FACTORS INFLUENCING ADOPTION AND NON-ADOPTION OF ACQUIRED KNOWLEDGE AND TECHNOLOGIES AT DENMAN RURAL TRAINING CENTRE, GABORONE AGRICULTURAL REGION, BOTSWANA

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ABSTRACT

This paper investigates the factors that influence adoption and non-adoption of agricultural technologies presented to farmers who attended training courses at the Denman Rural Training Centre in Botswana.

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A structured questionnaire was administered to 223 respondents, from these respondents 153 attended training at Denman Rural Training Centre, twenty-one respondents were never trained, thirty-three were extension agents, nine support staff, five instructors and two managers.

The findings of the study show that most of the respondents (61%) are implementing the acquired technologies, while 39% are not implementing. More than half (65%) of trained

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respondents indicated that they were never involved in identification of the courses they attended. Eighty percent reported that courses were suggested by extension agents. Thirty-six percent of respondents indicated that training had no impact at all on their production efficiency, while 45% indicated a moderate impact on their production to ensure that the training will be effective.

More than half of all extension staff (64%) reported that the status of implementation for acquired technologies is usually negative, indicating that there was less or no implementation. The most important factor revealed by the study contributing to non-adoption of technologies is lack of resources. The study concluded that extension has to address the needs and perception of trainees to ensure that the training will be effective.

1. INTRODUCTION

Since the establishment of the first rural training centre in Botswana in 1967, extension has been trying to develop farmers through farmer training courses, but the impact of farmer training in Botswana in terms of its influence on farmers' production efficiency is not well known. A systematic in-depth study on the factors influencing adoption has not been conducted. The only study, conducted by Montsho (2002), focused on the extent to which horticultural farmers applied what they have been taught. The study did not address all the courses offered, and it ignored the intervening human causes, which are critical in behaviour change.

The objectives of the study were:

i) To investigate the factors that determine adoption and non-adoption of agricultural technologies,

ii) To investigate the extent to which farmers contribute to the development of the training programs and the criteria for selecting course participants,

iii) To determine the impact of the knowledge gained from the training program on the farming practices of the trainees.

A model illustrating the relationship between the problem its objectives and the behaviour determining variables is shown in Figure 1.

The model (Figure 1) assumes that to address the problem properly, the study has to address each objective in relation to the independent and intervening variables, which determines behaviour and its consequences.

