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SWAZILAND CROPPING SYSTEMS RESEARCH AND EXTENSION TRAINING PROJECT IMPACT ASSESSMENT STUDY

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INTRODUCTION

This report summarizes the results of a series of studies that were designed to assess the rate of technology adoption by Swazi Nation Land farmers. These data provide indirect evidence of the impact of the Swaziland Cropping Systems Research and Extension Training Project on the uses of recommended practices. Since some of these data have been obtained within the last four months, this report will hopefully also be useful to officials in the Swaziland Ministry of Agriculture and Cooperatives and the Malkerns Research Station for information and planning.

The report is divided into four major sections. The first section describes the research procedures including the samples utilized, the research design, and the design of the analytic approach. The second section summarizes the findings including 1) the rates of adoption of a series of recommended practices, 2) the percent of farmers who use the recommended rates of application of these practices, 3) the level of homestead self-sufficiency, 4) the extent of contacts by farmers with the extension and the research system, 5) the relationship between extension and research contacts and adoption rates, 6) levels of ownership of agricultural equipment, 7) an analysis of gender differences relating to the adoption of practices, and 8) the relationship of off-farm income to adoption of technology. The conclusions are reported in the third section and the last section of the report includes an appendix.

RESEARCH PROCEDURES

Since 1985, several surveys have been conducted by the Socioeconomic Section of the Swaziland Agricultural Research Division. The data presented in this report are drawn from these surveys. In this section, each survey

will be described, the research design utilized will be explained, and the limitations of the study will be discussed.

The Surveys

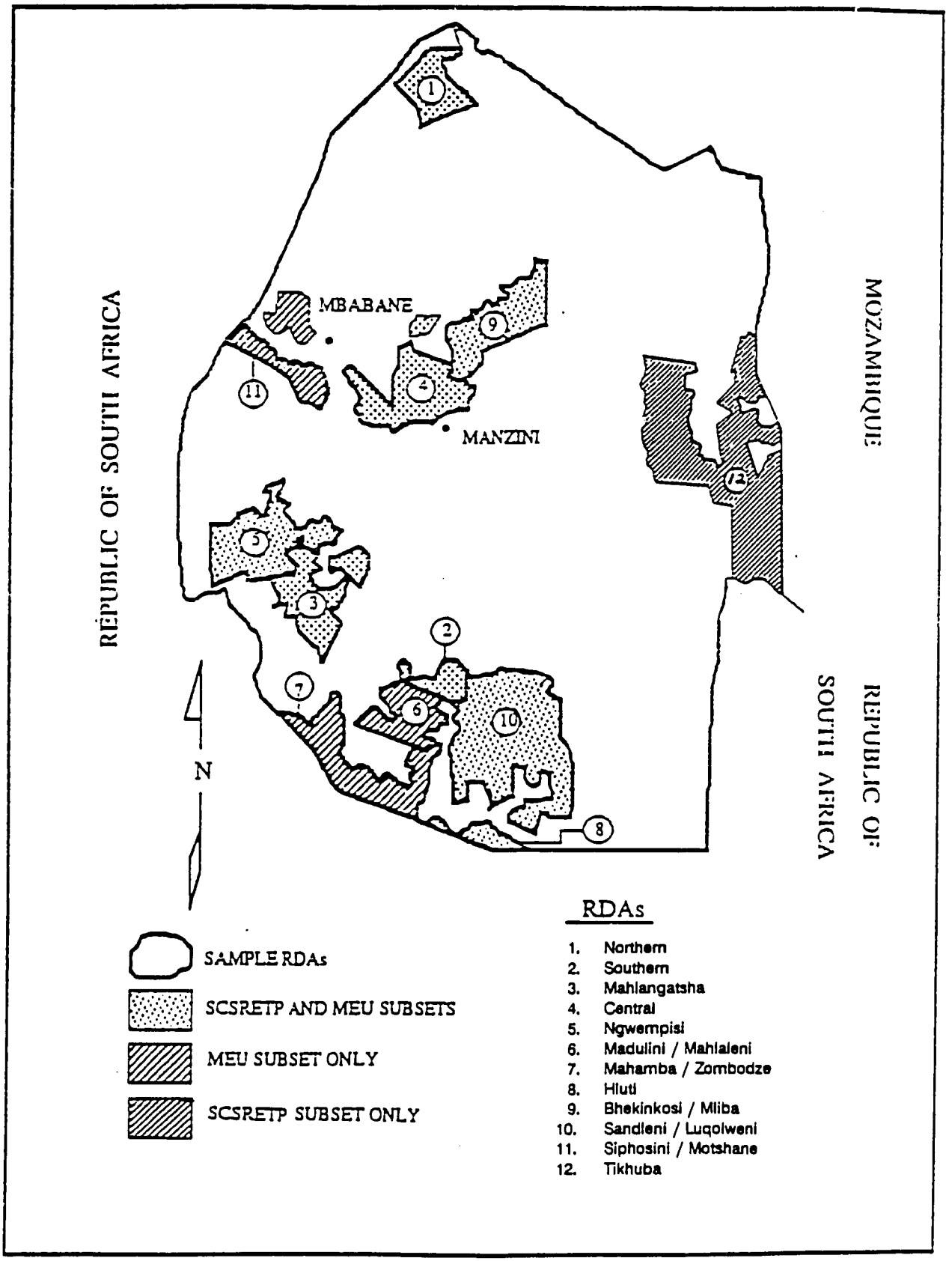
The first survey, which will be referred to as the "Curry Survey," was conducted during the 1985-86 cropping season by Dr. John Curry. The original sample consisted of 120 homesteads, but this study utilized the 102 homesteads which were located in the Highveld and Middleveld regions of Swaziland where most of the maize is grown. These 102 homesteads are located in 18 sub-areas of nine Rural Development Areas (RDAs). Location of the RDAs from which the sample was drawn are displayed on Map 1. Characteristics of the RDAs have been described elsewhere (Curry, 1988; Stokes, et al., 1988).

The sample was drawn using a random cluster without replacement technique. The initial list of farmers was developed from extension workers' farmer lists. The first 12 homesteads were chosen in random order, six from each of two areas within the RDA. Interviews in the sample RDAs began during the first week of November, 1985. The interviews continued weekly until all the fields of the homestead had been harvested. All interviews were completed by June of 1986. Additional details concerning how the Curry Survey was conducted can be found in Curry (1988) and Stokes, et al. (1988).

The second survey, labeled the "Dlamini Survey," was conducted in 1988. The Dlamini Survey was conducted with 200 Swazi Nation Land homesteads growing maize in the Middle and Highveld areas of Swaziland. A subsample of 90 homesteads which were part of the 1985 Curry Survey were reinterviewed. A second subsample of 110 homesteads was selected from a set of farmers who were part of the Monitoring and Evaluation Unit's (MEU) farm management survey.

