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AGRICULTURAL TECHNOLOGY IMPROVEMENT PROJECT (ATIP)

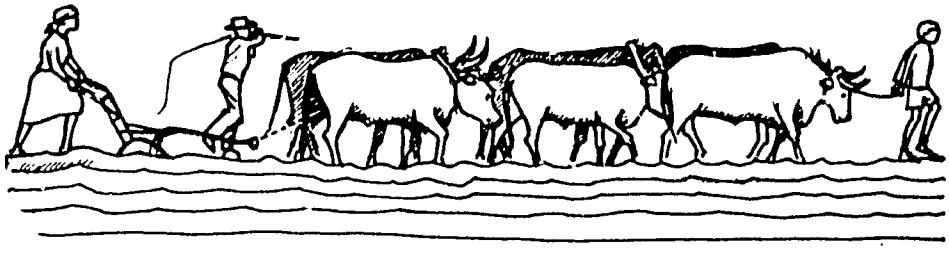
1989 ADOPTION STUDY
SPONTANEOUS TECHNOLOGY ADOPTION IN FARMER GROUPS

BY

F. WORMAN, L. WILLIAMS, C. TIBONE, AND G. HEINRICH

ATIP WORKING PAPER

ATIP WP-34



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DEPARTMENT OF AGRIC. RESEARCH
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ATIP WORKING PAPERS CONSIST OF METHODOLOGICAL AND EMPIRICAL MATERIAL WHICH HAS BEEN REVIEWED INTERNALLY BY ATIP BUT DO NOT NECESSARILY REFLECT THE VIEWS OF THE DEPARTMENT OF AGRICULTURAL RESEARCH, MINISTRY OF AGRICULTURE, BOTSWANA

PREFACE

ATIP Working Papers consist of methodological and empirical material which has been reviewed internally by ATIP. Working Papers are prepared and circulated to make ATIP research findings easily available to GOB personnel and researchers interested in Botswana farming systems.

This paper describes a study to determine the spontaneous adoption (i.e., use on their own initiative) of "new" technologies by members of the ATIP Farmer Technology Options Testing Groups (FTOTGs). The study was based on an Adoption Survey which is described and the findings of the survey are presented. Additional findings based on household characteristics of the FTOTG members are also presented.

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1989 ADOPTION STUDY

SPONTANEOUS TECHNOLOGY ADOPTION IN FARMER GROUPS

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ABSTRACT

The 1989 Adoption Study was based on a survey of 158 farmers who had participated in the ATIP researcher managed, farmer options testing groups. The purpose of the survey was to determine the extent of spontaneous technology adoption in the groups. Forty-one of the farmers interviewed used a "new" technology during the 1988-89 season. "New" technologies were used on 35 percent of the land planted by the adopters. The most popular technology was double ploughing, either alone or in combination with other technologies (usually row planting).

INTRODUCTION

In 1983 the Agricultural Technology Improvement Project (ATIP) began on-farm agricultural research activities in the villages of Matobo, Mathangwane and Marapong in the Tutume Agricultural District. From the project's inception, farmers were involved with experimental trials (researcher managed, farmer implemented) on their farms. In 1985 ATIP researchers began working with Farmer Technology Options Testing Groups (FTOTGs) in one village. The approach was modified and introduced in two other villages in 1986-87. In these groups, farmers conducted trials (farmer managed, farmer implemented) of technologies of their choosing, on their own farms. During the 1988-89 cropping season the FTOTGs were in their third year. In addition to being members of a group, some of the farmers were in their sixth year working with ATIP on RMFI trials.

There has been a continuing question as to whether farmers are adopting the technologies they have been testing. Observation and informal discussion with farmers indicated that spontaneous adoption was taking place. Thus it was decided to conduct a formal survey to determine the extent of this spontaneous adoption.

OBJECTIVES

The objectives of this study were:

(a). To determine to what extent spontaneous adoption of "new" technologies was taking place among the farmers who had been working with ATIP,
(b). To identify the types of technologies being adopted, and
(c). To describe the household characteristics of the adopter group.

APPROACH

It was decided that the adoption study would be based on a survey of all farmers who had participated in the researcher managed FTOTGs during the 1985-1989 period. A survey instrument (Appendix A) was devised and interviews were conducted in July and August 1989. The questions were designed to identify farmer's use of "new" technologies and the area on which "new" technologies were used during the 1988-89 cropping season. A "new" technology, for the purposes of this study, was a technology which the farmer had not been using prior to the 1984-85 season.

Household characteristics data, collected earlier, on FTOTG members were integrated with the survey data to provide a database for the analysis of household characteristics.

Hildebrand and Poey[1] (pp. 122-123), describe an Index of Acceptability. This index may be used in determining when a technology, that is undergoing large-scale farmer verification testing in a specific recommendation domain, is ready for more general dissemination through extension. The Index of Acceptability is calculated as the percent of interviewed farmers using the technology being tested (C), times the percent of their crop land on which they are using the technology (A), divided by 100. This gives an index with a range from 0 to 100. Hildebrand and Poey suggest that a technology undergoing widespread testing is likely to be adopted under general extension conditions when the Index of Acceptability is at least 25, and the percentage of farmers interviewed who are using the technology is equal to or greater than 50. While this index gives an overall measure of acceptability, the authors caution that it is important to look at both components of the index when analyzing the results, as a technology may be accepted by a large percentage of the farmers, but only used on a small portion of their total lands. Likewise a technology relevant to only a small portion of the farmers, but used by them on a high proportion of their lands, will also show a low adoption index. However, in either case the technology may be of value for extension to farmers in a particular recommendation domain.

The survey instrument developed for this study contained questions designed to collect data necessary to calculate an Index of Acceptability, namely the total area planted by each farmer and the area planted utilizing a "new" technology.

Data analysis included descriptive statistics and a calculation of the overall Index of Acceptability for all "new" technologies combined, and by household characteristics. Additional statistical analysis included two-way analysis of variance (ANOVA) on the square root of the area planted to a "new" technology by farmers in the various household characteristic groups[2]. With area measurements the mean and variance are often correlated, so the square root transformation was used to stabilize the variance. Due to the relatively small number of adopters in each group, the ANOVA was done on each pair of household factors to determine main effects and interactions. A Generalized Linear Model was also used to compare the proportion of farmers adopting by household characteristics. In order to perform this test, the proportions were transformed according to the logit transformation and the error was defined to be binomial. The statistical package used for this procedure was Genstat V. These statistical analyses were conducted to identify interactions among the various household characteristics as they reflect the farmers' propensity to adopt "new" technologies.