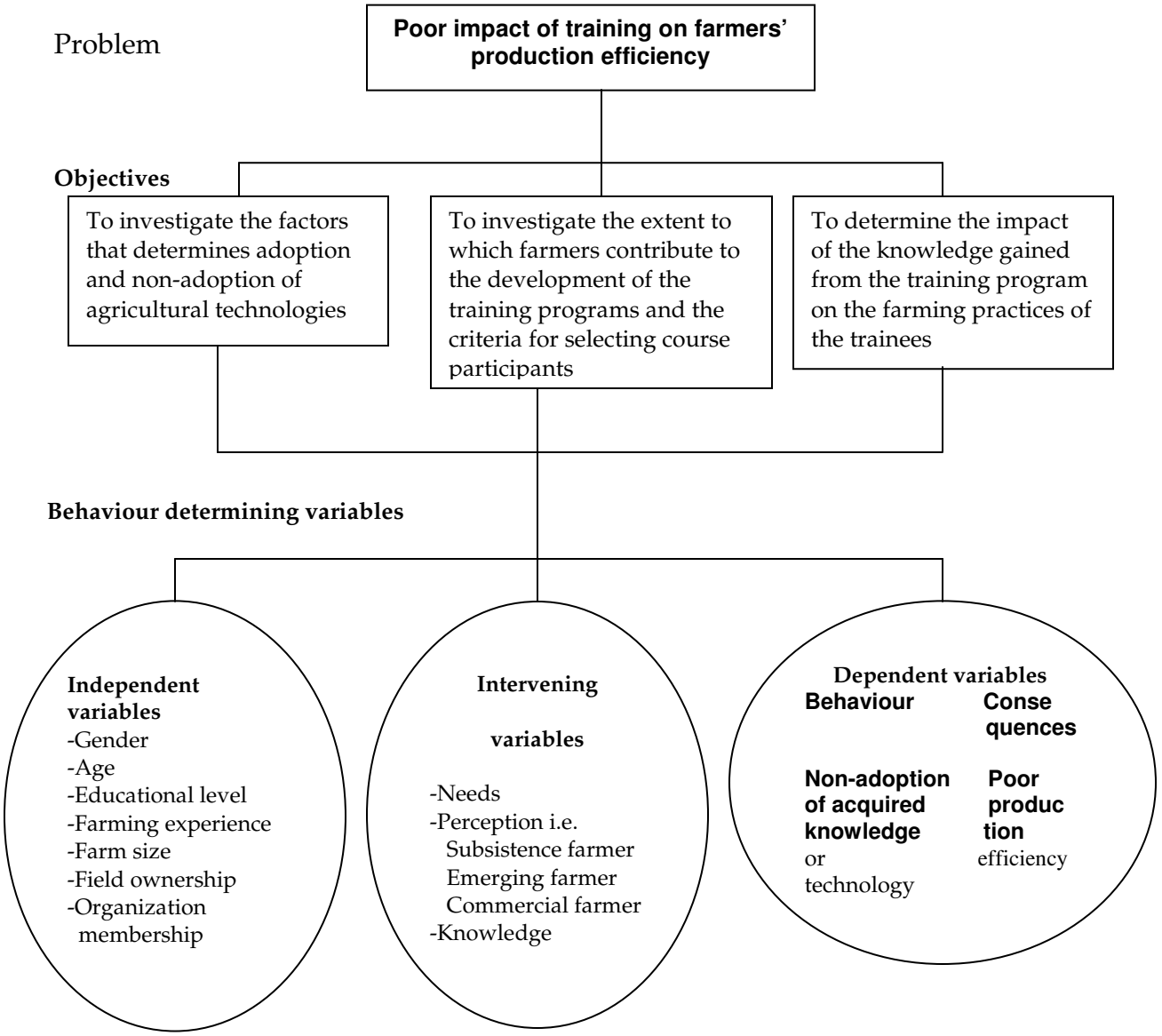

Figure 1: The link between the problem, objectives and behaviour determining variables

With the focus of the article being on factors influencing adoption and non-adoption the following research hypotheses were formulated:

Hypothesis 1: Poor impact of training on farmers' production efficiency is a function of non-adoption or implementation of acquired knowledge or technology.

Hypothesis 2: Training offered at Denman Rural Training Centre does not address the intervening variables namely needs and perception of participants.

2. MODELS OF ADOPTION BEHAVIOUR

There are several models of adoption behaviour. Commonly recognized ones include Düvels model (1991), The Field Theory of Lewin (1951) and the Tolman model (1967).

According to Düvel (1991:78) the non-adoption of innovations and practices can be traced back to two basic causes:

a) The individual is either uncapable or unwilling to adopt the recommended practice.

(b) Unwillingness to adopt can directly or indirectly be linked to a lacking need, and the related aspects of perception and knowledge.

Lewin's (1951) Field Theory regards behaviour (B) of an individual to be a function (f) of the total situation, i.e. the life space (lsp) or cognitive field, which consists of both the condition of the individual (P) and the environment (E). It is formulated as follows:

$$B = f(lsp) = f(P,E)$$

Tolman (1967) introduced the concept of independent, intervening and dependent variables. According to him, independent variables are the initiating causes of individual's action consisting of the environment entities presented to the individual factor at a given moment. Intervening

variables are postulated explanatory entities conceived to be connected by one set of causal functions to the independent variables, on one side, and by another set of functions to the dependent variables of behaviour, on the other side. Dependent variables are a combination of verbal, skeletal, and visceral reactions to the external stimuli.