MAP 1

Location of Sample RDAs in Swaziland



These included homesteads in 11 RDAs, eight of which were homesteads located in the same RDAs as the Curry Survey homesteads and three in other Middle and Highveld RDAs (see Map 1).

The 110 MEU sample was also drawn by using a random cluster without replacement technique from aerial photo maps. Enumeration areas to be surveyed were selected, the cluster of homesteads covering a certain radius were formed, and the required number of clusters was selected. The farmers were interviewed from April 1 to June 15, 1988. Yield and plant population estimates were done during March and April, 1988, and fields were measured during June, July and August of 1988. Further details on the Dlamini Survey can be found in Dlamini (1990).

The third survey was also conducted in 1988. This survey is called the "Malaza Survey" and was conducted in both the RDAs and the nonRDAs. The 1986 census enumeration area map was used to define the sampling frame. A proportionate sample of 203 homesteads was randomly drawn from the sampling frame of all homesteads from each ecological zone. Given the density of homesteads, most of the 203 homesteads selected were from the Middleveld and Highveld.

The "Dlamini-Warland Survey" was conducted from February 4, 1991 to April 5, 1991. Ninety-eight homesteads which were part of the Curry Survey were reinterviewed and 102 of the Dlamini Survey MEU subsample of homesteads were reinterviewed. Questions asked on the earlier surveys were repeated. Because of the short time available to collect and analyze the data (4 months), no information on yields, plant populations or field sizes was obtained.

The Research Design

These four surveys were linked to create the research design. The three samples (Curry, Dlamini, and Malaza) formed the basis for the research design as displayed in Table 1. Most of the farmers who were part of Curry's 1985 Survey were interviewed three times (1985, 1988, 1991). This panel design makes it possible to chart changes in the adoption of recommended agricultural practices over a six year period. In 1985, 102 farmers were interviewed. The 1988 Dlamini Survey did not include the 12 farmers in the Tikhuba RDA which is located in the Lubombo Plateau, so only 90 of the farmers from Curry's 1985 sample were interviewed. In the Dlamini-Warland 1991 Survey, an attempt was made to contact all 102 farmers interviewed in 1985. We were able to locate 98 of these farmers.

Table 1. Design at the Technology Adoption Study

	Year of Survey		
	1985	1988	1991
Curry Sample	102[a]	90	98
Dlamini Sample		110	102
Malaza Sample		203	

[a]Number of farmers interviewed

The Dlamini sample of farmers was interviewed at two different points time (1988, 1991). Of the original 110 farmers interviewed in 1988, we were able to locate 102 of these farmers in 1991. The Malaza sample farmers were interviewed only once (1988).

As will be discussed in more detail below, conventional quasi-experimental designs to assess the impact of the Swaziland Cropping Systems

Research and Extension Training Project are not possible. The research design displayed in Table 1, while not a quasi-experimental design, provides valuable information about adoption of technology and provides some indirect evidence about the correlation of certain Swaziland Cropping Systems Project activities and SNL farmer adoption patterns. Not only can the adoption behavior of these farmers be charted over time, but the three samples make possible a series of comparisons among the groups.

The three samples appear to have been associated with the Swaziland Cropping Systems Research and Extension Training Project (SCSRETP) in different ways. The SNL farmers in Curry's sample became involved in on-farm trials which were developed by the SCSRETP, and were also involved in studies such as the Labor and Input Survey which were conducted during the lifetime of the project. The SNL farmers in the Dlamini sample lived in the RDAs which were often a focal point for SCSRETP activities, but were not as involved with the on-farm trials as were Curry's farmers. The SNL farmers in Malaza's sample were drawn from a national sample of farmers (both in RDAs and in nonRDAs). This sample is a different group of SNL farmers because they were not involved with on-farm trials or the MEU surveys. While it is impossible to conclude that any given farmer was influenced by the project, the probability of the Curry SNL farmers being influenced by the project was higher than for the SNL farmers in either Dlamini or Malaza samples.

Limitations of the Research Design

In a conventional impact or evaluation study, a quasi-experimental design is utilized to connect the treatment with the intended outcomes (Campbell and Stanley, 1963; Cook and Campbell, 1979). A quasi-experimental design is not

possible for this impact study. There is no baseline study to establish the basis for change, although some estimates can be made of farmer adoption rates in 1980. There is no control group, although the creation of a control group would have been impractical since no program would ever want certain farmers to be systematically excluded from having access to the information it develops and disseminates. The "treatment" from the SCSRETP has been diffuse and difficult to precisely identify or differentiate from other agencies and donors active in the country. In some cases, such as on-farm trials, the treatment can be more easily identified but not isolated from other activities.

Therefore, the research design utilized is open to both internal and external threats to validity (Cook and Campbell, 1979). The threats that are most likely to be present include selection, maturation, testing, the interaction of testing and treatment, and the interaction of selection and treatment. Thus, if we observe a change in adoption rates, is it due to the program or due to the fact that those who were involved in the program were more progressive and would have improved even without the program? Is a change due to the program or to the fact that reinterviewing farmers makes them more aware of these practices and they, in turn, become motivated to adopt before the next interview? The point is that, without an experimental or accepted quasi-experimental design, there is no way to directly connect program activities with adoption outcomes.

However, even a short time series design such as the one displayed in Table 1 has some advantages (Campbell and Stanley, 1966). If we find abrupt changes in the trend of the adoption of a practice over time and there is evidence that the program was emphasizing this practice, at least we have a

correlation between the program activity and the change. All of the threats to validity still apply, but we can cautiously interpret this correlation. A second advantage is that if the changes in the adoption of several practices all move in the same direction over time, we can draw some conclusions from the pattern of change. Finally, if we have some evidence that one group of SNL farmers were more involved with the project than the other group of SNL farmers, comparisons between these groups may also allow one to draw some conclusions.

FINDINGS

The linkage of these surveys makes possible comparisons of the same farmers over time as well as comparisons of farmers from different samples. The findings presented in this section of the report are based on both these comparisons. The statistical tests are either X^2 tests, Z tests for difference of proportions, or Z tests for difference between two proportions when using the same respondents at two different points in time. Because of the large number of possible statistical tests, only the key statistical tests will be discussed in the report.

In addition to the statistical tests, we will also look for overall patterns of change. If the direction of change is the same over a number of indicators, this overall pattern of change will also provide evidence of a trend. In either case, such changes will be viewed cautiously given the limitations discussed earlier and the warnings given by many researchers about "gain scores" (Alwin and Sullivan, 1975), i.e., basing a conclusion only on the simple change in an indicator from one time to another.

Adoption of Recommended Practices

The surveys conducted between 1985 and 1991 asked the farmers about a series of recommended farming practices. These included 1) planting hybrid maize, 2) use of basal fertilizer, 3) use of nitrogen topdress fertilizer, 4) use of pesticides, and 5) tractor plowing. There were also recommendations concerning seeding rates for hybrid maize, application rates for basal fertilizer, plant populations, and rates for tractor plowing. The findings in this section will consider if the farmers were using the practice or not, and the next section will report the findings on recommended rates of these practices. For more details concerning these recommended practices, see Dlamini (1990).

