washington counties claim to recycle 29.4 and 24.5 percent of their total solid waste, respectively. These results suggest that the 25 percent mandate can be achieved with relative ease.

Interviews with county recycling coordinators show, however, that actual rates fall far below these amounts. In Floyd County, for example, the recycling coordinator reports that about 5 percent of total residential solid waste is currently being recovered through his operation. Pulaski County reports that about 7 percent of their residential solid waste is currently being recycled.[3]

This disparity between predictions of recycling rates from the survey and actual reported quantities from the recycling coordinators is most likely a result of residents' over-estimating their recycling. Over-estimation is common in such surveys as people tend to believe they recycle more than they actually do (Epp and Mauger; or Hopper, Nielsen, and McCarl). This over-estimation can be interpreted to mean that there is more potential for recycling in the study area. People would like to recycle more than they actually do, but they are constrained in one way or another from doing so. Some constraints to recycling can be eliminated, thereby increasing the rate of recycling.

[2] This 70 percent figure is arrived at after adjusting for yard waste. Since yard waste virtually never enters the waste stream in rural areas (it is usually composted), total waste amounts are lower than in urban areas. Thus, recyclables represent a higher proportion of total residential solid waste in rural areas (See Novak for details of these calculations).

[3] Pulaski County recycles 18 percent of all its solid waste. This rate is achieved by including commercial and industrial solid wastes along with residential solid waste. Commercial and industrial solid wastes account for about 22 percent of total solid waste in Pulaski, but comprises about 76 percent of the total material recycled.

FACTORS AFFECTING RATES OF RECYCLING

More information about the relationship between household composition, the various costs of recycling, attitudes about recycling, and the impact of different types of programs on recycling rates is obtained by conducting a regression analysis that examines the influence of each variable on the percentage of each type of material being recycled by the household, holding all other factors constant. The variables employed in the regression analysis are from the survey and are described in Table 2.

Each variable is expected to have an impact on the rate of household recycling. By examining the impact of each variable, while holding the influence of the other variables constant, the influence each variable actually has can be determined. As the results are interpreted, their implications for policy or program design are discussed.

The regression results reveal several points (Table 3). Income alone is not a significant determinant of rates of recycling of any material.[4] Household income does affect recycling through its impact on the value of people's time. The *Timecost* variable, constructed using the value of time spent recycling, has only a weak effect on recycling of newspaper; it has zero effect on glass, plastic, and aluminum recycling.

The fact that *Timecost* has only a weak effect on recycling does not mean that all private costs of recycling have no impact. In fact, the variable *Inconvenience,* a measure of the "psychic" or "implicit" costs of recycling, has a consistently strong negative effect on recycling. Those people who think that the high implicit costs associated with recycling outweigh its benefits participate less in the program. These implicit costs are the clutter that recycling creates in the home and the time and effort that are needed to separate and haul the recyclable material.

Programs might be designed to reduce some of these "psychic" costs. Curbside recycling, programs that do not require prior separation of the recyclables, and creation of more recycling centers to reduce travel costs in rural areas are examples of designs that might increase participation rates. These alternatives and their impact on recycling behavior are examined in more detail.

Accurate knowledge about the recycling program (*Awareness*) is strongly associated with higher rates of recycling of all materials. The evidence shows quite clearly that people who are more knowledgeable about recycling opportunities recycle more extensively. Increased information about such opportunities should raise participation rates and help counties meet their targets. Although not obvious from Table 3, *Awareness* has its strongest positive influence on newspaper recycling. Since newspaper constitutes the highest fraction, by weight, of recyclable materials, providing increased information about recycling opportunities will have a strong positive impact on the total weight of recycled materials.

[4] A variable representing income of the household was entered in the regressions. This variable did not have a statistically significant impact on recycling rates of any material, and thus was excluded from the model.

Table 2. Variables used in the study.

Variable	Description
Timecost	The estimated monetary value of time it takes to travel to the recycling collection site. Variable computed using time spent traveling to a recycling center multiplied by average hourly income.
Inconvenience	An objective measure of the "psychic" or "implicit" costs incurred by recycling. Variable computed using specific questions about the mess created in the home and car, the time associated with separation and hauling, and the general inconvenience associated with recycling.
Awareness	A measure of knowledge about access to recycling centers in a community.
Attitude	An objective measure of the respondent's general concern (attitude) for the environment. Variable created using responses to questions about the degree of concern by respondents for air and water pollution and litter in their area.
Action	A measure of whether the respondent encourages others to recycle or is a member of an environmental advocacy group.
Idle	Presence of unemployed or retired adults in household.
Education	Educational level of respondent.
Family size	Total number of people in household.
Children	Presence of children in household.
Age	Average age of adults in household.