3. RESEARCH METHODOLOGY

The problem of poor impact of training on farmers' production efficiency is a national one, experienced at all five rural training centres in Botswana. Due to limited resources of manpower, funds and time, the study however focused only on one rural training centre namely the Denman Rural Training Centre (DRTC) conducted in Gaborone Agricultural Region in the southern part of the country. Gaborone region consists of five districts being Kgatleng, Southeast, Kweneng south, Kweneng north and Kweneng west.

The survey research design was used in this study. A questionnaire design technique consisting of six questionnaires was used to collect data from 223 respondents, namely farmers, frontline extension agents, support staff, instructors and managers. The Statistical Package for the Social Sciences (SPSS version 13) was used for data analysis.

4. RESULTS AND DISCUSSION

4.1 Independent variables

The possible influence of some independent variables on the adoption or non-adoption of agricultural technologies and the interrelationship between the independent variables will be discussed.

4.1.1 Gender and age

A total of 61% of the trained respondents are female and the similar pattern occurs within the control group where 76% of the respondents are females.

The age distribution of respondents ranged from 20 to 84 years. A total of 29% respondents fall within 51-65 years, while there is significantly more (39.3%) males who are over 65 years of age than females (18%). Female respondents are significantly younger (χ^2 = 8,110; p = 0.04) than their male counterparts.

4.1.2 Education level

One of the critical attributes to knowledge and information is education which can assist farmers in decision-making. The significant difference between the formal education of male and female respondents is illustrated in Table 1.

Table 1: Distribution of male and female respondents according to education levels

Education level Trained Respondents	Gender				Total		χ^2	
	Male		Female					
	N	%	N	%	N	%	Value	p
No education	38	64	21	22	59	39	27.975	0.000
Sub A – Sub B	3	5	7	8	10	6		
Standard 1 – 7	13	33	46	49	59	39		
Form 1 – 3	3	5	16	17	19	12		
Form 4 - 5	2	4	4	4	6	4		
Total	**59**	**100**	**94**	**100**	**153**	**100**		
Control Group							**Fisher's Exact Test**	
	N	%	n	%	N	%	Value	p
No education	4	80	2	13	6	28	7.499	0.011
Sub A – Sub B	0	0	1	6	1	5		
Standard 1 – 7	1	20	13	81	14	67		
Form 1 - 3	0	0	0	0	0	0		
Form 4 - 5	0	0	0	0	0	0		
Total	5	100	16	100	21	100		

The noticeable finding is the low formal qualification of male respondents. As many as 64 percent trained and 80 percent control group male respondents, have no formal education as opposed to 22 percent trained and 13 percent control group female respondents. This concludes that female respondents are significantly more literate than male respondents.

4.1.3 Field size

The field size for respondents ranged from 2 to 88 hectares of land. The majority of respondents (72%) have between 2 to 7 hectares. No differences occur between male and female respondents with regard to size of land available for farming.

4.1.4 Field ownership according to age

The issue of land ownership is crucial in most third world countries including Botswana. The difference on field ownership according to age is indicated in Table 2.

Table 2: Distribution of field ownership according to age categories

Trained respondents	Resp	Age groups								Total		Fisher's	
		<=35		36-50		51-65		>65					
Variable		**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Value**	**P**
Do you own this field	Yes	7	47	33	89	41	98	36	97	117	89	22.0	0.000
	No	8	53	4	11	1	2	1	3	14	11		
Total		**15**	**100**	**37**	**100**	**42**	**100**	**37**	**200**	**131**	**100**		
Control group		**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Value**	**P**
Do you own this field	Yes	0	0	5	100	10	100	5	100	20	95	7.3	0.048
	No	1	100	0	0	0	0	0	0	1	5		
Total		**1**	**100**	**5**	**100**	**10**	**100**	**5**	**100**	**21**	**100**		

According to the above table 89% of the respondents own the land. The majority of these respondents fall within the range of 51 to above 65 years of age. The table also shows a significant relationship between age and land ownership. The older the respondents the more they own the land while 53% of the trained respondents younger than 35 years still do not own the land.