Table 2 reports the proportion of the Curry sample farmers using these various farming practices over the three time periods. We did not include herbicide use or the use of the modified ox-planter shoe because only a few percent of these farmers had used these practices.

The first three columns of Table 2 summarize the proportion of SNL farmers in the Curry sample who were using each of the recommended practices during the year each of the surveys was conducted. With the exception of hybrid maize seed which was used by a very high proportion of farmers from 1985-1991, the proportion of farmers using these practices increased significantly from 1985 to 1991. The increase in both basal fertilizer and pesticide use occurred from 1985 to 1988, the use of tractor plowing increased steadily over the six year period, while the proportion of farmers using

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[1]There were also recommendations for early planting, but because the planting dates in both 1985 and 1991 were influenced by weather conditions, we decided not to include planting dates in the analysis.

Table 2. Percentage of SNL Farmers in Curry's Sample Who Were using the Recommended Practices (N=85)

	1985 Survey	1988 Survey	1991 Survey	Discontinuity	Experience with Practice
Hybrid Maize Seed[a]	95	93	93	6	99
Basal Fertilizer	83	94	94[b]	4	98
Topdress Fertilizer	32	26	73[c]	17	90
Pesticides	36	62	72[c]	18	90
Tractor Plowing	61	71	87[c]	8	95

[a]All statistical tests compare 1991 proportions to 1985 proportions
[b]$p < .05$
[c]$p < .01$

topdress increased sharply (from 26 percent to 73 percent) from 1988 to 1991. We will comment on reasons for these changes later in the report.

The last two columns of Table 2 provide data on discontinuity of the use of the practices and experience with the practices. In the 1991 Dlamini-Warland survey, the farmers who were not currently using a particular practice were asked 1) if they had ever used the practice in the past, 2) when they last used the practice, and 3) why they stopped using the practice. For all practices, some of the farmers who were not currently using each practice had used the practice before, particularly topdress fertilizer (17 percent) and pesticides (18 percent). The most frequently cited reason for farmers discontinuing the use of hybrid seed, basal fertilizer and topdress fertilizer was lack of cash. Most farmers stopped using pesticides because they had no

pests, and the majority of farmers who stopped using tractors for plowing did so because the tractors were not available. Very few farmers had stopped using any of the practices because they were not effective or because the farmers were unable to successfully use them.

The last column in Table 2 summarizes the percentage of the SNL farmers in Curry's sample who had experience with each practice. "Experience" is defined as the proportion of farmers who had used the practice in the past. For topdress fertilizer, 73 percent of the farmers were using this practice in 1991 and 17 percent had used topdress fertilizer in the past. Thus 90 percent (73 + 17) had used topdress fertilizer at some time. Since most farmers who were not using a particular practice in 1991 had used the practice within the last two or three years, the experience with the practice is recent. Ninety percent or more of the SNL farmers in the Curry sample had experience with each of the five practices.

The data summarized in Table 3 include the SNL farmers in Curry's sample from the Tikhuba RDA who were interviewed in 1985 and 1991. The rates of adoption and the level of experience for Curry's sample with the Tikhuba farmers included are similar to those of Table 2. The adoption rates and the experience levels of these SNL farmers in 1991 are relatively high.

Table 4 presents the data for the Dlamini sample. For four of the five practices, the rate of use of recommended practices increased from 1988 to 1991. The one exception was basal fertilizer, where the usage proportion dropped from 86 percent to 80 percent. The increases in topdress fertilizer and tractor plowing are statistically significant. The change in topdress fertilizer use is very similar to the changes reported for the Curry farmers (30 percent to 70 percent for the Dlamini sample; 26 percent to 73 percent for

Table 3. Percentage of SNL Farmers in Curry's Sample (Including Tikhuba RDA) Who Were Using the Recommended Practices (N=96)

	1985 Survey	1991 Survey	Discontinuity	Experience with Practice
Hybrid Maize Seed	97	93	6	99
Basal Fertilizer	84	95[a]	3	98
Topdress Fertilizer	30	70[b]	20	90
Pesticides	33	71[b]	18	89
Tractor Plowing	60	87[b]	8	95

[a] $p < .05$
[b] $p < .01$

Table 4. Percentage of SNL Farmers in Dlamini's Sample Who Were Using the Recommended Practices (N=99)

	1988 Survey	1991 Survey	Discontinuity	Experience with Practice
Hybrid Maize Seed	84	86	11	97
Basal Fertilizer	86	80	13	93
Topdress Fertilizer	27	69[a]	14	83
Pesticides	59	65	13	78
Tractor Plowing	58	78[a]	12	90

[a] $p < .01$

the Curry sample). The number of farmers in Dlamini's sample who had experience with each practice is also relatively high ranging from 78 percent with pesticides to 97 percent with hybrid maize seed. The reasons given for farmers discontinuing the use of a practice are very similar to those given by the farmers in Curry's sample.

The final table (Table 5) in this group of tables summarizes the rates of practice usage by the farmers in the Curry sample, the Dlamini sample, and the Malaza sample. To standardize the comparisons, only the data obtained by the surveys in 1988 are presented. The overall pattern that emerges from Table 5 is that rates of usage are highest for the SNL farmers in Curry's sample, the rates of usage are lowest for the farmers in Malaza's sample, while those farmers in Dlamini's sample are between the other two groups of farmers. The exception to this pattern is the rate of usage of topdress fertilizer which is highest for Malaza's sample. The greatest differences are for soil testing (a practice that was measured only once for each sample) where those in the Curry sample are four to six times more likely to have had their soil tested.

Interpretation of the Practice Usage Findings

Reviewing Tables 2 to 4, it is apparent that the SNL farmers in both the Curry and Dlamini samples increased their use of recommended practices. There was little change in the use of hybrid maize for either sample, and the farmers in the Dlamini sample decreased their use of basal fertilizer from 1988 to 1991. Otherwise, the use of all practices increased over the time periods the studies were conducted, although not all of these changes were statistically significant.

