

PRE-SURVEY MAILING DEVICES

AS A TECHNIQUE FOR IDENTIFYING FRAME OVERLAP IN MULTIPLE FRAME SURVEYS

SUMMARY

Multiple frame surveys, because of their efficiency and economy, are fast replacing many single frame surveys formerly used by the Statistical Reporting Service. One problem remaining in the use of two frames is the positive identification of sampling units which are members of both frames. If these units are not detected the result is an improper definition of the sampling domains. Erroneous estimates, perhaps of serious magnitude, could occur.

This experiment was designed to test the effectiveness of pre-survey mailing devices as a means of identifying persons who are sampling units in each of two frames - an area frame and a list frame.

The devices tested were three publications and two fold-over postal cards of unique design. By the standard of accomplishing individual, positive identification of persons common to both frames (overlap) none of the devices performed well enough to be considered for use in an operational survey.

There is evidence that an undetermined portion of this failure may be due to psychological factors.

It is possible that mailing devices could be used and the conditional probabilities of specific responses with relation to the coverage of the list might serve as an aid in determining the need for additional action.

BACKGROUND

A major operational problem of multiple frame sampling is the positive identification of sampling units which occur in more than one of the frames being used. If the units of a sampling frame are subject to change through time, such as entries on a list of names of persons engaged in a particular activity, it is impossible to make a single, final determination that any given person is or is not a unit of that frame without additional information. As the activities of people change, so the frame itself changes. Thus, the identification of the sampling units must be on a current basis with reference to the survey being conducted.

Several methods of identifying individuals who are current sampling units in different frames have been or are being investigated. One possible procedure is to send a distinctive piece of mail to all persons who comprise Frame A. Frame B, or a sample from it, is then enumerated, and a question is asked to determine whether the respondent received one of the items mailed. The tentative conclusion is that if he did, he is a sampling unit in both frames. If he did not receive the item, he is not a unit of Frame A.

This technique was tested in a study conducted by the Institute of Statistics, Texas A&M University, with the Department of Agricultural Economics and Sociology cooperating. ^{1/} The device used was an educational leaflet designed for this specific purpose; it carried information highly pertinent to the recipients; it was printed on canary yellow paper. Many persons to whom it was mailed reported that they had not received it. Some persons to whom it was not mailed insisted that they had received it. From these results, the Texas experiment was pronounced "an obvious failure." Several factors were thought to contribute to this failure: (1) Use of third class mail for the devices, (2) suspected poor service by the post office, (3) recent severe weather which could have affected respondents' attitudes, and (4) memory bias.

It was decided that additional testing of the proposed technique was needed. Any failure associated with use of third class postal service could be eliminated by mailing under the Federal indicia. This seemed appropriate since that is the mailing procedure which would be used should the mailing devices be incorporated into operational surveys. Also, another test would provide the opportunity to evaluate devices of different designs.

THE SURVEY

An enumerative research survey designed to collect data on several aspects of multi-frame sampling was conducted in Oklahoma and Tennessee. The sampling frame in Oklahoma was a list compiled from county tax assessor's records by taking names of all persons or firms who had reported taxable livestock or farm machinery. In Tennessee, the ASCS list of persons (or firms) having farm numbers was used. The survey was restricted to not more than three counties in each State. Counties were selected by each State Statistical Office on the basis of local considerations such as ease and economy of travel or availability of enumerators. The survey counties were McClain and Payne, Oklahoma; Gibson, Grainger and Warren, Tennessee. For each State, a sample of 400 names was selected systematically after a random start from the lists of the chosen counties.

^{1/} Use of a Special List of Livestock Producers in a Two Frame Survey: The Beef List Study, D. E. Welsch, J. R. Connor, and B. B. Salfour II, Texas A&M University, April 1967.

To test the pre-survey mailing devices each State sample was systematically divided into four parts. A different mailing device was assigned to each of three portions. The devices were mailed, and the enumeration took place about two weeks later during the last week of June 1969. The fourth part of each list was held as a control and no devices were mailed to those names.