4.1.5 Farming experience

Farming experience is an aspect that could play an important role in decision-making. The results however indicated no differences and the majority of trained respondents 82 and 90% of the control group indicated that they have been farming for more than 10 years.

4.1.6 Organization membership

Membership of an organization provides a valuable learning and collective bargaining opportunity for farmers. A total of 54% of trained respondents are members of farmer organizations against only 10% of the control group. More female respondents (57%) than male respondents (49%) of the trained group are members of farmers associations. With regard to age groups, there are significantly more trained respondents belonging to organization in the older groups > 35 (62%) than in the group ≤ 35 years of age (19%).

4.2 Intervening variables

The effect of the independent variables on the intervening variables and the consequences with regard to behaviour change and adoption will next be discussed.

4.2.1 The intension of respondents after training

The intension of respondents with regard to implementation of what they have learnt is illustrated in Figure 2.

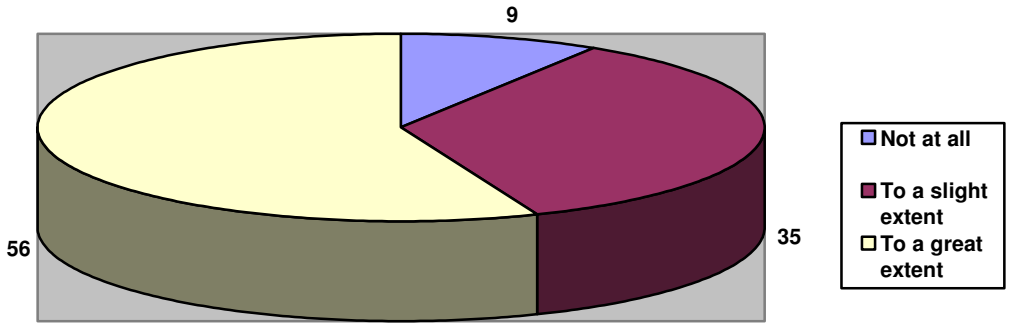

Figure 2: The implementation of acquired knowledge by respondents

Most of the trained respondents (56%) indicated that they were, to a slight extent, determined to implement ideas they have learnt after training, but only 35% indicated that they were, to a great extent, determined. The

extent to which they have implemented practices as well as the reasons for not implementing are indicated in Table 3.

Table 3: Implementation status of acquired knowledge and reasons for non-adoption by trained respondents

Practice	Frequency			Percent
	N	Male	Female	
Fence construction	22	22	-	14.37
Vegetable production	19	4	15	12.4
Row planting	13	3	10	8.49
Use and care of implements	8	4	4	5.2
Role of committee members	8	2	6	5.2
Food processing	6	1	5	3.9
Pests control	4	-	4	2.3
Plough across the slope	3	1	2	1.96
Crop rotation	3	2	1	1.96
Apply kraal manure	3	1	2	1.96
Planting cash crops	2	-	2	1.3
Crop marketing	2	-	2	1.3
Record keeping	1	-	1	0.65
Sub-total	**94**	**40**	**54**	**61**
Problems hindering implementation by trained respondents				
Reasons			**Frequency**	**Percent**
Did not attempt completely			33	22
Lack of resources			20	13
Social commitments			4	2.6
Old age			1	0.65
Shortage of rainfall			1	0.65
Sub-total			**59**	**39**
Total			**153**	**100**

Table 3 indicates that 61% of respondents implemented the acquired knowledge while 39% did not. Fence construction is done by 22 (14.3%) male respondents mostly as hired labourers. Amongst the 19 respondents (12.4%) producing vegetables 79% are female, while 21% are males. The

results indicated that 13 of respondents (8.49%) who do plant in rows, 77% are female, while 23% are males. According to Figure 2, 91% of the respondents indicated that they were determined to implement practices, but only 61% at the end, according to Table 3, did implement some practices while 39% did not implement practices at all. The two main reasons for non-application are that they did not even attempt to implement and the lack of resources. Except for fence construction training and implementation, more females than males did implement practices.