Note: More detail on the variable construction is in Appendix B.

The variable *Action,* measuring whether the respondent actively encourages other people to recycle or whether the respondent is a member of an environmental advocacy group, is also strongly associated with increased recycling. However, people who were concerned about litter and water quality were not any more likely to recycle than people who did not display such concern (*Attitude*). These results suggest that environmental improvement is not, by and large, a major goal of the majority of the people who recycle. Promotional campaigns for recycling that focus on civic pride and compliance with social objectives, rather than the environmental benefits associated with recycling, are suggested by the interpretation of the *Action* and *Attitude* variables.

Once all the other variables are accounted for, there is no remaining significant difference in recycling rates by county.[5] The differences in recycling rates by county (Table 1) are attributable to differences in socioeconomic characteristics across the counties. For example, the average age of the adult members of the household (*Age*) is the most important demographic determinant of recycling behavior. Households where the average age of members is older are more likely to recycle all

[5] Variables representing the county of residence were entered into the regression. These variables were never statistically significant, and thus were not included in the final analysis.

materials, but especially newspaper and plastic. The existence of retired people (*Idle*) or children has practically no effect on recycling, holding constant the average age of all family members. Similarly, family size has no meaningful effect, once all other variables are taken into consideration.

Younger families react negatively to the inconvenience associated with recycling. The need for programs designed to minimize inconvenience is reinforced by this finding. However, since these households are, in general, less likely to recycle than older families, it is not clear whether more information about recycling programs should be targeted at them.

Education has a weak positive effect on newspaper recycling, but a strong positive effect on glass recycling. Higher levels of education are associated with higher rates of recycling of these materials, but have no effect on recycling of plastic and aluminum.

Table 3. Impact of each variable on the proportion of each material recycled.

Variable	Aluminum		Newspaper		Glass		Plastic	
	Sign[a]	*Strength*[b]	*Sign*[a]	*Strength*[b]	*Sign*[a]	*Strength*[b]	*Sign*[a]	*Strength*[b]
Timecost	0	NA	positive	weak	0	NA	0	NA
Inconvenience	negative	strong	negative	strong	negative	strong	negative	strong
Awareness	positive	strong	positive	strong	positive	strong	positive	strong
Attitude	0	NA	0	NA	0	NA	0	NA
Action	positive	strong	positive	weak	positive	strong	positive	strong
Idle	0	NA	0	NA	0	NA	0	NA
Education	0	NA	0	NA	positive	strong	0	NA
Family size	0	NA	0	NA	0	NA	positive	weak
Children	0	NA	0	NA	0	NA	0	NA
Age	0	NA	positive	strong	positive	weak	positive	strong

[a] Sign of impact means the variable had a positive, negative, or no effect on recycling.
[b] Strength is the strength of the impact.
Source: Results of regression analysis, Appendix B.

What can be done to increase recycling?

The results of the analysis suggest several changes, such as information and education, that can be used to increase recycling. One major influence found in the study was a negative reaction to the messiness and inconvenience associated with existing recycling programs. The survey sought to elicit directly how respondents would react to specific changes in their localities' recycling programs. People were asked how much they were willing to pay for, and whether they would increase their recycling as a result of, the following changes in the program structure:

1. A curbside recycling pickup program;
2. A program where they would take their recyclables to a centralized collection center without having to sort these materials; and
3. A program that guaranteed they would be no more than 10 minutes from a collection center.

Each of these changes addresses different dimensions of the "psychic" or "implicit" costs identified as deterrents to recycling.

There appears to be little willingness to pay for such services (Table 4). Willingness to pay falls far short of the cost of delivering curbside recycling services. Recent estimates (Stedge and Shabman) show that a curbside recycling program costs about $100 per ton recycled more than a drop-off program. If Pulaski County, for example, were to use curbside recycling to recycle 25 percent of its residential solid waste, the cost would be about $6 per household per month, far more than the $1.07 that residents claim they are willing to pay for that service.[6]

The willingness to pay for curbside recycling is very close to willingness to pay for recycling without having to separate recyclables (Table 4). The inconvenience associated with separation is a major impediment to recycling, with the "psychic" cost of this inconvenience approaching the cost of transporting the materials to a recycling center. People will not pay much for shorter drives to recycling centers, but will pay so they do not have to separate the various materials. Since the cost associated with a program with post-collection sorting is probably far below the cost of curbside recycling, the feasibility of the former program ought to be examined. There are no known studies of the economics of post-collection sorting, but intuition says that such program costs cannot exceed, and are probably much lower than, curbside programs.