RESULTS

The Adoption Survey was administered to 158 out of 165 (96 percent) farmers who had participated in FTOTGs at some time during the 1984-88 period. Fifty-eight (100 percent) farmers were interviewed in Matobo, 64 (96 percent) in Mathangwane, and 36 (90 percent) in Marapeng. Farmers not interviewed were deceased or no longer lived in the village. A tabulation of responses to the survey questions is given in Appendix B.

TECHNOLOGIES

Of the 158 farmers interviewed, 26 percent (41) reported using a technology during the 1988-89 cropping season that they had not used prior to the 1984-85 cropping season. Of

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[1]. P. E. Hildebrand and F. Poey, ***On-Farm Agronomic Trials in Farming Systems Research and Extension***, Boulder, Colorado: Lynne Rienner Publishers, 1985.

[2]. The square root transformation was applied to each individual data point.

the adopters, 41 percent (17) were from Marapong, 32 percent (13) were from Matobo, and 27 percent (11) were from Mathangwane (Table 1).

Table 1 summarizes the characteristics of the "new" technologies being adopted. Most of the adopters used one "new" technology. A combination of technologies was considered one technology. Double ploughing, alone or in combination with another technology (usually row planting) was the most popular "new" technology. Double ploughing was used by 78 percent of the adopters. This was 20 percent of all farmers. Row planting, alone or in combination, was used by 41 percent of adopters, representing 11 percent of all farmers. The use of fertilizer (including manuring), alone or in combination, was practiced by 7 adopters.

In plots planted to "new" technologies, sorghum and maize were the most commonly planted crops. In some cases, particularly with row planting, an adopter would plant part of the plot with one crop and part with another, using the same tillage technology. Because the varieties planted were not "new", the two crops were treated as one technology.

Increased yield, alone or in combination, was reported by over half of the adopters as the reason they liked the technology. Other frequently mentioned reasons for liking a technology included: "less weeds, easier cultivation", "better germination", and "conserve moisture". A few farmers reported problems with the technologies (see Table 1).

Many adopters used a combination of technologies, and they reported a combination of sources of information about the technologies. The two major sources of information were ATIP and the extension service.

AREA PLANTED

Farmers interviewed planted a total of 988 hectares, with adopters (26 percent of total interviewees) planting 40 percent (392 hectares) of all land planted. Adopters planted 9.57 hectares on average, 88 percent more than non-adopters. A total of 138 hectares were planted in "new" technologies, for an average of 3.36 hectares per adopter. In addition, all interviewees planted on average slightly over one-quarter hectare each in ATIP trials. ATIP trials were generally "new" technologies but were being tested and did not represent adoption (see Table 2).

HOUSEHOLD CHARACTERISTICS

The overall adoption level of 26 percent varied significantly ($P<.01$) among villages. The highest adoption rate, in Marapong, was 47 percent. The lowest, 17 percent, was in Mathangwane. Matobo was closer to Mathangwane with a 22 percent adoption rate (Table 3).

The sex of head of household of the adopters was almost evenly split between male and female (including defacto female) headed households. The percentage of adopters among male-headed households was not significantly greater than for female and defacto female-headed households. Also adopters were almost evenly divided among those with heads of households under 50, between 50 and 60, and over 60.

As cattle ownership increased so did the proportion of farmers adopting. Forty percent of the owners of more than 40 cattle were adopters, while only 12 percent of the non-cattle owners adopted a "new" technology.

TABLE 1: CHARACTERISTICS OF "NEW" TECHNOLOGIES BEING ADOPTED

	NUMBER ADOPTING	PERCENT OF ADOPTERS	PERCENT OF TOTAL
NUMBER ADOPTING	41	100	25.9
VILLAGE:			
MATOBO	13	31.7	8.2
MATHANGWANE	11	26.8	7.0
MARAPONG	17	41.5	10.7
NUMBER OF DIFFERENT "NEW" TECHNOLOGIES			
ONE	37	90.2	23.4
TWO	4	9.8	2.5
"NEW" TECHNOLOGY ADOPTED			
DOUBLE PLOUGHING	16	39.0	10.1
FERTILIZER	5	12.3	3.2
ROW PLANTING	3	7.3	1.9
CROP ROTATION	1	2.4	0.6
DOUBLE PLOUGHING & FERTILIZER	1	2.4	0.6
DOUBLE PLOUGHING & ROW PLANTING	14	34.2	8.9
DOUBLE PLOUGHING & MANURING	1	2.4	0.6
CROP PLANTED USING A "NEW" TECHNOLOGY (ALONE OR IN COMBINATION)			
SORGHUM	16	39.0	10.1
MAIZE	16	39.0	10.1
MILLET	12	29.3	7.6
COWPEAS	6	14.6	3.8
GROUNDNUTS	2	4.9	1.3
JUGO BEANS	1	2.4	0.6
WHY LIKE THE "NEW" TECHNOLOGY (ALONE OR IN COMBINATION)			
INCREASED YIELD	22	53.4	13.9
BETTER GERMINATION	13	36.6	8.2
LESS WEEDS, EASIER CULTIVATION	16	39.0	10.1
CONSERVES MOISTURE	11	26.8	7.0
GREW BETTER	5	12.2	3.2
USE LESS SEED	2	4.9	1.3
WHY NOT LIKE THE "NEW" TECHNOLOGY (ALONE OR IN COMBINATION)			
APHIDS ON COWPEAS	2	4.9	1.3
CROPS CROWDED	1	2.4	0.6
FERT DOES NOT WORK IN DRY YEARS	1	2.4	0.6
FERTILIZER ENCOURAGES WEEDS	1	2.4	0.6
LABOUR CONSTRAINT	1	2.4	0.6
TOO LITTLE DRAUGHT POWER	1	2.4	0.6
SOURCE OF "NEW" TECHNOLOGY (ALONE OR IN COMBINATION)			
ATIP	25	61.0	15.8
EXTENSION SERVICE (AD)	18	43.9	11.4
OTHER FAMILY MEMBERS	3	7.3	1.9
NEIGHBOUR	1	2.4	0.6
OTHER[a]	1	2.4	0.6

a. Other is "adopted from late husband".