4.2.2 Farmers perception about themselves and their aspirations

The respondents' perception about themselves as well as their aspirations as to where do they see themselves in five years time, in relation to three categories of farmers, are shown in Table 4.

Table 4: Respondents' current perception and their aspiration in five years time

Farmers current perception	**Trained respondents**		**Trained respondents**	
	N	**%**	**N**	**%**
Subsistence farmer	122	85	19	91
Emerging farmer	15	10	2	10
Commercial farmer	7	5	0	0
Total	**144**	**100**	**21**	**100**
Farmers aspirations in five years time	**N**	**%**	**N**	**%**
Subsistence farmer	65	45	16	76
Emerging farmer	29	20	4	19
Commercial farmer	50	35	1	5
Total	**144**	**100**	**21**	**100**

The majority of trained respondents (95%) and 91% in the control group, perceived themselves as subsistence farmers. In five years time the perception of respondents' changes as these figures are reduced. According to the above table a total of 40% of the trained respondents who perceived themselves as subsistence farmers indicated that they aspire to be on a higher level of farming in five years time, while only 15% of the respondents in the control group, who perceived themselves

as subsistence farmers, indicated that they aspire to be on a higher level of farming.

This difference in aspiration could be because of trained respondents' exposure to training programs, while the control group were not exposed and never received new technologies to stimulate their aspirations to improve their farming operations. There is no significant differences between male and female respondents with regard to their perception and aspirations among the three former categories.

4.2.3 Respondent's age and their perception and aspirations with regard to farmer categories

The perception and aspiration of respondents in different age categories with regard to farmer categories are indicated in Table 5.

Table 5: Respondents' current perception and future aspirations according to age with regard to farmer categories

Trained respondents												
Farmers current perception	**Age groups**								**Total**		**Fisher's exact test**	
	<=35		**36-50**		**51-65**		**>65**					
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Value**	**P**
Subsistence	14	70	30	83	39	93	32	84	115	85	13.5	0.014
Emerging	5	25	1	3	3	7	5	13	14	10		
Commercial	1	5	5	14	0	0	1	3	7	5		
Total	**20**	**100**	**36**	**100**	**42**	**100**	**38**	**100**	**136**	**100**		
Control group												
Subsistence	1	100	4	80	9	90	5	100	19	91	2.2	1.000
Emerging	0	0	1	20	1	10	0	0	2	10		
Commercial	0	0	0	0	0	0	0	0	0	0		
Total	**1**	**100**	**5**	**100**	**10**	**100**	**5**	**100**	**21**	**100**		
Trained respondents												
Farmers aspirations in five years time	**Age groups**								**Total**		**Fisher's exact test**	
	<=35		**36-50**		**51-65**		**>65**					
	N	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Value**	**P**
Subsistence	4	20	12	33	23	55	21	55	60	44	12.3	0.051
Emerging	4	20	8	22	9	21	6	16	27	20		
Commercial	12	60	16	45	10	24	11	29	49	36		
Total	**20**	**100**	**100**	**36**	**42**	**100**	**38**	**100**	**136**	**100**		
Control group												
Subsistence	1	100	4	80	8	80	3	60	16	76	6.5	0.475
Emerging	0	0	1	0	2	20	2	40	4	19		
Commercial	0	0	1	20	0	0	0	0	1	5		
Total	**1**	**100**	**5**	**100**	**10**	**100**	**5**	**100**	**21**	**100**		

According to the above table there is significantly less trained respondents (70%) in the lowest age group (≤35) perceiving themselves as subsistence farmers than in the older categories (83 – 93%). The younger the trained respondents the more they aspire to became commercial farmers namely, only 5% perceived themselves as commercial farmers but 60% aspire to became a commercial farmer. In the age group of 51-65 not one respondent perceived himself as on a commercial level of farming and disappointingly only 24% aspire to become commercial farmers. In the control group no differences occur between and within the age categories with regard to their perception and aspiration.