Table 5. Comparison of Percentages of SNL Farmers in Curry, Dlamini, and Malaza Samples Who Were using Recommended Practices

Practice	1988 Curry Sample (N=85)	1988 Dlamini Sample (N=99)	1988 Malaza Sample (N=203)
Hybrid Maize Seed	93	84	79
Basal Fertlizer	94	86	66
Topdress Fertilizer	26	27	44
Pesticides	62	59	41
Tractor Plowing	71	58	44
Soil Testing	63 (1991)	19 (1991)	11

The most dramatic increase in use was for topdress fertilizer. For the Curry sample, the usage rates were relatively low in 1985 (32 percent) and 1988 (26 percent), but the rate increased to 73 percent in 1991. Similarly, the increase in usage of topdress fertilizer was 2.5 times from 1988 to 1991 for the Dlamini sample farmers. Given the abrupt change in these usage rates, we reviewed the program activities of the SCSRETP before and during the 1988 to 1991 period. We discovered that there was a significant research and extension effort during this time. Kirk Iversen, who was an extension agronomist for the project, described the activities during this time in a memo to the authors of this report. Part of that memo is reproduced below

> In general, project activities were primarily research-oriented from 1983 to 1987. Extension-type activities during that time were limited to field days at sites of on-farm trials and a few seminars for extension workers. Extension activities of the Project during that time were more oriented towards methodology than technical information. To generalize, 1983 to 1987 was the time period that results were found. 1987 and 1988 was when the

information was transferred to extension staff through Field Support Guides, training workshops, and other activities.

Nitrogen deficiency was identified early as a major limiting factor by the Malkerns Research Station (MRS) staff (mainly Seubert and Mamba). On-farm trials confirmed this and field days at the farms demonstrated this to farmers in the communities in which on-farm trials were conducted.

Surveys of extension staff in 87 and 88 identified N fertilization as a major concern of theirs. This served to make the topic a priority in T&V messages and extension training.

Training workshops on nitrogen recommendations were conducted in 1988. Maize variety recommendation leaflets produced for suppliers and farmers were released in 1988; these included recommendations for N topdressing and were distributed by extension staff and at retail shops. In 1988 N fertilizer recommendations were included in one-day seminars for retailer/ suppliers in each region.

Publications:

Nitrogen top dressing of maize
Cold drink can method of fertilization
Maize variety recommendations leaflet
(Iversen, 1991)

There is at least a correlation between the activities of the project and the abrupt increase in topdress fertilizer use. The limitations discussed above also apply, so cause-effect statements are inappropriate.

The changes in pesticide use, which primarily occurred between 1985 and 1988 cannot be linked as directly to the project, although there was an extension effort in this area between 1988 and 1991 (Diamond, 1990). The changes in tractor plowing usage are also difficult to link to the project. During this period, the Ministry of Agriculture and Cooperatives was engaged in a longstanding effort to increase the use of tractors. These data may reflect the efforts of this project.

A large number of SNL farmers in both samples reported having experience with these practices. It would appear the extension and research system in Swaziland has had good success in encouraging farmers to try these practices. We will present more data on this point later in the report.

Recommended Rates of Application for Practices

In his M.S. thesis, Dlamini (1990) reported recommended rates of application for hybrid maize seed, basal fertilizer, plant populations, and rates for tractor plowing. These rates were based on his review of publications from the Ministry of Agriculture and Cooperatives. In this section, data will be presented for the three samples regarding the use of the recommended rates of application of these four practices.

Table 6 presents the results of the analysis of the recommended application rates. The rates reported by Dlamini (1990) were 20 kg/ha or more for hybrid maize seeding, 2) 52.5 kg/ha or more for basal fertilizer, 3) 1.5 hours per ha or more for tractor plowing, and 4) 33,000 or more maize plants per ha for plant populations. We were unable to determine the hybrid seed rate in the 1985 Curry Sample because weather conditions required many farmers to plant twice (Curry, 1988). As reported above, we were unable to measure plant populations in 1991.

The data presented in Table 6 are organized differently from the previous tables. Since we were unable to measure field sizes in 1991, we were unable to determine the maize hectares for 18 percent of the homesteads that had increased their farm size. A second restriction was that Dlamini was able to use only 136 of 195 homesteads in 1988 for the analysis of application rates because of missing data problems. Preliminary analysis indicated that

Table 6. Percentage of SNL Farmers in the Curry Sample and the Dlamini Sample Who Used the Recommended Application Rates

Practice	Curry 1985 Sample (N=90)	Dlamini 1988 Sample (N=136)	Dlamini 1991 Sample (N=100)
Hybrid Maize Seed Rate	--	38	62[c]
Basal Fertlizer Rate[a]	29	43	47[b]
Tractor Plowing Rate[a]	45	44	58[b]
Plant Population Density	36	51[b]	--

[a]Tests of differences in proportions for 1991 vs. 1985
[b]$p < .05$
[c]$p < .01$

using only the homesteads that were in the Dlamini 1988 restricted sample and had not become larger by 1991 created a serious systematic bias. We decided to use a more conservative approach (i.e. where the differences over time were much smaller). We took all the farmers in Curry's sample (except those in the Tukhuba RDA), the restricted 1988 Dlamini sample, and those farmers from the restricted 1988 Dlamini sample whose fields had not increased in 1991, and treated those samples as three comparison groups.

The results regarding basal fertilizer and tractor plowing are similar to the trends reported for utilization rates. Plant populations increased from 1985 to 1988. The most interesting result, however, is the abrupt change regarding the use of the recommended rate for hybrid maize seed. Since the 1988 and 1991 samples are relatively comparable (e.g. 100 of the farmers are the same farmers), this change from 38 percent to 62 percent is noteworthy,

particularly in light of the fact that there were virtually no differences in the utilization rates for hybrid maize seed.

In the memo provided us by Kirk Iversen (1991), he pointed out that the SCSRETP was also emphasizing seed rates during this period. In his memo he states:

> Poor plant population was identified early as a major limiting factor by the Malkerns Research Station (MRS) staff (mainly Seubert and Mamba). Contributing factors were
>
> * low seed rate
> * desire by farmers for large cobs and multiple-cobbing
> * seed burn by starter fertilizer in ox-drawn planters
> * poor planter adjustment (tractor and ox-drawn)
> * poor tillage
>
> Surveys of extension staff in 87 and 88 identified plant population as a major concern of theirs. This served to make the topic a priority in T&V messages and extension training.
>
> Training workshops on seed rate recommendations were conducted in 1988. The 1988 maize variety recommendation leaflets that were distributed by extension staff and at retail shops also included recommendations for seed rate. In 1988 seed rate recommendations were also included in one-day seminars for retailers/suppliers in each region.
>
> Publications:
>
> How to choose your maize varieties
> Maize variety recommendations leaflet
> Maize seed sizes and selecting SAFIM planter plates
> The ox-drawn planter
>
> *(Iversen, 1991)*

Again we have a correlation between a project activity and an abrupt change in the use of a recommended practice.

Baseline Estimates of Use of Recommended Practices

As pointed out earlier, no baseline study was available to chart the changes over the lifetime of the project. In the 1991 Dlamini-Warland Survey,

all farmers who were currently using a practice were asked what year they first tried the recommended practice. The information given by the farmers indicates the proportion of current adopters who had tried the practice before the project began. Recognizing the possibility of errors in recall, these data provide a rough estimate of a baseline for the Curry and Dlamini samples.