TABLE 2: TOTAL AND MEAN AREAS FOR TOTAL AREA PLANTED, AREA PLANTED TO "NEW" TECHNOLOGY AND AREA PLANTED IN ATIP TRIALS, IN HECTARES

	ALL RESPONDENTS	NON-ADOPTERS	ADOPTERS	ADOPTERS % OF TOT
NUMBER OF RESPONDENTS	158	117	41	26
TOTAL AREA PLANTED (IN HECTARES)				
TOTAL AREA	988	596	392	40
AVERAGE AREA PER FARM	6.25	5.09	9.57	153
STANDARD DEVIATION	5.87	5.17	6.51	111
AREA PLANTED IN "NEW" TECHNOLOGIES (IN HECTARES)				
TOTAL AREA	138	0	138	100
AVERAGE AREA PER FARM	0.87	0	3.36	386
STANDARD DEVIATION	3.31	0	5.86	177
AREA PLANTED IN ATIP TRIALS (IN HECTARES)				
NUMBER OF TRIALS	109	77	32	29
TOTAL AREA	31	22	9	29
AVERAGE AREA PER FARM	0.28	0.29	0.27	96
STANDARD DEVIATION	0.38	0.45	0.11	29

TABLE 3: PROPORTION OF ADOPTERS BY HOUSEHOLD CHARACTERISTICS

FACTOR	NUMBER OF RESPONDENTS	NUMBER OF ADOPTERS	ADOPTERS AS PROPORTION OF FACTOR CATEGORY RESPONDENTS[a]	PERCENT OF ADOPTERS BY FACTOR
TOTAL NUMBERS	158	41	26	100
VILLAGE[b]				
MATOBO	58	13	22	32
MATHANGWANE	64	11	17	27
MARAPONG	36	17	47	41
SEX OF HEAD OF HOUSEHOLD				
MALE	74	21	28	51
FEMALE	57	15	26	37
DEFACTO FEMALE	25	5	20	12
AGE OF HEAD OF HOUSEHOLD				
UNDER 50	56	13	23	32
50 TO 60	52	15	29	36
OVER 60	44	13	30	32
CATTLE OWNERSHIP CATEGORY				
NO CATTLE	16	2	12	5
1-15 HEAD	79	17	22	41
16-40 HEAD	41	14	34	34
41 OR MORE	20	8	40	20
DRAUGHT SOURCE				
DONKEY	9	1	11	2
CATTLE	117	30	26	73
TRACTOR	29	9	31	23
CONTROL DRAUGHT				
CONTROL DRAUGHT[c]	100	31	31	77
DRAUGHT DEPENDENT[d]	55	9	16	23

a. This is "C" in the formula for Index of Acceptability.
b. Based on a Generalized Linear Model using proportions, the Village effect was significant (P<.05) when paired with whichever other factors were included in the model.
c. Own draught.
d. Hire, cooperative arrangement, or family supplied draught.

The lowest proportion of adopters was among donkey draught users, while the highest proportion of adopters was among tractor draught users. The proportion of adopting farmers who controlled (owned) their own draught were almost twice the proportion of adopters who were dependent on others for draught.

Using the Chi-square statistic on cross-tabulations of the adoption variable with the household characteristics variables, it was determined that the only significant effect on adoption was village. A Generalized Linear Model procedure used on the proportion of adopters confirmed this finding, but showed several significant interactions. Significant interactions (Table 4) were found between sex of head of household and age of head of household ($P<.01$), between sex of head of household and draught control ($P<.05$), and between draught source and draught control ($P<.01$). This indicates that the proportion of defacto female-headed households under 50, the proportion of female-headed households between 50 and 60, and the proportion of male-headed households over 60 were all significant. Likewise the proportion of female-headed households who were draught dependent was significant. Finally, the proportion of tractor owners who controlled their own draught and the proportion of donkey owners who were draught dependent were both significant.

Among the villages, there was some difference in technologies utilized. Double ploughing (DP) and double ploughing with row planting (DP/RP) were more popular in Matobo and Marapong, and fertilizer was more popular in Mathangwane. In Matobo double ploughing alone was twice as popular as the double ploughing plus row planting combination, while the opposite was true in Marapong. This may be because there has traditionally been more row planting in Marapong (Table 5).

ATIP was the most important source of information in Matobo and Marapong, while the extension service was the most important in Mathangwane. This may be partly related to the relative importance of double ploughing, an ATIP technology, in the first two villages, and fertilizer, an extension technology, in Mathangwane.

In terms of the sources of information, there is again a difference between male and female-headed households, with male-headed households being almost evenly split between ATIP and extension, while female-headed households utilized ATIP twice as often as the extension service. This latter observation is interesting because most of the participants in the groups were women, no matter what the sex of the head of household. It may be that those women from male-headed households received more information through their husband's contacts with extension than did female household heads, in which case this finding suggests a male gender bias within the extension organization.

The youngest age group favoured double ploughing alone while the other two groups preferred double ploughing plus row planting. Since there was a significant interaction between age and sex, it is possible that the older males (which predominated in the interaction) were able to do the row planting in addition to double ploughing because they controlled more resources. ATIP predominated (almost 2 to 1 over extension) as the source of information for the under 60 groups, while extension was used by the over 60 group. It is possible that this finding reflects an extension bias towards working with people who have leadership roles in the community, or it may indicate that the older group actually received information on the "new" technologies previously from extension (prior to the current drought when extension was doing more training), and were adopting the technologies after having their value reinforced through on-farm trials.

TABLE 4: TABLE OF PROPORTIONS OF ADOPTERS FOR SIGNIFICANT INTERACTIONS[a]

AGE	SEX OF HEAD OF HOUSEHOLD		
	MALE	FEMALE	DEFACTO FEMALE
- < 50	3/15 (20)	5/25 (20)	5/16 (5)
- 50-60	6/28 (21)	9/22 (41)	0/2 (0)
- > 60	12/17 (71)	1/9 (1)	0/6 (0)

TWO-WAY INTERACTION SIGNIFICANT $P < 0.01$

	SEX OF HEAD OF HOUSEHOLD		
	MALE	FEMALE	DEFACTO FEMALE
FARMERS WHO CONTROL DRAUGHT	21/56 (37)	7/25 (28)	3/19 (16)
FARMERS WHO ARE DRAUGHT DEPENDENT	0/18 (0)	7/31 (23)	0/4 (0)

TWO-WAY INTERACTION SIGNIFICANT $P < 0.05$

	DRAUGHT SOURCE		
	DONKEY	CATTLE	TRACTOR
FARMERS WHO CONTROL DRAUGHT	0/8 (0)	27/86 (31)	4/6 (67)
FARMERS WHO ARE DRAUGHT DEPENDENT	1/1 (100)	3/31 (10)	5/23 (22)

TWO-WAY INTERACTION SIGNIFICANT $P < 0.01$

a. Numbers in parenthesis are percentage of adopters.