These results are supported by literature review and according to Gorfe (2004:45) who reported positive relationships between age and the adoption behaviour of farmers and the resulting production efficiency. He indicated that, generally it is assumed that younger people are more open to ideas than older ones and therefore, are believed to be more likely to adopt agricultural technologies relatively. It is also clear that the trained respondents in all age categories do have higher aspirations. The attendance of training courses at DRTC did have a positive effect on respondents specifically with regard to their aspirations.

4.2.4 Trained farmers' perception and aspirations based on educational level

The result of farmer categorization based on the level of education is tabulated in Table 6.

According to Table 6 there is a significant difference ($p = 0.05$) between trained respondents (92%) with no education and those respondents with some level of education (80%) indicating that they perceive themselves as subsistence farmers. No differences occur between the two education categories and their aspirations of where they aspire to be in five years time. It is however clear that exposure by means of training courses did positively effect all the respondents with regard to their aspirations.

Table 6: Respondents' current perception and future aspirations based on education with regard to three farming categories

Trained respondents								
Farmers perception at present	**Education level**				**Total**		**Fisher's exact test**	
	No education		**Some education**					
Farmer categories:	**n**	**%**	**n**	**%**	**n**	**%**	**Value**	**P**
Subsistence	54	92	68	80	122	85	5.903	0.053
Emerging	5	8	10	12	15	10		
Commercial	0	0	7	8	7	5		
Total	**59**	**100**	**85**	**100**	**144**	**100**		
Farmers aspiration in five years time	**Trained respondents**				**Total**		**X^2**	
	No education		**Some education**					
Farmer categories:	**n**	**%**	**n**	**%**	**n**	**%**	**Value**	**P**
Subsistence	27	46	38	45	65	45	.369	0.831
Emerging	13	22	16	19	29	20		
Commercial	19	32	32	36	50	35		
Total	**59**	**100**	**100**	**100**	**144**	**100**		

4.2.5 The relationship between size of land and farmer categories

Field size is one of the environmental factors that, in general, have been found to be an important behaviour determinant (Rogers & Shoemaker, 1971). A possible reason for this is that the appropriateness of the innovation is very often dependent on farm size. The importance could also be attributed to other factors such as net worth or wealth, which is often associated with large farming units. Table 7 illustrates the farmers' perception and aspirations with regard to farmer categories and the influence of field size.

Table 7 clearly indicated that significantly (p = 0.02) less trained respondents (76%) with more than 10 ha of land perceived themselves as subsistence farmers than trained respondents (90%) with between 6 to 10 ha and trained respondents (90%) with less than 5 ha of land. In the control group no differences occur between the field size categories and the respondent's perception of farmer categories. The significant relationship ($\mathbf{X^2}$ = 10.248; p = 0.02) is supported by Abd-Ella (1981:45) who reported that larger farm size means more resources and greater ability to take the risk involved in the adoption of recommended practices. Rogers (1983:252) has also generalized that early adopters have a larger-sized units than later adopters.

Table 7: Respondents' current perception and future aspirations with regard to farmer categories based on size of land

Trained respondents										
Farmers perception at present	**Field size in hectares (ha)**									
	<=5		**6 – 10**		**>10**		**Total**		**χ^2**	
	N	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Value**	**P**
Subsistence	44	90	44	90	28	76	116	86	10.248	0.022
Emerging	4	8	5	10	3	8	12	9		
Commercial	1	2	0	0	6	16	7	5		
Total	**49**	**100**	**49**	**100**	**37**	**100**	**135**	**100**		
Control group										
Subsistence	6	86	5	83	8	100	19	90	1.673	0.505
Emerging	1	14	1	17	0	0	2	10		
Commercial	0	0	0	0	0	0	0	0		
Total	**7**	**100**	**6**	**100**	**8**	**100**	**21**	**100**		
Farmers aspirat-ions in five years time	**Trained respondents**									
	N	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**Value**	**P**
Subsistence	26	53	24	49	12	32	62	46	5.521	0.238
Emerging	9	18	11	22	7	19	27	20		
Commercial	14	29	14	29	18	49	46	34		
Total	**49**	**100**	**49**	**100**	**37**	**100**	**135**			
Control group										
Subsistence	6	86	4	66	6	75	16	76	2.755	0.792
Emerging	1	14	1	17	2	25	4	19		
Commercial	0	0	1	17	0	0	1	5		
Total	**7**	**100**	**6**	**100**	**8**	**100**	**21**	**100**		