These data are summarized in Table 7. For both samples, the percentage of SNL farmers who tried each practice by 1980 and after 1980 are displayed. For four of the five practices, over one-half of the Curry SNL farmers had tried the practice by 1980. Keep in mind that trying a practice does not indicate that the farmer used the practice continuously from that date on. For the farmers in the Dlamini sample, over one-half tried four of the five practices after 1980. The data suggest that large numbers of both samples first tried each practice after 1980, but the farmers in the Curry sample had more experience with the practices by 1980 than did the SNL farmers in Dlamini's sample.

Table 7. Estimated Percentage of SNL Farmers Currently Using Practices Who Had Tried the Recommended Practices By 1980 and After 1980

Practice	Curry Sample (N=85)		Dlamini Sample (N=99)	
	By 1980	After 1980	By 1980	After 1980
Hybrid Maize Seed	45	55	35	65
Basal Fertilizer	64	36	51	49
Topdress Fertilizer	52	48	37	63
Pesticides	61	39	40	60
Tractor Plowing	58	42	46	52

Outcome Measures

One of the major goals of the Swaziland Ministry of Agriculture and Cooperatives and the SCSRETP is to help farmers grow enough maize to feed the members of their homestead. Another goal is to have the country's agriculture develop to the point where the SNL farmers can raise enough maize to sell. We now turn to the data related to self-sufficiency and selling maize.

Table 8 presents the data related to these two goals for the three samples. The farmers were asked, "In most years, do you produce enough maize to feed your household?" and "Did you sell any of your maize last cropping season?" The data in Table 8 indicate that there have been modest gains in self-sufficiency and the number of farmers who sell maize. From 1985 to 1991, the percentage of the SNL farmers in the Curry sample who reported they were self-sufficient increased from 75 percent to 94 percent.[2] The gains for selling maize was 7 percent from 1988 to 1991. Gains for the Dlamini sample were 4 percent for self-sufficiency and only 2 percent for selling maize. Only the increase in self-sufficiency from 1985 to 1991 for the Curry Sample is statistically significant.

The differences between the three samples deserve comment. For example, in 1988 the self-sufficiency rates were 86 percent for the Curry sample, 67 percent for the Dlamini sample, and 50 percent for the Malaza sample. In the discussion of the three samples, we noted that the SCSRETP was more directly involved with the SNL farmers in the Curry sample because of the on-farm trials. In both 1988 and 1991, the SNL farmers in the Curry sample have

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[2]The measure of self-sufficiency for the 1985 Curry sample is not identical to the 1988 and 1991 measures. Curry measured maize output "aim" while we measured maize output.

Table 8. Percentage of SNL Farmers Who Reported They Were Self-Sufficient and Who Sell Maize

	1978-1979	1985	1988	1991
Curry Sample				
Self-Sufficiency	--	75	86	94[b]
Sell Maize	--	--	49	56
Dlamini Sample				
Self-Sufficiency	--	--	67	71
Sell Maize	--	--	26	28
Malaza Sample				
Self-Sufficiency	--	--	50	--
Sell Maize	--	--	22	--
de Vletter Sample[a]				
Sell Maize	12	--	--	--

[a]de Vletter (1983)
[b]$p < .01$

higher rates of self-sufficiency and selling of maize than the farmers in either the Dlamini or Malaza samples. Thus there is a correlation between those farmers most associated with the project and levels of self-sufficiency and selling maize. Again, this correlation must be viewed with caution because of the internal validity threats of selection bias and maturation.

Data from a 1978-1979 study by de Vletter (1983) are also included in Table 8 as a quasi-baseline. In 1978-1979 de Vletter reported that 12 percent of the SNL farmers in his sample sold maize. By 1991, 56 percent of Curry's

sample, 28 percent of Dlamini's sample, and 22 percent of Malaza's sample were selling maize. All of these percentages are statistically significantly different from 12 percent ($p < .01$). Treating these four samples (de Vletter, Curry, Dlamini, and Malaza) as comparison groups, there has been a significant improvement over the ten to eleven year period in the number of farmers who sell maize.

In all three samples, there is a considerable difference between the percent of farmers who reported they grew enough maize to feed themselves and the percent who sell maize (38 percent for Curry sample in 1991, 43 percent for Dlamini sample in 1991, and 28 percent for Malaza sample in 1988). There are several possible reasons for these differences. Many family members who live off farm often are given surplus maize. Some SNL farmers find it difficult to transport their maize to buyers such as the Swaziland Milling Company. Other SNL farmers produce at or slightly above the level required for self-sufficiency, and don't have any surplus they can sell.

Other data related to self-sufficiency and maize sales can be found in Appendix A. Self-sufficiency levels, maize sales, and practice usage are given for each RDA. Information on what farmers do with the money they obtain from the sale of their maize is also reported in the appendix.

Self-sufficiency and maize sales are related to maize yields. Unfortunately, reliable data for maize yields are very limited. Curry (1988) indicated that the yield data from only six of the RDAs in his sample were reliable. Because of the short time available to conduct the 1991 Dlamini-Warland Survey, it was not possible to obtain yield data. In retrospect, this is unfortunate given the large changes between 1988-1991 in use of topdress fertilizer and the use of the recommended rate of application for hybrid seed.

Thus the only comparison available is for 68 of the SNL farmers in Curry's sample from the six RDA's from 1985-1988. These data are presented in Table 9. The SNL farmers in the Curry sample had higher maize yields in the 1985-86 cropping season than during the 1987-88 season. These 68 SNL farmers averaged 2.19 metric tons per hectare in 1985-86 but only 1.74 metric tons per hectare in 1987-88. These yields were very similar to the country as a whole, which also enjoyed a higher yield on the 1985-86 cropping season than in the 1987-88 season (Patrick, 1990).

Table 9. Maize Yields For a Subset (N=68) of the SNL Farmers in the Curry Sample

Metric Tons Per Hectare	1985-1986 Cropping Season	1987-1988 Cropping Season
Less than 1.5 metric tons	19%	46%
1.5 to 2.0 metric tons	33	23
2.01 to 3.0 metric tons	35	18
3.01 and more metric tons	13	13
Average Metric Tons Per Hectare	2.19	1.74

Extension and Research Contacts

In the Dlamini-Warland 1991 Survey, we asked a series of questions about the SNL farmers' contacts with the extension system, the research system, and other donor projects. There were two purposes for obtaining these data. The first was to determine the degree of recent contact of the SNL farmers with the extension and research system in the country. The second purpose was to

determine the relationship of these contacts to recommended production use and outcomes measures.

The data relevant to the extension and research contacts for the SNL farmers in the Curry and Dlamini samples are presented in Table 10. Over the 12 different measures, it is clearly evident that the SNL farmers in the Curry sample have interacted much more with the extension and research programs than the farmers in the Dlamini sample. The differences are often two to three to one, and 11 of the 12 differences are statistically significant. The most dramatic difference involves the on-farm trials in which 96 percent of the farmers in Curry's sample participated versus only 3 percent of the farmers in Dlamini's sample. As stated earlier, these on-farm trials were associated with SCSRETP (Curry and Seubert, 1988). The findings reported earlier clearly indicate that the SNL farmers in Curry's sample were the most progressive of the three samples. Data in Table 10 suggest these farmers are also the most active in seeking and obtaining information about agriculture. In many ways, the Curry sample farmers resemble "early adopters" often discussed by adoption-diffusion researchers (Rogers, 1983).