The owners of 1 to 15 head of cattle showed most diversity in the technologies they adopted, favouring double ploughing alone, whereas the groups owning over 15 head preferred double ploughing plus row planting. Again this may be a question of the groups, owning more cattle, having more resources at their disposal and/or being less concerned with risk than the owners of few cattle. Owners of 1 to 15 head of cattle and over 40 head utilized ATIP as their source of information twice as often as they did the extension service, while the group owning 16 to 40 head used the extension service more frequently. The extension service may be biased towards farmers with more resources, who tend to be male. The group of farmers with more than 40 cattle included general tractor owners who had an interest in a specific piece of ATIP supplied equipment.

Cattle draught users favoured double ploughing alone followed closely by double ploughing plus row planting, while tractor users were almost evenly divided between fertilizer use and double ploughing or double ploughing plus row planting combined. Cattle draught users were generally cattle owners, so they controlled the draught necessary to implement double ploughing and/or row planting. The tractor users who implemented double ploughing and/or row planting may have been the tractor owners, again a group that could invest in additional tillage operations. Almost half of cattle owners looked to ATIP for information, with a third also using information from the extension service.

TABLE 5: DISTRIBUTION OF "NEW" TECHNOLOGIES AND SOURCES OF INFORMATION BY HOUSEHOLD CHARACTERISTICS

	NO.	TECHNOLOGIES					SOURCE		
		DP	FERT	RP	DP/RP	OTHER[a]	ATIP	DAFS	OTHER[c]
		PERCENT OF ADOPTERS[b]					% OF ADOPTERS		
TOTAL NUMBERS	41								
% OF ADOPTERS		39	12	7	35	7	61	44	12
% OF TOTAL		10	3	2	9	2	16	11	3
VILLAGE									
MATOBO	13	20	0	2	10	0	27	12	0
MATHANGWANE	11	7	12	0	5	2	10	15	10
MARAPONG	17	12	0	5	20	5	24	17	2
SEX HEAD OF HOUSE									
MALE	21	17	2	5	25	2	24	27	7
FEMALE	15	17	8	2	8	3	27	12	5
DEFACTO FEMALE	5	5	2	0	2	2	10	5	0
AGE HEAD OF HOUSE									
UNDER 50	13	17	2	0	5	7	22	12	2
50 TO 60	15	12	8	2	15	0	24	12	7
OVER 60	13	10	2	5	15	0	15	20	2
CATTLE CATEGORY									
NO CATTLE	2	0	0	0	2	2	2	2	0
1-15 CATTLE	17	25	5	7	5	0	34	12	5
16-40 CATTLE	14	12	2	0	18	3	15	24	2
41 OR MORE	8	2	5	0	10	2	10	5	5
DRAUGHT SOURCE[d]									
DONKEY	1	0	2	0	0	0	0	2	0
CATTLE	30	34	0	7	27	5	49	32	7
TRACTOR	9	5	10	0	5	2	10	7	7
CONTROL DRAUGHT									
CONTROL DRAUGHT[e]	31	29	2	7	35	5	46	34	10
DRAUGHT DEPEND[f]	9	10	10	0	0	2	12	10	2

a. Other includes: Rotation (1), DP/fertilizer (1) and DP/manuring (1).
b. Percentage of adoption in each major category, i.e., percentages for all technologies for all three villages equal 100 percent.
c. Other includes: family members (2), neighbour (1) and adopted from late husband (1). Percentage totals more than 100 due to multiple sources of information.
d. Draught source for one adopter was not known.
e. Own draught.
f. Hire, cooperative arrangement, or family supplied draught.

Those who controlled their own draught favoured more draught intensive technologies (DP and DP/RP) while those who were draught dependent split between double ploughing and fertilizer, a non-draught using technology. Both groups used ATIP for information slightly more often than the extension service.

AREA BY HOUSEHOLD CHARACTERISTICS

The mean total area planted by adopters was more than 50 percent greater than the mean total area planted by all farmers. Also the mean total area planted by adopters was significantly greater ($P<.01$) than the mean total area planted by non-adopters[3]. Overall adopters planted 35 percent of their total planted area with "new" technologies (Table 6).

[3] The t-value = 3.99 with separate variance estimates, DF = 59.

TABLE 6: MEAN AREAS, IN HECTARES, FOR TOTAL AREA PLANTED AND AREA PLANTED TO "NEW" TECHNOLOGIES, BY HOUSEHOLD CHARACTERISTICS

	NOS. ADOP-TERS	TOTAL AREA PLANTED					"NEW" TECHNOLOGY		
		TOT POP		ADOPTERS		%[a]	ADOPTERS		%[b]
		MEAN	S.D.	MEAN	S.D.	TOT	MEAN	S.D.	TOT
OVERALL MEAN	41	6.3	5.9	9.6	6.5	152	3.4	5.9	35
VILLAGE									
MATOBO	13	5.2	3.1	6.0	2.7	115	0.3	0.3	5
MATHANGWANE	11	5.9	6.9	9.9	5.7	168	4.4	3.4	44
MARAPONG	17	8.5	6.8	12.1	7.9	142	5.0	8.2	41
SEX HEAD OF HOUSE									
MALE	21	6.8	5.4	10.2	7.3	150	4.6	7.7	45
FEMALE	15	5.8	6.6	8.2	4.2	14	11.6	2.7	20
DEFACTO FEMALE	5	5.4	5.3	10.9	9.2	202	3.6	3.3	33
AGE HEAD OF HOUSE									
UNDER 50	13	5.3	4.0	8.2	6.1	155	2.7	3.2	33
50 TO 60	15	7.4	8.2	11.7	7.8	158	5.4	8.7	46
OVER 60	13	6.2	4.4	8.5	4.9	137	1.7	2.7	20
CATTLE CATEGORY									
NO CATTLE	2	3.2	2.9	8.8	3.2	275	0.5	0.7	6
1-15 CATTLE	17	5.6	5.5	6.5	3.3	116	1.2	1.8	18
16-40 CATTLE	14	7.0	5.3	10.0	6.4	143	4.0	5.8	40
41 OR MORE	8	9.7	7.9	15.5	8.8	160	7.4	9.7	48
DRAUGHT SOURCE									
DONKEY	1	3.7	2.0	3.5	0.0	95	2.0	0.0	57
CATTLE	30	6.2	5.5	8.3	4.9	134	1.6	2.4	19
TRACTOR	9	6.8	7.6	14.3	9.3	210	9.8	9.6	69
CONTROL DRAUGHT									
CONTROL DRAUGHT[c]	31	7.1	6.6	10.2	6.8	144	3.6	6.6	35
DRAUGHT DEPEND[d]	9	4.6	3.6	7.2	5.3	156	2.9	2.5	40
"NEW" TECHNOLOGIES[e]									
DOUBLE PLOUGH	16			8.0	4.7		1.7	2.9	21
FERTILIZER	5			9.1	6.5		5.7	2.9	63
ROW PLANT	3			7.2	3.7		0.1	0.1	1
DP & RP	14			13.0	8.2		5.0	8.9	39
ANY DP	32			9.9	6.9		3.3	6.4	33
ANY RP	17			12.0	7.8		4.1	8.3	34