Both of the lower-cost program options (no need to separate and more easily accessed recycling centers) will lead to nearly the same increase in recycling as the more expensive curbside program. Institution of curbside recycling would induce most households to recycle more, but the likely increase in the amount recycled as a result of curbside recycling probably does not warrant its extra cost.

Table 4. Willingness to pay for recycling program changes and effects of such changes on recycling behavior.

Willingness to:	Floyd	Pulaski	Washington	Average all three counties
pay to have	----------$/month----------			
Curbside recycling	1.33	1.07	0.51	1.29
No need to sort recyclables	1.17	0.95	0.94	1.04
Less than 10 minute drive to recycle	1.14	0.35	0.94	0.85
increase recycling if have	----------percent increase----------			
Curbside recycling	63	66	51	61
No need to sort recyclables	58	38	57	52
Less than 10 minute drive to recycle	64	40	48	53

[6] The Pulaski recycling coordinator reports that about 36,700 tons of household solid waste were collected in Pulaski in 1994. If 25 percent were to be recycled, the 9,175 tons of material would be recycled at a total added cost for curbside recycling of $917,500. This cost would amount to about $6 per household per month. (There are about 12,800 households in Pulaski County.)

CONCLUSIONS

There are several options for rural localities that wish to increase their rates of recycling to meet the legislated mandate that localities recycle 25 percent of their solid wastes. First, they might try to engage in a partnership with an adjacent urban area where rates above 25 percent can be achieved at a lower cost. This option was not examined in this study and would not appear to be feasible for many isolated rural areas. But in cases where it is feasible, it should be explored. Floyd County, for example, might partner with nearby Roanoke. Rural counties might group together among themselves and in so doing share some of the fixed costs associated with running, for example, a curbside program. This study did not examine whether such cost savings would be substantial, but such a prospect might be investigated.

A second option rural localities might investigate is to encourage commercial recycling in an area. Commercial recyclers are very efficient at locating low-cost source material (recyclable waste) and thus increasing rates of recycling. In Pulaski, for example, there is a commercial metal recycler whose presence boosts the total recycled amount substantially. Such recyclers, however, often attract recyclable material from other localities, and one county's loss may be another county's gain. The total potential for commercial recyclers in rural Virginia appears small.

A third option, and one that was explored in this study, is to enact program changes to encourage increased program participation. The results suggest that several strategies might be effective in increasing rates of recycling in rural areas: 1) lowering the inconvenience associated with the program; 2) increased advertising, especially by targeting certain materials; and 3) moral pressure.

The inconvenience associated with separating, storing, and transporting recyclables is a clear deterrent to rural recycling. People object to this inconvenience, and it is difficult to develop an advertising or a peer pressure campaign that would succeed without first addressing this fundamental problem. Recycling coordinators and public officials may object to program changes on the grounds that they are costly, but the cost shifting associated with inconvenient programs cannot be ignored. As more "psychic" costs are shifted to residents, their level of recycling will certainly decline.

Post-collection sorting is one promising option that may be a low-cost means of encouraging significant increases in recycling behavior. It is not known whether such post-collection sorting leads to lower qualities of the recycled materials because plastics and metal cans are mixed with newspapers, but the option should be explored. Increasing the number of centers in rural areas ought to be investigated in some cases. Limited pilot programs for curbside collection might be tried.

Information should be provided about program goals, the types of materials that are eligible to be recycled, and where the centers are located. These advertising campaigns, when combined with civic pressure, ought to stress the civic goal of reaching the 25 percent level and downplay the environmental benefits associated with recycling. People seem to respond positively to their civic duties, but they might be suspicious of the prospect of any substantial environmental benefits.

Changing people's attitudes relative to recycling may take time, especially in rural areas. Green box systems for solid waste disposal were not immediately popular. But their presence, over time, has changed attitudes toward roadside dumping and burning of waste and has dramatically improved the landscape and quality of life in rural Virginia by reducing unsightly dumping and litter. Recycling may eventually be as widespread and automatic as is dumping garbage in green boxes, but reaching such a goal will take effort, education, and improved information.