Data in Table 10 indicate that some of these farmers have been involved with programs sponsored by other donors. Eighteen percent of the farmers in Curry's sample and seven percent of Dlamini's sample have participated in the Chinese Scheme. Extension activities and the radio appear to be the most widely used sources for agricultural information by both samples.

Table 10. Extension and Research Contacts With SNL Farmers in the 1991 Curry Sample and the 1991 Dlamini Sample (N=200)

Extension or Research Activity	Curry Sample (N=85)	Dlamini Sample (N=99)
Met with an extension worker in the last 12 months	51%	22%[b]
Attended training on farm operations	36	14[b]
Attended other meetings organized by extension	57	35[b]
Attended the Field Day at the Malkerns Research Station	20	7[b]
Attended on-farm trials observations at the RDA	26	11[b]
Attended other field days in the area	25	7[b]
Attended agricultural shows	24	6[b]
Participated in on-farm trials	96	3[b]
Participating in the National Maize Competition	15	2[b]
Participated in the Chinese Scheme	18	7[a]
Read newspapers or newsletters about agricultural information	18	5[b]
Listen to agriculture programs on the radio	69	58

[a] $p < .05$

[b] $p < .01$

We also examined the relationship of these 12 activities and the usage of the five practices discussed earlier and the measures of self-sufficiency and maize sales. There are too many crosstabs (84 crosstabs) to discuss, so

we selected a subsample which was representative to include in the report. To simplify the presentation of data, we have combined the Curry and Dlamini samples. Exploratory analysis indicated the patterns of relationships were similar for both samples.

The relationship between each of these 12 research and extension activities and the use of topdress fertilizer can be found in Table 11. We selected topdress fertilizer because of the substantial increase in the use of this practice between 1988 and 1991, and because these relationships are very representative of those found between these activities and use of the other practices. In Table 11 we included the current (1991) users of topdress, those who used topdress at some time in the past, and those who had never used topdress. With only one exception (other field days in the area), the patterns of research and extension activities are very similar for the current and past users of topdress fertilizer. Although the differences are not always statistically significant, it is evident that those who have never used topdress fertilizer are far less active in these research and extension programs than the current and past users. These differences are particularly pronounced for contact with extension workers, attending training on farm operations, attending other meetings organized by extension, participating in on-farm trials, and the Chinese Scheme.

The data in Table 11 suggest that experience with a recommended practice, whether it be now or in the recent past, is related to contacts with the research and extension system. In other words, farmers who have experience with a practice they are not currently using have approximately the same degree of contact with research and extension programs in Swaziland as do current users of a practice. The issue of discontinuity of usage appears

Table 11. The Relationship of Research and Extension Contacts to the Use of Topdress Fertilizer (Dlamini-Warland Survey)

Research and Extension Activity	Adopter Group		
	Current	Past	Never
Met with extension worker in last 12 months	46%	33%	11%[b]
Attended training on farm operations	28	33	7[a]
Attended other meetings organized by extension	53	44	23[b]
Attended the Field Day at the Malkerns Research Station	17	15	0
Attended any on-farm trials at the RDA	23	24	4[a]
Attended other field days in the area	22	9	4[a]
Attended any agricultural shows	18	18	4
Participated in on-farm trials	50	58	26[a]
Participated in the National Maize Competition	12	9	0
Participated in the Chinese Scheme	19	15	0[a]
Read newspapers or newsletters about agriculture	15	18	0
Listen to agriculture programs on the radio	68	64	56

[a] $p < .05$
[b] $p < .01$

to be more a matter of constraints (e.g. lack of cash) than unsuccessful experience with the practice or lack of information about the practice.

The relationships of self-sufficiency and maize sales to contacts with the research and extension activities are presented in Table 12. The patterns of differences are consistent, although the differences are statistically significant more frequently for those comparisons involving selling maize (12 of 12 significant) than for self-sufficiency (4 of 12 significant). In all 24 comparisons, farmers who indicated they were self-sufficient or sold maize reported more contacts with the various research and extension programs than did those SNL farmers who were not self-sufficient or did not sell maize. For both outcomes, the differences are particularly noteworthy for contact with an extension worker, meetings organized by extension, participation in on-farm trials, and participation in the Chinese Scheme.

The activities most closely related to SCSRETP were extension activities via training programs (Diamond, 1990) as well as direct involvement (Diamond, 1990; Iversen, 1991), and the on-farm trials (Curry and Seubert, 1988). As we have continually pointed out, cause-effect relationships are not possible. It would appear, however, that some of the research and extension activities which were at least in part related to SCSRETP may have had an indirect effect on the usage of these practices and self-sufficiency and maize sales. We will never be able to sort this out clearly, because there is evidence that other donor programs (Chinese Scheme) as well as other local and national programs were also related to these successes.

The last analyses related to research and extension activities are reported in Tables 13 and 14. The SNL farmers who were using a recommended practice were asked who advised them to use the specific practice. Their

Table 12. The Relationship of Research and Extension Contacts to Self-Sufficiency and Selling of Maize (Dlamini-Warland Survey)

Research and Extension Activity	Self-Sufficient	Not Self-Sufficient	Sell Maize	Don't Sell Maize
Met with extension worker in last 12 months	44%	17%[b]	49%	32%[b]
Attended training on farm operations	28	19	35	20[a]
Attended other meetings organized by extension	53	28[b]	59	40[b]
Attended the Field Day at the Malkerns Research Station	15	6	26	5[b]
Attended any on-farm trials at the RDA	22	11	28	15[a]
Attended other field days in the area	19	11	28	9[b]
Attended any agricultural shows	17	8	26	8[b]
Participated in on-farm trials	56	17[b]	68	35[b]
Participating in the National Maize Competition	11	3	21	2[b]
Participated in the Chinese Scheme	18	3[b]	25	9[b]
Read newspapers or newsletters about agriculture	15	6	23	7[b]
Listen to agriculture programs on the radio	67	56	77	57[b]

[a] $p < .05$
[b] $p < .01$

Table 13. Who Advised the SNL Farmers in Curry's Sample to Use Recommended Practices (1988 and 1991)

Practice	Neighbors & Family Members	Extension Worker	Other Technical Sources	Self
1988				
Hybrid Maize Seed	14%	61%	11%	14%
Fertilizer[a]	12	61	8	19
Pesticides	14	73	1	12
Tractor Plowing	30	24	2	44
1991				
Hybrid Maize Seed	12	47	10	31
Fertilizer	12	56	12	20
Pesticides	15	56	8	21
Tractor Plowing	13	26	1	60

[a]Basal and topdress fertilizer were not identified separately in the 1988 Dlamini Survey. The basal and topdress responses to the 1991 Dlamini-Warland Survey have been averaged to match the 1988 data.

responses were collapsed into the four categories that appear in Tables 13 and 14. Since these questions were asked in both 1988 and 1991, we are also able to compare the responses of the SNL farmers in both the Curry and Dlamini samples over these two time periods.