a. Mean total area planted by adopters as a percent of mean total area planted by all respondents.
b. Mean of area planted to "new" technology as a percent of mean total area planted by adopters. This is "A" in the Index of Acceptability formula.
c. Own draught.
d. Hire, cooperative arrangement, or family supplied draught.
e. Except for the ANY DP category, this analysis omits one DP & Fert, one DP & Manure, and one Rotation.

Adopters in Matobo planted the smallest total area and by far the smallest area to "new" technologies. Two possible reasons for the small area planted to "new" technologies in Matobo are that farmers were still "testing" the technologies on small plots, looking for the right combination for their situation, or that they were using the technology, particularly double ploughing, on small sole plantings of high value crops, i.e., cowpeas and groundnuts. The area planted to "new" technologies by adopters in Matobo was only 5 percent of the total area they planted, much below the 44 percent in Mathangwane and the 41 percent in Marapong.

Male-headed adopting households planted 45 percent of their total planted area with "new" technologies, compared to 33 percent for defacto female-headed households and 20 percent for female-headed households. Defacto female-headed adopter households planted more than twice the mean total area for all defacto female-headed households. Adopting households with heads aged 50 to 60 planted 46 percent of their land with "new" technologies, more

than double the area planted to "new" technologies by the over 60 households. This is interesting since the two groups have almost an equal percentage of adopters. The primary reason for the high percentage of land planted to "new" technologies in the 50-60 age group was probably the presence of tractor owners who used a tractor mounted planter to combine the ploughing and planting operations, rather than perform two separate tillage operations. They used this technology on a large proportion (69 percent) of their land.

The percentage of land planted to "new" technologies increased with cattle ownership. Non-cattle owning adopters planted only 6 percent of their land using "new" technologies, with the percentage of land increasing to 48 percent for those owning over 40 cattle. Again the most probable reason for this high percentage of land planted to "new" technologies in the latter category was the presence of tractor owners in the group.

Draught controlling adopters planted slightly more total land to "new" technologies than did non-draught controlling adopters. However, those who did not control draught planted a slightly higher percentage of their land to "new" technologies.

Those adopters using fertilizer planted the largest average areas using a "new" technology, and also planted the highest percentage of their total area to the "new" technology. Adopters who planted the largest average total area were those combining double ploughing and row planting. Again, this was probably the result of including a few tractor owners using a combined plough/planting operation in this group. Farmers using row planting or double ploughing, alone or in combination, used the "new" technology on approximately one-third of the total land they planted.

As noted above, tractor owners who used a new technology on large areas seemed to have had a major impact on the categories in which they were included. Table 7 demonstrates this impact in a two-way ANOVA pairing draught source and draught control. When the tractor owners category was removed from the data, the same analysis indicated no significant difference.

Because the mean area planted by tractor owners to a "new" technology was so much greater than other means, it overpowered the rest of the data. In order to examine the data for other interactions, the tractor owners were removed and an analysis was undertaken using two-way ANOVA including each pair of household characteristics as factors, with data transformed using the square root of the area planted to a "new" technology. Whichever pair of household characteristics were analyzed, village was consistently significant, with no interactions. It appears that farmers in Matobo planted significantly less land to "new" technologies. Additionally, there was a significant difference ($P<.05$) between draught control categories when considering number of cattle owned. Again there was no significant interaction. This finding would be expected as cattle owners with more than a few head can generally gather enough animals to make a span for ploughing. Table 8 provides the means of the square root of area planted when tractor owners were excluded from the data set. This analysis generally substantiates previous analyses and so does not provide any evidence to alter earlier conclusions.

ADOPTION BY NON-GROUP FARMERS

One set of questions was designed to determine if FTOTG members knew of non-group farmers who were using "new" technologies, and to identify such farmers for a possible future study. Forty of those interviewed knew of such farmers. A total of 18 non-group

TABLE 7: TABLE OF MEAN AREAS PLANTED TO "NEW" TECHNOLOGIES, BY DRAUGHT SOURCE AND DRAUGHT CONTROL

FACTOR	NUMBER OF FARMERS	MEAN OF AREA PLANTED TO NEW TECHNOLOGY
MAIN EFFECTS		
DRAUGHT SOURCE		
DONKEY	1	2.00
CATTLE	30	1.60
TRACTOR	9	9.76
CONTROL DRAUGHT		
CONTROL DRAUGHT[a]	27	3.61
DRAUGHT DEPENDENT[b]	9	2.88

TWO-WAY INTERACTION MAIN EFFECTS SIGNIFICANT $P < 0.01$

TWO-WAY INTERACTIONS

	DRAUGHT SOURCE[c]		
	DONKEY	CATTLE	TRACTOR
CONTROL DRAUGHT	0 (0)	1.55 (27)	17.55 (4)
DRAUGHT DEPENDANT	2.00 (1)	2.02 (3)	3.57 (5)

TWO-WAY INTERACTION SIGNIFICANT $P < 0.01$

a. Own draught.
b. Hire, cooperative arrangement, or family supplied draught.
c. Numbers in parenthesis are number of farmers adopting any "new" technology.

adopters were reported, 11 in Mathangwane and 7 in Marapong. No non-group adopters were reported in Matobo (Table 9).

