CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Chapter three commences by briefly describing the two areas where the research had been conducted. Report on the research design proceeds with sampling and data collection methods. This is followed by definition of the variables and the statistical analysis procedure employed.

3.2 THE STUDY AREA

The study was conducted in the Southern part of Ethiopia in the Shashemene district and the Debrezeit town (Ada Liben) of Oromia regional state during the period February to December 2002 (Fig. 3.1).

Shashemen district is well known for its potential in maize production and is one of the districts where the package-based extension program was first initiated by the SG 2000 project. Moreover, a dairy establishment, the second interest of the researcher, is found along the highway to Shashemene, which makes the nomination of Shashemene and Debrezeit realistic not only from a technical point of view but also due to its economic relevance. This is to say that due to financial and time constraints the study was conducted only in one district concerning maize. However, the results are expected to be reasonably representative of the wider maize growing areas than is usually possible. Most of the maize growing areas in the country are found under similar geographical (Low and medium agro ecological zones) and socio-economic conditions (similar input and output marketing system, similar technology and technology promotion services, similar land ownership policy etc.). Similar assumptions apply in the case of dairy production.

Fig. 3.1 Location of the study sites

3.2.1 Shashemene District

It is located some 275 km South of Addis Ababa nearby the capital of Southern Nations, nationalities and peoples' region, Awassa. It comprises the three traditionally known agro ecological zones (AEZs) namely the low altitude (below 1500masl.), the middle altitude (1500-2500masl.) and the high altitude (2500-3500masl.) AEZs.

Maize is believed to be one of the most widely grown cereals in the first two AEZs planted along with wheat, potato and beans. The rainfall is bimodal; the major rainy season (July to September) offers the main harvest for the district. During the small rainy season, which covers the periods February to March, farmers grow potato and maize to sell while the cob remains still green to earn a small income. Lack of water is a major constraint in the use of recommended practices especially in the lower altitude zone where the rainfall is highly erratic, small in amount and irregular in distribution.

A typical farmer in Shashemene district is believed to own only a small piece of land (<2 ha.) and on average only one ox (an important element of the farming system), 2 to 3 other farm animals, a few sheep and a donkey (mainly used as a source of income and for draught purposes. The farmlands are usually flat and gently sloping and fertile. Most of the marginal lands are found either near depressions (highly eroded) sloping or hilly areas and mainly used for afforestation or communal grazing supporting farm animals.

According to a report from the district Bureau of Agriculture, the district has 36 peasant associations (PAs[1]) of which 28 are located in the low and middle altitude AEZs and 15,000 farm families are believed to reside in the first two maize growing AEZs having an average of 530 farm households per PA. PAs are the most important institutions in the village, which were first established during the previous socialist oriented regime of the military government with the purpose of facilitating the participation of the peasant community in the development process of their village and the country at large. They are responsible to organize the community to participate and nominate its representatives during elections and are delegated by the government to administer rural land especially farm lands. Service cooperatives are the second forms of peasant institutions (mainly working in close association to the PAs catering for provision of agricultural inputs such as fertilizer, seed and agro chemicals and agricultural credit. Two to three PAs form a service cooperative. These important institutions are currently in the process of being reinstated in the district after they collapsed during the change in the government in 1991 and are not yet in a position to offer the required services to members.

Extension is one of the most important services provided by the government to the district. There is one development center per PA with a multipurpose development agent, usually a certificate holder, deployed at each center. In view of the very critical yet very demanding nature of the profession, however, the quality of training of DAs does not seem to be sufficient. The government being aware of this problem has embarked on a very ambitious, but rather naïve training program. 3000 trainees nominated from all over the country, including Shashemene have, for example, recently been enrolled in one of

[1] Lowest administrative unit

the training centers situated some 100 km away from Shashemene without prior preparation of the syllabus and program.