The questionnaire contained this statement and question:

Recently our State office sent this written material to some persons and firms in this area.

Did you receive one of these in the mail?

Answer spaces were provided for "yes," "no," and "don't remember." The enumerator was instructed to show a device as he asked the question. Each questionnaire was labeled with name and address of the respondent before the enumeration and it was also precoded to tell which mailing device to show. Questionnaires for the control group (no device mailed) also carried such a code. The enumerator did not know which respondents were in the control group.

THE MAILING DEVICES

The goal in selecting or developing these devices was twofold:

- (1) A piece of mail that was interesting enough that the recipient would not throw it away unopened.
- (2) An overall appearance or message sufficiently impressive that it would be remembered for several weeks.

Certain restrictions applied. Anything selected must be inexpensive, readily obtainable, appropriate to the dignity of Federal and State agencies, inoffensive to the recipient. The final choice was (1) small publications, either USDA or State, and (2) a letter or postal card of unique design.

Publications

Lists and displays of USDA pamphlets and bulletins were examined: the two State offices evaluated local publications. In no case was any suitable publication discovered which had not been previously distributed. Despite this obvious disadvantage, three were selected:

- (1) Popular Publications for the Farmer, Suburbanite, Homemaker, Consumer. List No. 5, Office of Information, USDA. This is a letter-size catalogue of selected USDA publications which are available without cost to anyone requesting them. It includes a Guide to Subjects to expedite selection and an easy-to-use order form. Although this is an established Departmental publication, a revised list had become available shortly before the survey. It had not yet been widely distributed, and its color (yellow) was different from the previous one. The catalogue was chosen because it offered a service to the farm operator (or his family) which would cause it to be examined and remembered. Also, it has visual appeal. This catalogue was designated for use in both survey States.
- (2) How to Use USDA Grades in Buying Food. USDA, Consumer and Marketing Service, PA-708 was chosen as the second device for Tennessee. It is letter-size and contains a condensed but adequate description of USDA grades for dairy products, poultry, fruits and vegetables, eggs, and meat. It is illustrated with reproductions of the various inspection and grade stamps and a few drawings of products. The narrative portion is concise but very easy to read. It was selected because (1) its color, format, and content are entirely different from the first device, and (2) although it was designed primarily for the consumer of farm products, the information it contains could be equally useful and interesting to the farm operator.
- (3) Oklahoma Wheat Quality, 1968 was published by the Oklahoma State Board of Agriculture, the Oklahoma State Statistical Office (SSO) and the Oklahoma Wheat Commission. It is an illustrated 8-1/2" x 11" bulletin containing text plus graphic and tabular information about production and quality characteristics of Oklahoma wheat. Data are for 1967 and 1968. This pamphlet was used as the second device in Oklahoma because its subject matter should have wide appeal and its multicolor cover has visual appeal.

All three publications were mailed in envelopes bearing the return address of the appropriate SSO.

Original Postal Cards

The only way to be sure of having a unique device was to create one. Something of little or no intrinsic value was considered as an enclosure in letters or fold-over postal cards. Paper bookmarks, exotic seeds, wallet-sized plastic cards and a sample of newly developed food were suggested. Eventually the thought of an enclosure was abandoned because of the numerous regulations, laws, or policies which apply to such mailings. In addition to that, selecting and obtaining the appropriate item could be costly in time and effort even though inexpensive.

A letter with no enclosure seemed dull by comparison. Government envelopes lack visual appeal and restrictions prohibit much adornment of them. With plain white envelopes, we feared some people might discard the letter unopened because of the "we get too much of this stuff" attitude. The letter was eliminated.