Based on the observations of the 40 group members reporting adoption by non-group members, double ploughing with row planting was the primary technology used by non-group adopters, with double ploughing alone being the second most used technology. Double ploughing, alone or in combination, was used by 90 percent of the non-group adopters.

INDEX OF ACCEPTABILITY

According to Hildebrand and Poey (p. 122)[4] the Index of Acceptability can be calculated as follows:

$$I_a = (C \times A) \div 100$$

where: I_a = Index of Acceptability

C = The percentage of the farmers interviewed who used the "new" technology on at least part of their land

A = From among those farmers who used the "new" technology, the percentage of the area they planted using the "new" technology compared to the total area they planted.

[4]. See footnote 1 for full reference.

TABLE 8: TABLE OF MEANS FOR SQUARE ROOT OF AREA PLANTED TO "NEW" TECHNOLOGIES

FACTOR	NUMBER[a]	MEAN SQUARE ROOT FOR AREA PLANTED TO NEW TECH
VILLAGE[b]		
MATOBO	13	0.49
MATHANGWANE	9	1.66
MARAPONG	14	1.32
SEX OF HEAD OF HOUSEHOLD		
MALE	17	0.96
FEMALE	14	1.09
DEFACTO FEMALE	5	1.67
AGE OF HEAD OF HOUSEHOLD		
UNDER 50	13	1.33
50 TO 60	11	1.12
OVER 60	12	0.86
CATTLE OWNERSHIP CATEGORY[c]		
NO CATTLE	1	1.00
1-15 HEAD	17	0.87
16-40 HEAD	12	1.19
41 OR MORE	6	1.62
DRAUGHT SOURCE		
DONKEY	1	1.41
CATTLE	30	1.00
TRACTOR	5	1.73
CONTROL DRAUGHT		
CONTROL DRAUGHT[d]	27	0.98
DROUGHT DEPENDENT[e]	9	1.50

a. Does not include tractor owners.
b. Based on two-way ANOVA, the means for Village were significantly different ($P<.01$) when paired with other household characteristics.
c. Based on two-way ANOVA, the means for Draught Control were significantly differe... ($P<.05$) when paired with Number of Cattle. There was no significant interaction.
d. Own draught.
e. Hire, cooperative arrangement, or family supplied draught.

TABLE 9: GROUP MEMBERS WHO KNEW NON-GROUP MEMBERS ADOPTING A "NEW" TECHNOLOGY

	TOTAL NUMBER	TOTAL PERCENT	MATOBO NUMBER	MATHAN NUMBER	MARAPONG NUMBER
KNEW NON-GROUP MEMBERS WHO HAVE ADOPTED A "NEW" TECHNOLOGY	40	25	0	27	13
NUMBER OF NON-GROUP ADOPTERS	18		0	11	7
"NEW" TECHNOLOGY ADOPTED					
DOUBLE PLOUGHING	6	15	0	4	2
ROW PLANTING	3	8	0	2	1
DOUBLE PLOUGHING & FERTILIZER	1	2	0	0	1
DOUBLE PLOUGHING & ROW PLANTING	29	73	0	20	9
ROW PLANTING & MANURING	1	2	0	1	0

This Index of Acceptability gives an index with a range from 0 to 100. The information provided by the index is a useful way of integrating information on the percentage of farmers using a "new" technology and the proportion of the total area they planted using the

"new" technologies, into an overall measure of acceptability by groups with different household characteristics. Table 10 contains the Indexes of Acceptability by household characteristics.

TABLE 10: INDEXES OF ACCEPTABILITY BY HOUSEHOLD CHARACTERISTICS

FACTOR	ADOPTERS NO.	ADOPTERS % OF TOT[a]	NEW TECH AREA % OF ADOPT TOT[b]	INDEX OF ACCEPTABILITY
TOTAL NUMBERS	41	26	35	9.2
VILLAGE				
MATOBO	13	22	5	·1.1
MATHANGWANE	11	17	44	4.8
MARAPONG	17	47	41	19.3
SEX HEAD OF HOUSE				
MALE	21	28	45	12.6
FEMALE	15	26	20	5.2
DEFACTO FEMALE	5	20	33	6.6
AGE HEAD OF HOUSE				
UNDER 50	13	23	33	7.6
50 TO 60	15	29	46	13.3
OVER 60	13	30	20	6.0
CATTLE CATEGORY				
NO CATTLE	2	12	6	0.7
1-15 CATTLE	17	22	18	4.0
16-40 CATTLE	14	34	40	13.6
41 OR MORE	8	40	48	19.2
DRAUGHT SOURCE				
DONKEY	1	11	57	6.3
CATTLE	30	26	19	4.9
TRACTOR	9	31	69	21.4
CONTROL DRAUGHT				
CONTROL DRAUGHT	31	31	35	10.9
DROUGHT DEPENDENT	9	16	40	6.4
"NEW" TECHNOLOGIES[c]				
DOUBLE PLOUGH	16	39	21	8.2
FERTILIZER	5	12	63	7.6
ROW PLANT	3	7	1	0.1
DP & RP	14	34	39	13.3
ANY DP	32	78	33	25.7
ANY RP	17	41	34	13.9

a. Adopters as percent of category, i.e., adopters in Matobo as a percent of Matobo farmers. For "new" technologies, adopters are a percent of all adopters, i.e., double ploughing adopters as a percent of all adopters.

b. Area planted by adopters to "new" technologies as a percentage of total area planted by adopters.

c. With the exception of the ANY DP category, this analysis omits one DP & Fert, one DP & Manure, and one Rotation.

Generally the Indexes of Acceptability were low, ranging from 0.1 to 26. This may be because the FTOTG's were involved in testing numerous technologies to obtain farmer evaluations for a research programme, rather than doing widespread testing of a single technology with the expectation of offering the technology immediately for extension. Perhaps more important in contributing to a low adoption rate was that many of the technologies required substantial resources or support systems for adoption. ATIP has not had a mandate for providing these resources or support for other than small-scale testing. Hence, there was a lack of adoption of technologies, especially new varieties and equipment, which were not readily available. The results also indicated a definite bias towards adoption

by farmers with more resources who were better able to support the "new" technologies. While the absolute level of the index number is low, the relative differences between numbers does give an indication of what types of household characteristics one can look for in adopters.