3.2.2 Ada Liben Woreda Dairy and Dairy Products Marketing Association

This association is found in the town of Debre Zeit situated in the Oromia region, 45 km south east of Addis Ababa. It was established about four years ago with the major objective of providing services vital to its members such as artificial insemination, animal health, training, marketing and input delivery. It works towards fulfilling the growing demands for milk by the surrounding urban and peri-urban areas such as Addis Ababa, Nazareth, Debre Zeit, Dukem, and Mojo. It also aims at promoting dairy production technologies for the surrounding rural communities and plays the role of a model farm for currently emerging similar associations in other areas of the country.

Presently, it has seven milk collection sites engaged with the collection, handling and transportation of milk to the cooperative shop from where it is finally hauled to terminal markets. The association is currently looking for financial sources to implement its plan of expanding the current dairy plant to a fully-fledged establishment consisting of a dairy processing plant, feed processing plant, animal health unit, artificial insemination unit, conference and training unit, and other service providing units. Although there are other cooperatives equally becoming important and flourishing within a radius of 200 km around Addis Ababa, ALWDDPMA was selected because of cost implications. ALWDDPMA is closer to the second study site, Shashemene, which allowed for significant savings in survey cost and time.

3.3 SAMPLING AND DATA COLLECTION

The formal field survey began by a ten days reconnaissance survey aimed at nomination of representative sample areas, interviewers, and community leaders who would be involved in the study. The draft questionnaire (see Appendix 3.1) was thoroughly

discussed with researchers and subject matter specialists working in extension. This is followed by a one-week training of interviewers conducted along with the pretest of the questionnaire.

Care was taken to ensure randomness of the sample by making sure that every PA and maize and dairy farmer had an equal chance of being selected and that the sample size was reasonably representative. Regarding maize, simple random sampling techniques were employed to choose four among the 28 maize growing peasant associations (PAs), two from each AEZ. However, in one case, another adjacent PA had to be considered due to the inaccessibility of the nominated PA and the unavailability of the assigned development agent (the interviewer).

Finally, considering the available time and financial resource allocated for the research and assuming that a sample size of about 10 percent is a fairly representative one, 50 farmers from each of the four PAs or a total of 200 farmers from 2120 farm households of the two AEZs were randomly drawn. The same procedure was followed to nominate 200 dairymen for the study. But the fact that dairy farmers are residing in one town, decreased travel and other expenses and enabled to cover more farmers (46 percent) with the available budget than in the case of maize farming.

3.4 DEFINITIONS AND MEASUREMENT OF VARIABLES

The variables identified to have an influence on behavior as established from the extensive review of the literature can broadly be classified into independent and intervening variables. Once the variables considered for behavior analysis were identified, scales were developed (Table 3.1) for purposes of quantification and for providing a basis for analyzing relationships. The procedure used to measure and categorize each of the independent, intervening and dependent variables considered in this study is provided in this section.

3.4.1 The independent variables

Independent variables considered in this study include personal variables such as attitude toward change, attitude toward education, attitude toward science, secularism and fatalism which were all aggregated into one composite variable, namely attitudinal modernity (David and Inkeles in Saeed 1999:309-316) age, education and literacy. Other variables included socio economic and communication variables such as farm size, the geographical region where farmers reside (agro ecology), organizational participation, change agent contact and mass media exposure (Rogers, 1983:251-258; Bembridge and Williams, 1990:53; Ristow & Bembridge, 1993:38-40; Elias, 1999:72-74). The following is a more detailed description of these variables:

Age: Measured on a continuous scale in terms of the respondent's number of years of age at the time of data collection. Based on the deviation of their age from the mean, maize and dairy farmers were categorized into four groups as indicated in Table 3.1.

Formal education: Measured in terms of the number of years of formal schooling the respondent has completed at the time of data collection. If the learner did not pass a year, he is enumerated as illiterate. Participants who completed grades 1 to 6 and 7 to 12 are said to have a primary and secondary level of education. Those farmers who passed secondary school leaving examinations and joined higher learning institutions were categorized into those who have a tertiary level of education.