Two postal cards were developed--one for each State. The emphasis was on color, layout, and tone of message. Preliminary cards were made by R&D personnel ^{2/}, then they were submitted to each SSO for review. The final artwork and drafting were done by the Departmental Arts and Graphics Office. Each card was 8" x 8" folded to 8" x 4". The message was entirely inside the fold with only address and return address on the outside. The U. S. Government postal indicia was preprinted.

The card for use in Tennessee carried the direct plea, "PLEASE REMEMBER that you received this card!" This was followed by a brief explanation of the purpose of the card over the signature of the State Statistician. The drawings were (a) a rural mailbox with the flag up, and (b) a postman making an in-town delivery. The message was printed in black ink. Tone and half-tone orange on yellow stock created a three-color impression.

The Oklahoma card was printed on medium blue stock with tones of green. Black was used for the message. A man's hand with a string tied in a bow on the index finger pointed to large lettering "SOMETHING TO REMIND YOU--." This was followed by an expression of appreciation to those persons whose cooperation makes possible the programs of the SSO. There was a "thank you" for the recipients who are now or had been cooperators and a "hope we meet you soon" for any who had not yet participated. The signature was that of the State Statistician.

RESULTS

Altogether, 597 devices were mailed. Of these, 38 were lost to the survey since there was no follow-up interview for them. In some cases, the addressee had moved or could not be located. Some devices were returned by the Post Office, most of which were marked Deceased. (First class postal treatment of the devices apparently was justified. A review of completed questionnaires shows that many were delivered in spite of incomplete or inaccurate addresses or names). Within the control group, there was also a loss of interviews because intended respondents had moved, had died, or could not be located. Results of all interviews are shown in Table 1. In Figure 1, the same data are shown as percentages of interviews completed. The question was: "Did

^{2/} Harvey Farrow, Sampling and Computations Group, did original art and design.

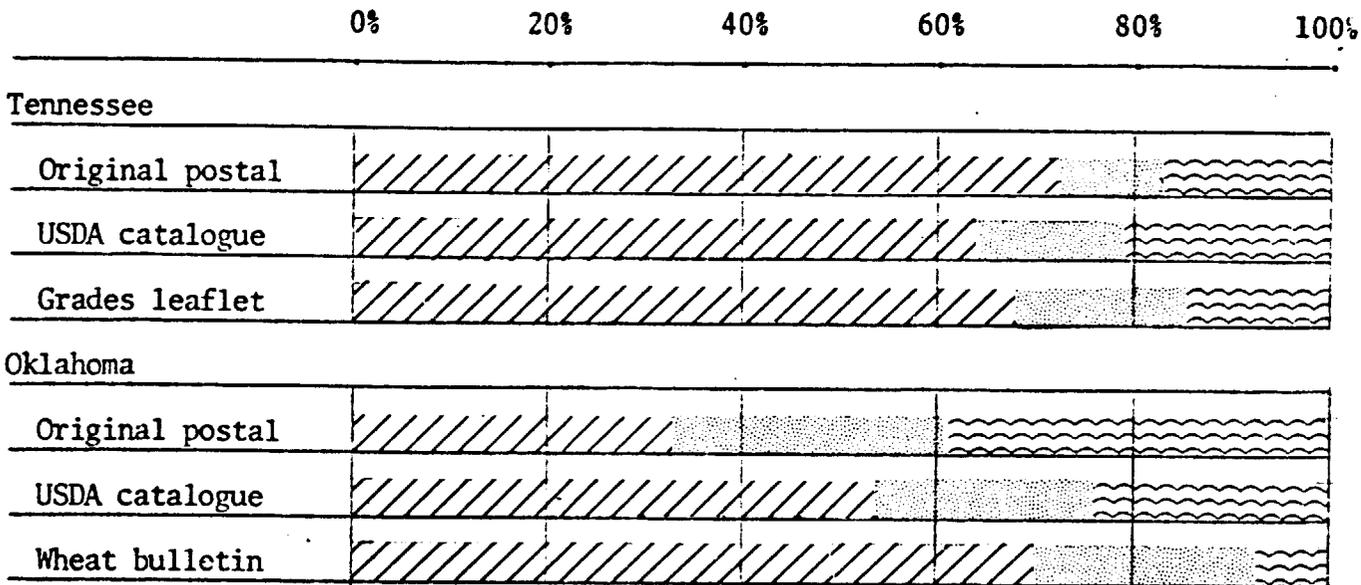
you receive one of these in the mail?"