BIBLIOGRAPHY

Epp, J. D., and P. C. Mauger. "Attitudes and Household Characteristics Influencing Solid Waste Generation: A Household Garbage Analysis." *Journal of the Northeastern Agricultural Economics Council.* 18(April 1989):42-51.

Hopper, J., R. Nielsen, and J. McCarl. "Recycling as Altruistic Behavior: Normative and Behavioral Strategies to Expand Participation in a Community Recycling Program." *Environment and Behavior.* 23(1991):195-220.

Novak, D. C.. "Meeting State Waste Stream Reduction Mandates through Recycling: Examining Residential Waste Disposal Behavior in Rural Virginia." MS thesis. Virginia Tech. 1995.

Stedge, G. D., and L. A. Shabman. *Municipal Solid Waste Management in Virginia: Rethinking the Choices.* Virginia Tech, Va. Coop. Ext. Pub. 448-306/REAP Policy Paper No. 6, 1995.

APPENDIX A: SAMPLE SURVEY

The survey instruments sent to Pulaski and Washington County residents differ slightly from the Floyd County survey. Questions #18a and #18b are not included in the Pulaski and Washington County versions of the survey because of the types of waste disposal and recycling systems used in these counties. Other than those two questions, the three versions of the survey were identical.

Household garbage includes any waste products that you throw away at the local dump or in the green-box dumpsters in your county.

(1) How long does it take you to travel from your home to the nearest dump, dumpster, or green box, where you can dispose of your household garbage?

_____ minutes
_____ I set my garbage at the roadside, where it is picked up for me. (Please go to **#3**)

(2) Do you typically combine the trip to dispose of your garbage with other activities such as: visiting friends, going to work, or running errands? (Please check your answer)

yes ☐ no ☐

When a product is **recycled** it is not thrown away but is instead removed from the rest of the garbage and used again to make new products. However, in order for a waste product to be recycled, the household must separate it from the rest of the garbage and transport it to a place where recyclables are collected. Please answer the following questions about your experiences with recycling.

(3) Have you **ever** lived in **any** area that operated a recycling program or had a site for collecting recyclables?

yes ☐ no ☐ not sure ☐

(4) Are there any collection sites for recyclables in the area where you **now** live?

yes ☐ no ☐ not sure ☐

(5) Are there separate bins for collecting recyclables at the place where you **usually** dispose of your household garbage?

yes ☐ no ☐ not sure ☐

(6) Whether you recycle or not, how long does it take you to travel from your home to the nearest place where you can dispose of recyclables?

_____ minutes don't know where a collection site is ☐

(7) Do you own a pickup truck that you can use to transport garbage or recyclables to a collection site?

yes ☐ no ☐

(8) Do you take any recyclables to a collection site?

yes ☐ no ☐ [If "**no**," please go to question **#10**]

(9) What percentage of the following items do you typically recycle?
(Please check the appropriate box)

	Aluminum Cans	Glass Bottles or Jars	Newspaper	Plastic Containers
Don't recycle				
Recycle about 25%				
Recycle about 50%				
Recycle about 75%				
Recycle about 100%				
There is no place to recycle this waste product				

(10) Indicate how you feel about the following statements. (Please circle your answer)

1 = STRONGLY AGREE 2 = AGREE 3 = NEUTRAL
4 = DISAGREE 5 = STRONGLY DISAGREE

a. Storing recyclables takes up a lot of space in my house 1 2 3 4 5

b. Storing recyclables creates a mess in my house 1 2 3 4 5

c. It takes too much time to separate newspaper, glass, aluminum, and plastic recyclables from each other 1 2 3 4 5

d. I do not have enough space in my vehicle to transport recyclables to a collection site 1 2 3 4 5

e. Transporting recyclables to a collection site makes a mess in my vehicle 1 2 3 4 5

f. It takes too much time to transport recyclables to a collection site 1 2 3 4 5

(11) Do you encourage others to recycle?

yes ☐ no ☐

(12) Are you a member of any environmental advocacy or conservation organization?

yes ☐ no ☐

(13) Indicate how you feel about the following statements.