The Index of Acceptability was highest in Marapong, with both components of the index being higher than in the other villages. Thus Marapong farmers were more likely to be adopters, a conclusion that supports the original selection of Marapong, in 1983, as a "progressive" village[5]. This was supported by statistical analysis of the proportion of adopters and means of the area planted by adopters.

Male-headed households were more likely to adopt than female-headed, and those in the 50 to 60 age group were more likely to adopt. Tractor users, those owning their own draught, and owners of more than 40 cattle were also most likely to adopt. Some form of double ploughing technology was the most likely to be adopted followed by some form of row planting technology.

CONCLUSIONS

There are a number of conclusions that can be drawn from the responses to this survey.

(a). Spontaneous adoption is taking place. Given that ATIP is involved in no extension effort to promote adoption, the extent of the spontaneous adoption appears to be substantial.

(b). The most adopted technology, double ploughing alone or in combination, is a water management technology which appears to meet a felt need of farmers. This finding supports the appropriateness of the current emphasis on water management-water harvesting within the Department of Agricultural Research.

(c). The average area planted to the "new" technology was substantial in two of the villages, but minimal in the third, the most traditional of the villages.

(d). Adopters planted larger areas than non-adopters and owned more cattle. This indicates that the technologies adopted may be biased towards adopters with more resources.

(e). In two villages the same "new" technologies were being used outside of the farmer groups. In some cases, particularly with row planting, these may not represent a "new" technology as the non-group farmers involved may have practiced the technology for a number of years.

(f). A profile of a household with the most potential to adopt "new" technologies can be constructed using the Index of Acceptability as an indicator. The household with most potential to adopt would be a male-headed household from a "progressive" village. The head of household would be between 50 and 60 years old, would own

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[5]. "Marapong represents a socially cohesive village which initiates communal activities and seems to be more willing than most to adopt new ideas and technologies which improve the welfare of individuals and the village as a group". (W. Miller, ATIP Selection of Villages and Participating Households in Tutume Agricultural District, ***ATIP PR F83-1***, 1983, p. 4)

41 or more cattle, and use tractor draught which he/she controls (owns). Probably few adopters meet all of these characteristics, but many may well have three or four of the them.

(g). This study did not address the question of potential spontaneous adoption which was unrealized due to resource constraints. Popular technologies during the testing stage included new varieties of cowpeas and groundnuts. Due to a lack of seed, farmers could not adopt these technologies on their own. Some types of equipment were also in short supply, limiting the amount of adoption possible with those types of equipment.

Finally, it may be concluded that, given exposure to "new" technologies which they can test for themselves, a substantial number of farmers in the ATIP research area will adopt one or more of these technologies.

APPENDIX A: SURVEY INSTRUMENT

ATIP FRANCISTOWN
1989 ADOPTION SURVEY FOR FARMER GROUP MEMBERS

SHEET 1

FARMER NAME: _____

FARMER GROUP NUMBER: _____ DVDU ____

VILLAGE: _____ ENUMERATOR: _____ VILL ____

NOTE: DO NOT INCLUDE AS A NEW TECHNOLOGY ATIP TRIALS BEING DONE WITH THE FARMER GROUP OR DIRECTLY WITH ATIP THIS SEASON (1988-89). WE DO WANT TO IDENTIFY ATIP TECHNOLOGIES NOW BEING USED BY THE FARMER OUTSIDE OF ATIP TESTS.

A NEW TECHNOLOGY IS ONE THAT THE FARMER HAS STARTED TO USE DURING THE LAST FOUR YEARS (SINCE THE 1984-85 SEASON).

1. DID YOU USE A NEW TECHNOLOGY THIS SEASON (1988-89)?
   (IF NO, ASK QUESTION 9 THEN TERMINATE INTERVIEW) NWTECH____

   YES ___ NO ___

2. DID YOU USE MORE THAN ONE NEW TECHNOLOGY (SEPARATE PLOTS)?

   YES___ NO ___ HOW MANY PLOTS? _____ NOTECH____

PLEASE COMPLETE ONE COPY OF SHEET 2 FOR EACH PLOT:

9. APPROXIMATELY WHAT WAS THE TOTAL AREA YOU PLANTED THIS SEASON? _____ HECTARES TOTAREA____

10. DO YOU KNOW OF ANYONE IN THE VILLAGE WHO HAS NOT PARTICIPATED IN THE ATIP FARMER GROUPS, BUT WHO HAS USED ONE OF THE TECHNOLOGIES TESTED BY ATIP EITHER LAST SEASON OR THIS SEASON?

    YES ____ NO ____ OTHERS____

    WHO? _____

    WHICH TECHNOLOGY? _____

    WHICHTEC____

NOTE: IF FARMERS DO NOT WISH TO IDENTIFY OTHER FARMERS, DO NOT TRY TO GET THE INFORMATION. YOU CAN EXPLAIN THAT WE ARE INTERESTED IN INFORMATION ON ADOPTION OF TECHNOLOGY AND ARE NOT TRYING TO INDIRECTLY INVESTIGATE ANY OTHER FARMERS. WE MAY WISH TO INTERVIEW OTHER FARMERS LATER.

11. HOW MANY ATIP PLOTS DID FARMER PLANT THIS YEAR? _____ ATIPTR____

A SIDE-BY-SIDE ATIP TRIAL HAS TWO PLOTS, A NEW TECHNOLOGY PLOT AND A CHECK PLOT. A VARIETY TRIAL (OR SEED TREATMENT TRIAL) MAY HAVE 2, 3 OR 4 PLOTS. IF SOME PLOTS ARE NOT THE USUAL 10 BY 50M PLOTS, PLEASE NOTE THE SIZE.