Table 1.--Summary of responses

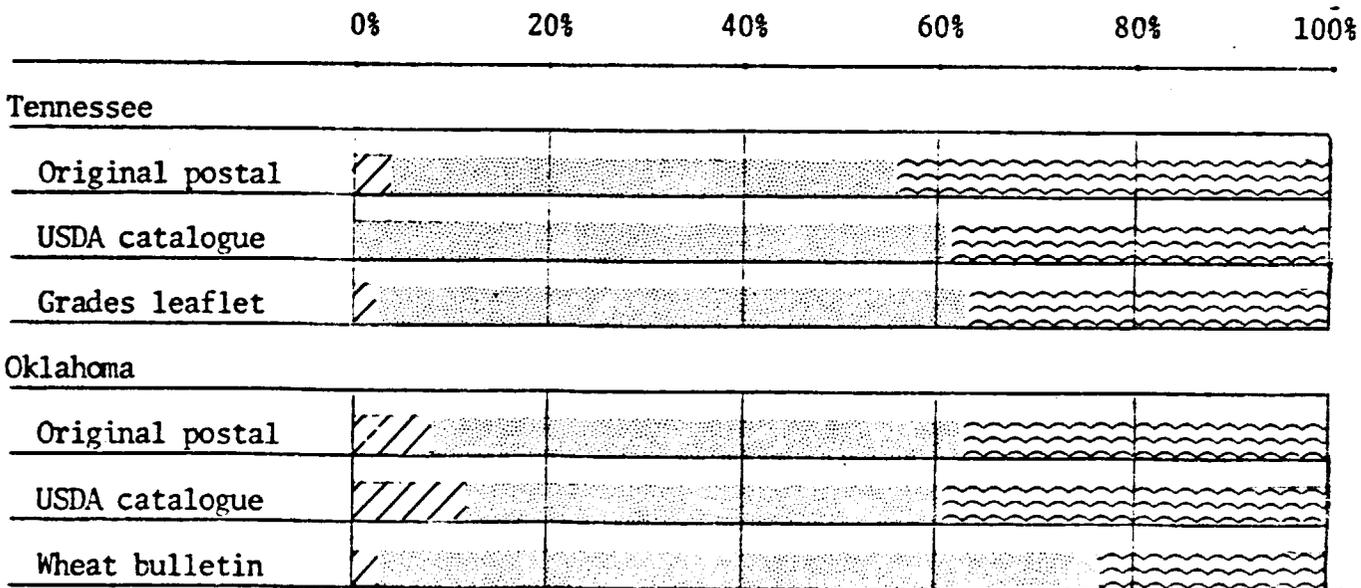
Item	Tennessee			Oklahoma		
	Original: postal card	Catalogue of U.S.D.A. publications	U.S.D.A. grades leaflet	Original: postal card	Catalogue of U.S.D.A. publications	Wheat Quality bulletin
Total sample size	134	134	134	134	135	135
	Device was mailed					
Number	101	98	99	99	100	100
Lost	7	6	9	4	7	5
Interviews	94	92	90	95	93	95
Responses						
Yes	68	59	60	32	50	67
No	9	13	16	27	21	21
Don't remember	17	20	14	36	22	7
	No device mailed					
Number	33	36	35	35	35	35
Interviews	25	31	33	32	33	31
Responses						
Yes	1	0	1	3	4	1
No	13	19	20	17	16	23
Don't remember	11	12	12	12	13	7