1 = STRONGLY AGREE 2 = AGREE 3 = NEUTRAL
4 = DISAGREE 5 = STRONGLY DISAGREE

a. Recycling is an important factor in protecting the environment..... 1 2 3 4 5

b. Recycling will reduce the amount of trash that must be landfilled..... 1 2 3 4 5

c. Disposing of waste in landfills is **not** an environmentally safe waste disposal method..... 1 2 3 4 5

(14) Indicate how you feel about the following questions

1 = STRONGLY AGREE 2 = AGREE 3 = NEUTRAL
4 = DISAGREE 5 = STRONGLY DISAGREE

a. It is important to reduce the amount of air pollution in the area where I live 1 2 3 4 5

b. It is important to reduce the amount of water pollution in the area where I live..... 1 2 3 4 5

c. It is important to reduce the amount of litter in the area where I live..... 1 2 3 4 5

d. A political candidate's stand on environmental issues is important to me..... 1 2 3 4 5

In order to participate in the **recycling** program in your community, you must separate newspaper, glass, plastic, and aluminum recyclables into different bags. You then must drive your vehicle to a recycling collection site and place the different bags of recyclables in separate containers. (**Consider each question separately**)

(15a) Would you increase the amount you recycled if you could set your recyclables and the rest of your garbage at the roadside, and it would be picked up for you? (You would still have to place the different recyclables in separate bags)

yes ☐ no ☐

(15b) How much would you be willing to pay to have your recyclables along with the rest of your household garbage picked up at the roadside?

nothing ☐ between 5-10 dollars/month ☐

less than 5 dollars/month ☐ more than 10 dollars/month ☐

(16a) Would you increase the amount you recycled if you could place **all** your aluminum, glass, newspaper, and plastic recyclables in the **same** collection bin?

yes ☐ no ☐

(16b) How much would you be willing to pay so you would **not** have to separate your recyclables from each other in order to participate in a recycling program ?

nothing ☐ between 5-10 dollars/month ☐

less than 5 dollars/month ☐ more than 10 dollars/month ☐

(17a) Would you increase the amount you recycled, if a recycling collection site were less than 10 minutes from your home? (Please go to question **#18a** if a recycling collection site is **already** less than 10 minutes from your home)

yes ☐ no ☐

(17b) How much would you be willing to pay to have a recycling collection site located less than 10 minutes from your home?

nothing	☐	between 5-10 dollars/month	☐
less than 5 dollars/month	☐	more than 10 dollars/month	☐

(18a) Would you increase the amount you recycled, if there were separate collection bins for recyclables at the **same** place where you **usually** dispose of your garbage? (If there are **already** separate collection bins for recyclables at the site where you dispose of your garbage go to **#19**)

yes ☐ no ☐

(18b) How much would you be willing to pay to have separate collection bins for recyclables located at the same place where you dispose of the rest of your garbage?

nothing	☐	between 5-10 dollars/month	☐
less than 5 dollars/month	☐	more than 10 dollars/month	☐

GENERAL INFORMATION The following questions will help us interpret your responses.

(19) Indicate the number of people (including yourself) in **EACH** age category who live in your house. Please **circle** the age category to which **YOU** belong.

_____ under	_____ 18 - 24	_____ 35 - 44	_____55 - 64
_____ 5 - 17	_____ 25 - 34	_____ 45 - 54	_____ 65 and over

(20) How many household members who are **at least 18 years old** are in each category below. (If zero, please leave the line blank)

employed outside the household	_____	self employed	_____
retired	_____	unemployed	_____
other	____		

(21) What is your gender?

male ☐ female ☐

(22) Do you rent or own the dwelling in which you live?

own ☐ rent ☐

(23) What is the highest level of school **YOU** have completed?

11th grade or less ☐	high school graduate or GED ☐	associate's degree or some college ☐
bachelor's degree ☐	technical or trade school ☐	post-graduate work ☐

(24) Check off the category that represents your **TOTAL** household income **BEFORE** taxes in 1993.

less than $5,000/year ☐	$5,000 - $14,999/year ☐	$15,000 - $24,999/year ☐
$25,000 - $34,999/year ☐	$35,000 - $49,999/year ☐	$50,000 or more/year ☐

In order to double check our mailing list, please indicate the county you live in.

I live in _____ County.

APPENDIX B: STATISTICAL ANALYSIS

This appendix is intended for those individuals interested in a more detailed discussion of the model used in the analysis. Some background in economics and statistics will be helpful when reading this section. It provides further information on the variables used in the regression analysis and the results of the analysis. For additional details on the variables and some of the intermediate analyses, the reader is referred to Novak.

All variables were created using the survey data. The variables and their construction are described in Table B.1. Since most of the variables are indices or binary variables rather than continuous, their interpretation as elasticities is impossible. The regression results in Table B.2 were used to create Table 3 in the body of the report.