The farmers in the Curry sample most frequently reported that the extension worker advised them on using hybrid maize seed, fertilizer, and pesticides. The farmers reported they primarily relied on themselves for tractor plowing. The farmers in Curry's sample indicated they relied more on themselves for all practices in 1991 than in 1988.

The farmers in the Dlamini sample also reported that the extension worker was the most frequent source of advice for seed, fertilizer, and pesticides in 1988 (Table 14). However these farmers relied more on neighbors and friends while the farmers in Curry's sample cited the extension worker and other technical sources more frequently. This pattern of early adopters depending more on technical sources and later adopters depending more on informal sources is consistent with the profile of adopter categories (Rodgers, 1983). It may be noted that from 1988 to 1991 farmers in both samples became more self-reliant.

Table 14. Who Advised the SNL Farmers in Dlamini's Sample to Use the Various Practices (1988 and 1991)

Practice	Neighbors & Family Members	Extension Worker	Other Technical Sources	Self
1988				
Hybrid Maize Seed	12%	41%	11%	26%
Fertilizer	33	37	6	24
Pesticides	34	36	2	28
Tractor Plowing	21	17	4	58
1991				
Hybrid Maize Seed	20	38	3	39
Fertilizer	18	43	4	35
Pesticides	19	37	6	38
Tractor Plowing	17	10	1	72

Other Related Findings

This section of the report presents findings from these surveys which are less directly related to the impact study, but nonetheless may be useful for the project evaluation. Findings related to ownership of agricultural equipment, the differences in the use of recommended practices and outcome measures by gender of the head of household, and the impact of off-farm income on the use of practices will be presented.

Ownership of Agricultural Equipment

In the 1985 Curry Survey and the 1991 Dlamini-Warland Survey, the SNL farmers were asked if they owned a variety of agricultural equipment. The data from these surveys are presented in Table 15. The first two columns compare the SNL farmers from Curry's sample and the last column presents data for Dlamini's sample. The major changes between 1985 and 1991 for the SNL Curry farmers include an increase in the ownership of ox harrows, cart, and sledges. The ownership of the other types of equipment changed less.

The ownership of the SNL farmers for ox ploughs, ox interrow cultivators, ox harrows, sledges, sprayers, bakkies, and cattle is higher for the SNL farmers in Curry's sample than those in Dlamini's sample. This pattern of ownership is again consistent with the profile of early adopters. Most farmers in both samples own draft animals, grain tanks, and tin roofs. These data suggest ownership of agricultural equipment is increasing and there is widespread ownership of certain types of agricultural equipment and other homestead amenities.

Table 15. Percentage of SNL Farmers in the Curry and Dlamini Samples Who Own Various Types of Agricultural Equipment

Type of Equipment	Curry 1985 Sample (N=85)	Curry 1991 Sample (N=85)	Dlamini 1991 Sample (N=99)
Draft Animals	NA[a]	92	82
Ox Plough	73	81	48
Ox Planter	47	48	30
Ox Interrow Cultivator	60	73	42
Ox Harrow	24	48[b]	27
Tractor	NA	11	6
Tractor Plough	9	8	7
Tractor Planter	0	6	5
Tractor Interrow Cultivator	0	4	3
Tractor Harrow	8	4	5
Cart	2	13[b]	10
Ridger	6	5	5
Sledge	22	62[b]	35
Knapsack Sprayer	NA	27	9
Bakkie or Truck	NA	21	8
Grain Tank	NA	94	80
Tin Roof(s)	NA	89	91
Cattle	79	80	50

[a]NA denotes not available

[b]$p < .01$ (for Curry sample only)

Use of Recommended Practices and Gender

There have been several studies that have suggested that female heads of household are less likely to adopt recommended practices than male heads of household due to time pressures and resource constraints (Staudt, 1987). The data collected in the recent Dlamini-Warland Survey provide an opportunity to test this proposition in Swaziland.

In the Dlamini-Warland Survey, approximately 29 percent of the heads of households were women. The percentage of homesteads using each recommended practice, and the percentage who are self-sufficient and sell maize are presented in Table 16. The only difference is the percent using topdress fertilizer, where 76 percent of the homesteads headed by males were using

Table 16. Relationship of Gender of Household Head and Use of Recommended Practices and Outcomes (Dlamini-Warland Survey)

Practice or Outcome	Male Head	Female Head
Percent Using Hybrid Maize Seed	90%	88%
Percent Using Basal Fertilizer	89	85
Percent Using Topdress Fertilizer	76	59[a]
Percent Using Pesticides	70	62
Percent Using Tractor Plowing	82	83
Percent Who Have Had Soil Tested	41	38
Percent Who Are Self-Sufficient	83	79
Percent Who Sell Maize	45	35

[a] $p < .05$

topdress fertilizer versus 59 percent of the female-headed homesteads. The males and females do not differ on the other seven practices or outcomes.

These findings clearly indicate that SNL female-headed homesteads do equally as well as their male counterparts. We can only speculate as to why this is the case. First, women are encouraged to attend meetings organized by extension and other groups in the country. Thus men and women have equal access to information, a situation that does not exist in all parts of Africa (Mugabe, 1986). In addition, women serve as extension field officers in Swaziland. According to Diamond (1990), approximately 26 percent of all extension field officers were women. Women in Africa are more likely to participate in agricultural extension programs when extension staff are women (Saito and Weideman, 1990). This finding requires further study.

Off-Farm Contributions

This last section presents data related to the impact of off-farm employment on the farming operations of the homestead. It is well known that off-farm income plays an important role in the agriculture of Swaziland. Table 17 summarizes the off-farm contributions of the 200 Dlamini-Warland SNL farmers. Approximately 30 percent of the heads of household provided agricultural inputs and cash to the homestead from off-farm income. Less than 10 percent of the homesteads received inputs from other adult family members who live full time on the homestead and work off-farm. Between 22 to 47 percent of the homesteads received various types of inputs and cash from other family members who work off-farm but who do not live on the homestead.

Table 17. Percentage of SNL Homesteads Whose Family Members Contribute Agricultural Inputs From Off-Farm Income (Dlamini-Warland Survey)

Agricultural Inputs	Head of Household	Family Member(s) Living on Homestead	Family Member(s) Not Living on Homestead
Seed	30	8	39
Fertilizer	30	8	36
Chemicals	26	7	30
Cash	31	8	47
Labour	NA[a]	NA	22

[a]NA denotes not available

The data displayed in Table 18 suggests that these contributions from those who work off-farm may result in higher adoption rates and higher self-sufficiency. Homesteads which receive contributions from those who work off-farm have significantly higher usage of hybrid seed, basal fertilizer,

topdressing fertilizer, tractor plowing, and are more self-sufficient. The importance of off-farm income should not be overlooked when studying adoption of technology in Swaziland, for off-farm income may help remove some of the economic constraints to the adoption of recommended practices discussed earlier.