ATIP FRANCISTOWN
1989 ADOPTION SURVEY FOR FARMER GROUP MEMBERS

SHEET 2

FARMER NAME: _____ FARMER GROUP NUMBER: _____ DVDU ____

PLOT NUMBER: _____

---

3. PLEASE DESCRIBE THE TECHNOLOGY (i.e., double ploughing, double ploughing with row planter, new cowpea variety with fertilizer, etc.) PROVIDE AS MUCH INFORMATION AS POSSIBLE:

_____

_____

_____

_____

WHAT CROP WAS PLANTED WHERE THIS NEW TECHNOLOGY WAS USED? _____

4. IN TOTAL, ON HOW LARGE AN AREA DID YOU USE THE TECHNOLOGY? AREA____

(1) THE SIZE OF AN ATIP TRIAL PLOT (10 X 50M) _____
(2) THE SIZE OF ____ ATIP PLOTS (10 X 50M EACH)____
(3) LESS THAN 1/4 HECTARE (UP TO 25 X 100M) _____
(4) 1/4 TO 1/2 HECTARE (25 X 100 TO 50 X 100M) _____
(5) 1/2 TO 3/4 HECTARE (50 X 100 TO 75 X 100M) _____
(6) 3/4 TO 1 HECTARE (75 X 100 TO 100 X 100M) _____
(7) MORE THAN 1 HECTARE (HOW MANY HECTARES) _____
(8) MEASUREMENT: WIDTH ____ LENGTH ___ AREA _____

5. WHAT DID YOU LIKE ABOUT THE TECHNOLOGY? LIKE____

_____

_____

6. WHAT DID YOU NOT LIKE ABOUT THE TECHNOLOGY? DISLIKE____

_____

_____

7. DO YOU PLAN TO USE THIS TECHNOLOGY AGAIN NEXT YEAR?

YES ____ NO _____ USEAGAIN____

8. WHERE DID YOU FIRST LEARN ABOUT THIS TECHNOLOGY? SOURCE____

(1) ATIP _____
(2) EXTENSION (AD) _____
(3) OTHER FAMILY MEMBER _____
(4) NEIGHBOUR _____
(5) OTHER (HOW? _____)

APPENDIX B: TABULATION OF RESPONSES

ATIP FRANCISTOWN
1989 ADOPTION SURVEY FOR FARMER GROUP MEMBERS

SHEET 1

VILLAGE: Matobo - 58, Mathangwane - 64, Marapong - 36

NOTE: DO NOT INCLUDE AS A NEW TECHNOLOGY ATIP TRIALS BEING DONE WITH THE FARMER GROUP OR DIRECTLY WITH ATIP THIS SEASON (1988-89). WE DO WANT TO IDENTIFY ATIP TECHNOLOGIES NOW BEING USED BY THE FARMER OUTSIDE OF ATIP TESTS.

A NEW TECHNOLOGY IS ONE THAT THE FARMER HAS STARTED TO USE DURING THE LAST FOUR YEARS (SINCE THE 1984-85 SEASON).

1. DID YOU USE A NEW TECHNOLOGY THIS SEASON (1988-89)?
   (IF NO ASK QUESTION 9 THEN TERMINATE INTERVIEW) NWTECH____

   YES 41 NO 117

2. DID YOU USE MORE THAN ONE NEW TECHNOLOGY (SEPARATE PLOTS)?

   YES___ NO ____ HOW MANY PLOTS? 1 plot - 37, 2 plots - 4 NOTECH____

9. APPROXIMATELY WHAT WAS THE TOTAL AREA YOU PLANTED THIS SEASON? 6.25 avg. HECTARES TOTAREA____

10. DO YOU KNOW OF ANYONE IN THE VILLAGE WHO HAS NOT PARTICIPATED IN THE ATIP FARMER GROUPS, BUT WHO HAS USED ONE OF THE TECHNOLOGIES TESTED BY ATIP EITHER LAST SEASON OR THIS SEASON?

    YES 40 NO 118 OTHERS____

    WHO? Matobo - 0, Mathangwane - 11, Marapong - 7

    WHICH TECHNOLOGY? DP - 6, RP - 3, DP & Fert - 1, DP & RP - 29, RP & Manure - 1 WHICHTEC____

11. HOW MANY ATIP PLOTS DID FARMER PLANT THIS YEAR? 0.28 HA avg. ATIPTR____

A SIDE-BY-SIDE ATIP TRIAL HAS TWO PLOTS, A NEW TECHNOLOGY PLOT AND A CHECK PLOT. A VARIETY TRIAL (OR SEED TREATMENT TRIAL) MAY HAVE 2, 3 OR 4 PLOTS. IF SOME PLOTS ARE NOT THE USUAL 10 BY 50M PLOTS, PLEASE NOTE THE SIZE.

ATIP FRANCISTOWN
1989 ADOPTION SURVEY FOR FARMER GROUP MEMBERS

SHEET 2

FARMER NAME: _____ FARMER GROUP NUMBER: _____ DVDU ____

PLOT NUMBER: _____

---

3. PLEASE DESCRIBE THE TECHNOLOGY (i.e., double ploughing, double ploughing with row planter, new cowpea variety with fertilizer, etc.) PROVIDE AS MUCH INFORMATION AS POSSIBLE:

Double plough only - 16, Fertilizer only - 5, Row plant only - 3 Rotation only 1, Double plough & row plant - 14, Double plough & Fertilizer - 1, Double plough & Manuring - 1

WHAT CROP WAS PLANTED WHERE THIS NEW TECHNOLOGY WAS USED? _____

Alone or in combination = Sorghum - 16, Maize - 16, Millet - 12, Cowpeas - 6, Groundnuts - 2, Jugo Beans - 1

4. IN TOTAL, ON HOW LARGE AN AREA DID YOU USE THE TECHNOLOGY? AREA____

0.87 hectares average for all respondents
3.36 hectares average for adopters

5. WHAT DID YOU LIKE ABOUT THE TECHNOLOGY? LIKE____

Alone or in combination = Increased yield - 22, Better germination - 13, Less weeds, easier cultivation - 16, Conserves moisture - 11, Grew better - 5, Use less seed - 2

6. WHAT DID YOU NOT LIKE ABOUT THE TECHNOLOGY? DISLIKE____

Aphids on cowpeas - 2, Crops crowded - 1, Fertilizer does not work in dry years - 1, Fertilizer encourages weeds - 1, Labour constraint - 1, Too little draught power - 1

7. DO YOU PLAN TO USE THIS TECHNOLOGY AGAIN NEXT YEAR?

YES 41 NO 0 USEAGAIN____

8. WHERE DID YOU FIRST LEARN ABOUT THIS TECHNOLOGY? SOURCE____

Alone or in combination:

(1)	ATIP	25
(2)	EXTENSION (AD)	18
(3)	OTHER FAMILY MEMBER	3
(4)	NEIGHBOUR	1
(5)	OTHER (HOW?	1)