4.2.6 Farmers' contribution to the development of the training programs

The extent to which trained respondents participated in the developing of courses they attended, are indicated in Figure 3.

Sixty-five percent of the respondents indicated that they were never involved in identifying the courses they attended, and only 11 percent indicated that they were involved annually. The question then arises, who was responsible for identifying the courses, the results are illustrated in Table 8.

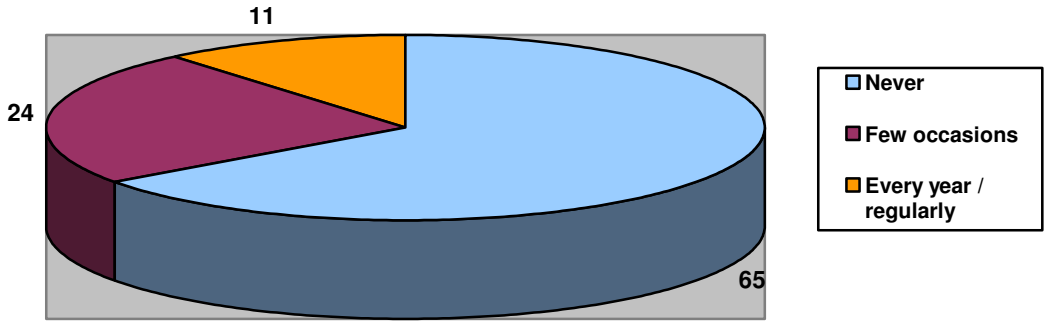

Figure 3: Respondents' involvement in training course identification

Table 8: Respondents' perception of who was responsible for identifying training courses

Categories	Frequency	Percent
Don't know	5	4
Others	4	3
Extension agent	113	80
Farmers committee	19	13
Total	141	100

Eighty percent of the respondents reported that the courses were suggested by extension agents, as compared to 13% who indicated that they were suggested by farmers committees.

The results in Figure 3 and Table 8 indicated that the felt needs of respondents were not addressed, ignoring the very important extension principle of participation.

4.2.7 Impact of knowledge gained on farming practices of trainees

Richardson (1999:46) argues that in judging public benefit, "people impact" is a key factor in program accomplishments. The people impacts may be indicated as financial gains, taxpayer savings; efficiencies gained; environmental enhancements or protection; individual life enhancements; resource preserved; or societal improvements. The status of the impact of training on respondents production efficiency is presented in Table 9.

Table 9: Status of training impact on farmers' production efficiency

Categories	Frequency	Percent
No impact at all	55	36
Moderate impact	68	45
Positive impact	28	19
Total	151	100

The results show that 36% of the respondents reported that the courses did not have any impact on their production efficiency, while 45% reported a moderate impact and only 19% indicated a positive impact.

The control group was requested to compare their production efficiency with the production efficiency of the trained respondents. The results are presented in Figure 4.