Table 18. Relationship of Contributions to the Farming Operation From Those Working Off-Farm and the Use of Recommended Practice and Outcomes (Dlamini-Warland Survey)

Practice or Outcome	Use of Practice/Outcome by Homesteads With Off-Farm Contributions	Use of Practice/Outcome by Homesteads With No Off-Farm Contributions
Hybrid Maize Seed	93%	80%[a]
Basal Fertilizer	93	72[b]
Topdress Fertilizer	74	56[b]
Pesticides	69	66
Tractor Plowing	81	54[b]
Self-Sufficiency	86	70[a]
Sell Maize	42	40

[a] $p < .05$
[b] $p < .01$

CONCLUSIONS

As we stated at the outset, it is not possible to isolate the impact of the SCSRETP. There are several findings that suggest at least a correlation between SCSRETP activities and changes in the use of recommended practices.

1. In the first phase of the project (1981-1986), the major emphasis was on research. One of the main ways the project interacted with farmers was through on-farm trials. Most of the farmers (96 percent) in Curry's sample participated in on-farm trials. The farmers who participated in the on-farm trials may have been selected in a way that may have created a selection bias. These farmers are similar to early adopters which may have produced a maturation bias. Nevertheless, the data presented in this report indicate that these SNL farmers made significant progress from 1985 to 1991. The percentage of those farmers using topdress fertilizer, pesticides, tractor plowing, and the recommended plant population all increased significantly. These farmers significantly increased self-sufficiency over this time period. Currently 94 percent of these farmers are self-sufficient. A majority of these farmers sell their maize. Hopefully these farmers will serve the role of early adopters in their communities and be helpful to others in the area to improve their state.
2. In the second phase of the project (1987-1991), the extension component was emphasized. At this stage, the project now had the capacity to reach a large number of SNL farmers. The two largest changes during this period were the usage of topdress fertilizer and the use of the recommended level of hybrid maize seed. These changes

were similar for the SNL farmers in both the Curry and Dlamini samples. It was found that the research-extension program of the project was emphasizing these two recommended practices at the time. Thus there is a correlation between the increase in the use of these practices and the project activities. There were also increases in the use of tractor plowing, use of the recommended rate for tractor plowing, and a smaller increase in pesticide use.

3. The changes in the outcome measures, namely self-sufficiency, selling of maize, and maize yields were more modest. Most of the increase was not statistically significant, although the self-sufficiency rates are relatively high. The yields from 1985 to 1988 actually declined, but were similar to the national average for both cropping seasons. The percentage of farmers selling maize increased little for the two samples, but were statistically different from the 1978-79 rate. The self-sufficiency estimates from the Malaza sample were considerably below the other two samples, although data for 1991 was not available from the SNL farmers in the Malaza sample to chart their progress.

4. The most impressive finding of all the analyses presented in this report is the steady progress the SNL farmers in these two samples have made. With the exception of maize yields (based on a very limited data set and no doubt influenced by weather), use of recommended practices, use of recommended rates of application, selling of maize, self-sufficiency, ownership of agricultural equipment, and self-reliance all increased for the SNL farmers in both the Curry and Dlamini samples. No doubt projects like SCSRETP,

the Chinese Scheme, and the programs of the Ministry of Agriculture and Cooperatives all contributed to this success, but it is ultimately the SNL farmers who take the initiative, attend the meetings, and take the risks that result in success. While we make no claims that these samples are a random sample of all SNL farmers, it is very encouraging to observe the progress that has been made. Hopefully, more studies of this type can be conducted in the future to continue to monitor the progress of these farmers.

5. The percentages of SNL farmers who have experience with the recommended practices are higher than we expected. Nearly 80 percent or more of the 200 farmers interviewed in 1991 had tried each of the recommended practices. Furthermore, those farmers who had discontinued using a particular practice reported the same level of contact with the research and extension systems as the current users did. The issue appears to be constraints, particularly credit or cash flow, not lack of information.
6. The remarkable similarity of the male and female heads of household use of most of the recommended practices, selling maize, and self-sufficiency also surprised the authors. The equal access of women and men to agricultural information in Swaziland may account for this finding, but hopefully more research can be conducted to determine why this pattern exists. Gender is a very important issue in development today, and a better understanding of the Swaziland situation should be of great interest to the rest of the region.
7. Finally one of our major goals was to demonstrate that timely data can be obtained so that officials can have up-to-date information for

planning and decision making. The 1991 Dlamini-Warland Survey began the first week of February, 1991. The last interview was conducted on April 5, 1991. Coding and data entry were completed by April 30, 1991. Analysis was conducted between May 1 and May 27, 1991 and the report was written between May 25 and June 7, 1991. Thus the entire process from beginning to end took 18 weeks. As Binnendijk (1989) has recently pointed out, evaluation results frequently are not available for several years after they are collected. We believe that use of current survey methodology, analysis systems, and management can reduce this time considerably.

Our purpose has been to provide information concerning the progress of the SNL farmers over the life of SCSRETP. It is ultimately up to others to decide what impact the project has had in Swaziland. Our hope is that these data will be helpful in this process.

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APPENDIX A

Table A1. Percentage of SNL Farmers Who Used Recommended Practices, Were Self-Sufficient, and Sell Maize in Each RDA

RDA	Hybrid Seed	Basal Fertilizer	Topdress Fertilizer	Pesticides	Tractor Plowing	Self-Sufficiency	Sell Maize
Northern	86	90	81	29	81	95	48
Mahlangatsha	82	86	82	86	74	86	52
Central	95	95	62	81	100	90	24
Ngwempisi	100	95	90	57	71	95	62
Bhekinkosi/Mliba	86	62	43	52	81	76	38
Southern	80	95	55	90	85	90	75
Tikhuba	91	100	55	64	91	100	64
Hluti	93	80	73	80	47	53	20
Sandleni/Luqolweni	100	95	63	74	47	68	16
Madulini/Mahlaleni	80	80	90	90	80	80	40
Siphocosini/Motshane	100	100	80	70	90	70	10
Mahamba/Zombodze	78	67	67	44	33	56	33
Sample (N=200) Average	89	87	70	68	75	82	42

Table A2. How Those SNL Farmers Who Sell Maize Used the Money (N=83)

Use of Money	Percentage of Farmers
Paid loans	4
Bought house building materials	13
Bought farm equipment	48
Bought livestock	1
Saved the money	17
Paid for school	21
Bought inputs (seed, fertilizer, etc.)	25
Hired a tractor	10