Figure 1.--Responses to Question as Percent of Interviews

A. Device was mailed and was shown to respondent.



B. Device was not mailed but was shown to respondent.



 Yes

 No

 Don't Remember

ANALYSIS AND EVALUATION

It should be emphasized that these data are responses to questions having categorical answers; they are not objective counts of specific items. They are the sums of single statements from many individuals. Traditionally, people are expected to tell the truth, especially about noncontroversial matters. At the same time it is important to recognize that any person might give a false answer through whimsy, irritation or ignorance; and memory is not infallible. Nonpersonal factors, too, could lead to incorrect answers:

- . The device was not returned by the post office. The implication is that it was delivered to the correct person, but there is no guarantee that this is true.
- . The address label bore both names of a partnership. One partner may have received the device and the other have been the respondent.
- . Although a special effort was made to interview the addressee there were cases when another member of the family was the respondent.

None the less, incorrect answers due to any of these factors, or other similar ones, would occur in an operational survey. It is apparent that they exist and must be used at face value.

To restate the purpose of this inquiry: In the case of a multi-frame survey, can positive identification of individuals (persons) who are sampling units in both frames be made by using pre-survey mailing devices? If so, what device, or kind of device, is most effective?

The hypothetical situation is this: Frame A is a list frame, source and quality not specified; Frame B is an area frame, therefore complete. A distinctive device is to be mailed to every unit of the list frame, every name on the list. The survey sample from Frame B (the area frame) will be enumerated later, probably 2-3 weeks after the mailing. Each respondent in the enumeration of Frame B is to be shown one of the mailed devices and asked, "Did you receive one of these?" If he says Yes, he is also on the list (a unit of Frame A); if he says No, he is not on the list.

In this research survey, all names used actually came from a list that might be used as Frame A in an operational survey. But no device was mailed to roughly 25 percent of them. They thus became a control group and also a representation of the Frame B (area) respondents who are not on the list being used as Frame A. In other words, in this inquiry, persons to whom no devices were mailed represent those units of Frame B (area)

who are not on the list.

The following analytical statements which made comparisons between on-the-list and not-on-the-list individuals or to the presence of overlap assume that persons who actually are not on a list would respond in the same fashion as those of the control group in this survey. The survey DID NOT provide any evidence to support that assumption.

Implications of the Answers

Yes: Ideally, each person to whom a device was mailed would reply Yes to the question--and only those persons. It is easy to appreciate a respondent's possible confusion about receipt of any of the publications. Either of the USDA pamphlets could have been obtained previously from various sources: Extension office, farm organization, personal request to the Department or a Congressman, probably other sources. It could very well have been received by mail. Thus, those persons in the control group who replied Yes easily could have received such a piece of mail even though it was not the survey device. The Oklahoma Wheat bulletin is in a similar position. It apparently has wide public appeal; it is probably distributed by each of the three cooperating agencies that produce it. In the face of these facts, one would normally expect an undetermined amount of upward bias in Yes answers relating to previously distributed devices.

As in the Texas A&M study, some persons in the control group said Yes when asked about the original postals. Each of these cards was unique; it was created solely for use in this survey; prior to the survey it was seen only by Washington, D.C. and State Statistical office personnel; it was not mailed to persons of the control group. Yet some of them said, "Yes, I received it". Functionally, those answers are failures, not of the device, but of the proposed technique. They indicate overlap when it does not exist.

No: No is the desired answer from each respondent in the control group. A No from persons to whom the device was mailed indicates failure of the device. Either the device went astray, it did not impress the recipient or, possibly, he did not care to say that he had received it. In any event, it is failure to detect overlap between the two frames.