Only variables that were statistically significant at the 10 percent level (t-statistics exceeding 1.65) were shown in Table 3 to have an influence. Non-significant variables are shown in Table 3 as having zero effect. Those significant variables with coefficients with magnitudes that were notably smaller in absolute value than the same variable in a different material regression were entered as having a weak effect. Also, those variables with relatively small coefficients and low t-statistics (near 1.65) were shown in Table 3 as having a weak effect. Thus, education has a weak effect on all recyclables, but a strong effect on the recycling of glass products. The use of the terms "strong" and "weak" in Table 3 is obviously subjective.

The signs of the effects in Table 3 were adjusted to be consistent with the concept being discussed. Education, for example, has a positive effect, even though its sign in Table B.2 is negative. The reason is that both education variables in Table B.2 were binary variables for low and medium levels of education; the deleted or comparison category is higher levels of education (some college and above). Thus, people with low levels of education are *less* likely to recycle glass than are people with higher levels, and education, therefore, has a *positive* effect on recycling.

Table B.1. Description of variables used in regression analysis.

Variable	Units	Values/Range	How created
Timecost	dollars per trip		average wage times distance traveled to recycling center
Idle	binary variable	=1 if household contains anyone who is unemployed or retired, =0 otherwise	survey question 20
Inconvenience	index	6-36, low values mean that individuals disagree that different recycling activities (separation, etc.) are inconvenient	survey questions 10
Awareness	binary variable	=1 if individual is well aware of recycling facilities in area, =0 otherwise	survey question 4
Attitude	index	2-10, high values mean that respondent disagrees that it is important to reduce the amount of water pollution and litter	survey question 14
Action	binary variable	=1 if individual actively encourages others to recycle, =0 otherwise	survey question 11
Low education	binary variable	=1 if respondent has 11th grade or lower education, =0 otherwise	survey question 23
Medium education	binary variable	=1 if respondent has completed high school and or trade school but no other education, =0 otherwise	survey question 23
Family size	number	number of adults plus children	survey questions 19
Children	binary variable	=1 if children are present, =0 otherwise	survey questions 19
Age	years	average age of adults in the household	survey question 19

Table B.2. Results of regression analysis for various materials.[a]

Variable	All materials	Aluminum	Newspaper	Glass	Plastic
Intercept	-59.79	-45.86	-69.72	-49.55	-74.06
	(-3.28)[b]	(-1.90)	(-3.03)	(-2.28)	(-3.39)
Timecost	11.00[c]	13.96[c]	26.09[c]	10.50[c]	-6.54[c]
	(.99)	(0.95)	(1.86)	(0.79)	(-0.49)
Idle	7.86	12.87	8.28	6.49	3.79
	(1.26)	(1.56)	(1.05)	(0.87)	(0.51)
Idle*Timecost	-2.53[c]	-37.82[c]	-29.86[c]	-21.03[c]	-12.51[c]
	(-1.34)	(-1.51)	(-1.26)	(-0.93)	(0.55)
Inconvenience	-1.76	-2.01	-1.63	-1.44	-1.98
	(-4.04)	(-3.47)	(-2.96)	(-2.75)	(-3.77)
Awareness	28.35	24.43	29.59	28.18	31.19
	(5.77)	(3.75)	(4.77)	(4.80)	(5.29)
Attitude	-2.26	-3.19	-2.52	-1.92	-1.43
	(-1.53)	(-1.62)	(-1.35)	(-1.08)	(-0.80)
Action	21.19	28.13	10.97	24.69	20.97
	(4.44)	(4.44)	(1.83)	(4.33)	(3.67)
Low education	-13.62	-11.81	-13.78	-18.81	-10.09
	(-1.78)	(-1.16)	(-1.43)	(-2.10)	(-1.10)
Medium education	-6.49	-3.04	-6.33	-9.83	-6.77
	(-1.42)	(-0.50)	(-1.10)	(-1.80)	(-1.23)
Family size	3.70	2.89	2.64	3.51	5.76
	(1.28)	(0.75)	(0.72)	(1.01)	(1.66)
Children	2.60	11.60	-2.49	0.91	0.01
	(0.39)	(1.32)	(-0.23)	(0.11)	(0.05)
Age	0.63	0.43	0.98	0.44	0.66
	(2.88)	(1.47)	(3.57)	(1.71)	(2.52)
N	196	196	196	196	196
R^2	.42	.32	.28	.33	.34

[a] Dependent variables: percentage of each waste product recycled.
[b] t-statistics in parentheses.
[c] Actual value times 10^6.

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1996 Virginia Cooperative Extension Publication 448-222 / REAP R024

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