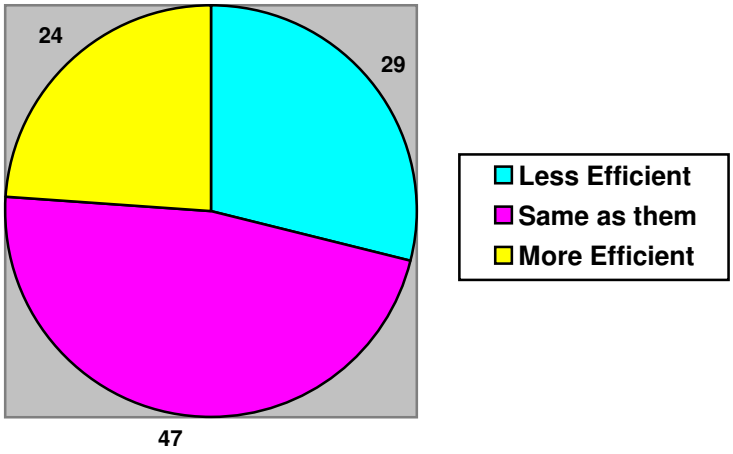

Figure 4: Control group's perception about their production efficiency with regard to trained farmers

Almost half (47%) of the control group respondents feel that their production efficiency is the same as for trained farmers and 24% indicated that they are even more efficient. This must be seen as a warning light with regard to the effectiveness of the training courses.

4.2.9 Status of technology adoption according to extension staff

The results of implementation of acquired knowledge and the reasons why courses are effective or not effective as perceived by extension agents, support staff and instructors are narrated in Table 10.

Table 10: Implementation status of acquired knowledge and reasons why courses are effective or not effective

Variable	Implementation status							
	Categories	Respondents						
		Agents		Support		Instructors		Total	
		n	%	n	%	n	%	n	%
What is usually the status of implementation of acquired knowledge when making follow-up visits	Positive	12	36	3	33	2	40	17	36
	Negative	21	64	6	67	3	60	30	64
Total		**33**	**100**	**0**	**100**	**5**	**100**	**47**	**100**
Explanation why courses are effective or not effective									
Reasons		**Respondents**							
		Agents		**Support**		**Total**			
		n	**%**	**n**	**%**	**n**	**%**		
Farmers implement technologies		10	30	4	44	14	33		
No implementation/adoption		21	64	5	56	26	62		
Material not relevant to farmers' needs		2	6	0	0	2	5		
Total		**33**	**100**	**9**	**100**	**42**	**100**		

A total of 64% of all staff respondents feel that there is no implementation (negative) of the acquired knowledge or technology. These results are supported by the reasons given, where 62% of all staff respondents reported that courses are not effective because there is no implementation. In its simplest form the non-adoption of innovations and practices according to Düvel (1991:78) can be traced back to two basic causes:

i) The individual is either uncapable or unwilling to adopt the recommended practice.

ii) Unwillingness to adopt can directly or indirectly be linked to a lacking need, and the related aspects of perception and knowledge. The non-implementation of acquired knowledge by the trained respondents in this study, can be based on the fact that they did not perceive any inconsistency or recognize that a

need exist and according to staff respondents (64%) the main reason for non-implementation is a shortage of resources.

5. CONCLUSIONS AND RECOMMENDATIONS

In conclusion the study established that the intervening variables are the most important and crucial variables in behaviour analysis, especially if compared to the limited influence of the independent variables. These findings conclude that for training to be effective and to have an impact on respondents' production efficiency, extension has to address the needs and perception of the trainees. Independent variables that need to be taken in consideration are:

- Gender (61% of respondents were female/age (majority in age group 51.7).

- Females are more literate than males

- The larger the land available for farming the more respondents perceive and aspire to be commercial farmers.

It has been revealed that more than half of the respondents did not participate in identification of the courses they attended. This supports the hypothesis that the training program does not address the needs and perception of respondents. The impact of knowledge on farming practices of trainees is not significant, due to the fact that respondents do not implement the acquired technologies. This also support the hypothesis that the poor impact of training on farmers production efficiency is a function of non-adoption or implementation of acquired knowledge. One of the main reasons for non-implementation noted by all respondents is a lack of resources.

Proposed recommendations:

- The Extension service should develop a system to involve farmers when planning and developing training courses in order to address the farmers needs.

- Training should be focused on young male and female farmers who more readily perceive themselves as commercial farmers.

- Clear mechanisms of how to evaluate the impact of training should be established for each course and evaluation should be compulsory.

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