Don't Remember: The original expectation was that all respondents would reply Yes or No. The possibility of Don't Remember was recognized only in the latter stages of planning the survey. Enumerators were instructed to record it only if it was the genuine response, not to supply the idea that it was one of

the expected answers. Don't Remember is the least informative reply possible; it also carries the greatest condemnation of the device since it implies that the device made (or would make) so little impression that it was not noticed. Of the 744 total persons interviewed, 24.6 percent said Don't Remember. In Tennessee, the percentage was 25.6; in Oklahoma, 25.6. Incidence of this response, as a number and as a percent of interviews, shows by device, within State, in Table 2.

Table 2.--Don't remember response

Item	Tennessee			Oklahoma		
	Original postal card	Catalogue of U.S.D.A. publications	U.S.D.A. grades leaflet	Original postal card	Catalogue of U.S.D.A. publications	Wheat Quality bulletin
	Device was mailed					
Number	17	20	14	36	22	7
Percent	18.1	21.7	15.6	37.9	23.7	7.4
	No device mailed					
Number	11	12	12	12	13	7
Percent	44.0	38.7	36.4	37.5	39.4	22.6
	All interviews					
Number	28	32	26	48	35	14
Percent	23.5	26.0	21.1	37.8	27.8	11.1

In Oklahoma these responses indicate a substantial difference between the effectiveness of the original postal and the Wheat Quality bulletin. It seems reasonable to get proportionately more Don't Remembers from the no-device-mailed group than from the other respondents. But the overall number of these answers raises a question: Are all these devices really that deficient as attention-getters or are some people loath to make the positive statement? Is there an element of hedging on the part of the respondent in the face of a new situation? It would be unfortunate indeed to be forced to conclude that approximately one quarter of our

potential respondents have perception or memory so poor.

Comparative Success of Devices

From the data in Table 1 and the percentage distributions in the bar charts of Figure 1, certain relationships are apparent. Several of these were tested for statistical validity by using the chi-square test of independence. At 95 percent level of confidence, two degrees of freedom, we can confirm two statements about responses from the groups to whom devices were mailed:

- (1) The three devices were equally effective in Tennessee.
- (2) The three devices were not equally effective in Oklahoma.

By pooling all answers, including the successes and failures of the control group, the test results remain the same.

The USDA catalogue is the only identical device used in both States. There was no significant difference between its performance in Tennessee and in Oklahoma.

The two individually designed cards achieved both the best and the poorest success rates if measured by the percent of Yes answers in the device-was-mailed group. The implied conclusion is that the difference is attributable to the cards themselves. Recipients of the Tennessee card were more impressed with its colors, art work, or message (or some combination of these) than were those who received the Oklahoma card.

Overall Success of the Devices

There were a total of 734 interviews in the two States. If we state that a person to whom a device was mailed should have replied Yes and a person to whom no device was mailed should have answered No, then overall correct answers were 59.5 percent for the two states combined, 65.5 percent in Tennessee and 54.1 percent in Oklahoma. Persons to whom a device was mailed said Yes 60.1 percent of the time, and persons to whom no device was mailed said No at the rate of 58.4 percent.

PROBABILITY OF UNITS BEING ON THE LIST

Because there was no significant difference among the success rates of the three devices in Tennessee, data from all of them have been pooled for the following calculations. Oklahoma data were not included because of the disparity of the three success rates.

It is known whether persons were "on the list" or "not on the list" -- that is, the device-was-mailed group versus the control group. Therefore, it is known what each respondent should have replied. Based on this information, conditional probabilities can be computed that an individual is on the list based on the interview replies Yes, No, or Don't Remember.

Events

- M : individual to whom a device was mailed. He is on the list.
- M' : individual to whom a device was not mailed. He is not on the list.
- Y : Yes response
- N : No response
- DR: Don't Remember response

From the experiment data, the following conditional probabilities were calculated:

- $P(Y|M) = 187/276 = .6775$
- $P(N|M) = 38/276 = .1377$
- $P(DR|M) = 51/276 = .1848$
- $P(Y|M') = 2/89 = .0225$
- $P(N|M') = 52/89 = .5843$
- $P(DR|M') = 35/89 = .3932$

Other sources (censuses, local knowledge, etc.) provide information for the estimates:

$$P(M) = \frac{\text{estimated number of farms on list}}{\text{estimated number of all farmers}}$$

$$P(M') = 1 - P(M)$$

The formulae 1/ are

1/ Bayes' formula.

$$P(M|Y) = \frac{P(M) P(Y|M)}{P(M) P(Y|M) + P(M')} P(Y|M')} = \text{Probability}$$

that individual is on the list if he replies Yes.

$$P(M|N) = \frac{P(M) P(N|M)}{P(M) P(N|M) + P(M')} P(N|M')} = \text{Probability}$$

that individual is on the list if he replies No.

$$P(M|DR) = \frac{P(M) P(DR|M)}{P(M) P(DR|M) + P(M')} P(DR|M')} = \text{Probability}$$

that individual is on the list if he replies Don't Remember.

Table 3 shows several sets of these conditional probabilities computed with selected arbitrary values for P(M).

Table 3.--Probability of being on list, various responses

If P(M) is	Probability that respondent is on list if he says		
	Yes	No	Don't remember
	P(M Y)	P(M N)	P(M DR)
.95	.998	.818	.899
.90	.996	.680	.809
.80	.992	.485	.653
.70	.986	.355	.523
.60	.978	.261	.413
.50	.968	.190	.320
.40	.953	.136	.239
.30	.928	.092	.168
.20	.883	.056	.105

The probabilities of being on the list, and especially their relationship to the extent of list coverage, P(M), indicate:

- A. It would be possible to reduce the requirement of positive identification of overlap if we could afford the consequent increase in the error of the estimate. For example, if the probability were .996 that a respondent is on the list if he says Yes, we could accept all Yes individuals as units of the list frame at an established risk. In this case $P(N) = .90$ the risk of error is quite high if we accept No or Don't Remember as identifying non-overlapping units of the other frame (.680 and .809). These responses might then be subject to further verification or required to satisfy additional criteria to determine non-overlap.
- B. In this application, a great degree of precision in stating $P(N)$ is not required. A reasonable estimate should be adequate since the probability of being on the list with a Yes response (column 2, Table 3) declines at a much slower rate than $P(N)$.
- C. When list coverage of the total population is very small, say $P(N) = .20$, there appears to be little risk in accepting No (.056) and Don't Remember (.105) answers as valid for identifying non-overlapping units of the other frame. At the same time, there is a slightly increased risk, $P(Y|M)$ from .996 to .883, in accepting a Yes answer as indicating a unit belonging to both frames.

Any applied usage would require the collection of control type data simultaneously with the operational survey in order to compute pertinent probabilities.

CONCLUSIONS AND RECOMMENDATIONS

In this test, the use of pre-survey mailing devices with enumerative follow-up for the purpose of identifying overlap in multi-frame surveys has not proven to be very successful. The proportion of correct answers to the identifying question is too low to justify this technique as a single criterion for identification purposes. It might be useful as a supplemental tool or as one of a series of actions. There is some indication that conditional probabilities could be used as an aid in evaluating the need for additional actions.

This study suggests that there are psychological factors which are important to the possible success of mailing devices. Those factors should be better understood and more aptly applied if there is any further attempt to develop the technique.

A modification of the follow-up enumerative technique should be tried if there are future tests of mailing devices. One or two probing questions might refresh the respondent's memory or reveal the basis for No or Don't Remember answers. Or the respondent might be asked to hold the device either until a certain date or until the enumerator asked about it. This could verify receipt of the device and also serve as a means of checking accuracy of name and address.

Additional information is needed to confirm or refute the assumption that persons actually not on a list respond in the same fashion as the control group selected from a list in this survey.

Follow-up studies using this method should include an evaluation of achievement versus cost. Since other techniques for identifying overlap are being studied, the relative effectiveness of mailing devices should be determined when results are available concerning other methods.