Literacy: Refers to the ability to read and write. It was measured on the ordinal scale by asking respondents to read few written lines. It was, however, dropped from further analysis as it was found to be multicollinear with formal education.

Farming experience: Defined as the chronological time or the number of years spent in farming by the respondent. Among respondent maize farmers' farming experience revealed a high degree of multicollinearity with age. Dairy farmers were categorized into three farming experience groups of, least, medium and most based on the deviation of their experience from the sample mean.

Organizational participation: This reflects on the degree of involvement of the respondent in existing formal and or non-formal organizations during the last five years. Respondents were categorized into those who have low or high participation based on the deviation of their mean organizational participation score from the sample mean score obtained by aggregating item values.

Gender: Refers to the sex of respondent or head of the household.

Attitudinal modernity: Is a composite variable encompassing analytical (disposition to hold opinions, planning orientation, belief in the calculability of the world, distributive justice etc.), topical (kinship and family, women's rights, birth control, religion, social stratification, physic adjustment etc.) and behavioral (political orientation, religious affiliation, media exposure, etc.) factors assumed to be able to measure the level of modernity (Inkeles, 1920: 35). The 33-item socio-psychological OM Scale (Smith & Inkeles, 1966:353-377) was used for this purpose. Based on the deviation of their attitudinal score from the sample mean score, respondents were classified into low, medium and high attitudinal modernity groups.

Agro ecology: Refers to the geographical area in which the maize respondent is currently residing and producing. Hundred farmers were drawn equally from each of two-agro ecological zone namely lower and middle altitude known for growing maize.

Farm size/size of enterprise: Farm size is defined as the scale of operation. As far as maize farming is concerned, it was measured as the total land holding of the respondent excluding land leased-in and out. In dairy this is measured by the preceding year's average fortnightly milk supply of the individual to the dairy marketing association. This was found to be an appropriate measure since it was assessed to be an established procedure where the cooperative had been using it to classify its members. Dairy farmers were also suspicious and not willing to report on the actual and exact number of their dairy cattle whereas the amount of milk supplied to the cooperative could easily be captured from milk and financial records found in the cooperative office. Maize and

dairy farmers were grouped into small, medium and bigger farm size groups depending on the deviation of their score from the mean.

Change agent contact: This refers to the frequency of contact that the respondent made with the various information sources. Field experience with the package program has shown that, farmers require extension advices mainly at critical periods like during planting, weeding, topdressing, spraying, etc. These activities are roughly occurring one month apart from each other. If farmers have access to extension during these periods, they are expected to receive sufficient information required to properly implement their field activities. Respondents having an average contact of at least once a month were categorized into the high extension contact group whereas those having a contact of less than once a month were categorized into the low contact category.

Mass media exposure: This is also a composite score measured on an ordinal scale. The number of times, which a respondent listens to radio and TV, participate in meetings and read any print material were used as the basis to form a composite scale of respondents' level of exposure to media and classify them into low and high media exposure categories.

3.4.2 The Intervening variables

According to Düvel (1995:46), the obvious variables on which attention needs to be placed in behavior analysis are the intervening variables. He broadly categorized these variables into needs, perceptions, and knowledge. There is a certain degree of overlapping between these concepts, certain aspects of knowledge, for example, are synonymous with aspects of perceptions and needs and are sufficiently covered by them (Düvel, 1991:81). Needs and perceptions are considered in this study.

Table 3.1 Categorization of maize and dairy farmers regarding independent variables

Variable	Maize		Dairy	
	Category	Frequency	Category	Frequency
Age	18-30	54	13-38	53
	31-41	50	39-45	47
	41-52	44	46-57	48
	55-85	52	58-80	52
Agro Ecology	Low altitude	100	-	-
	Middle altitude	100	-	-
Gender	Male	184	Male	166
	Female	16	Female	34
Farming Experience	Least	65	Least	68
	Medium	58	Medium	67
	Most	77	Most	65
Education	Illiterate	98	Illiterate	39
	Primary	70	Primary	29
	Secondary	32	Secondary	95
			Tertiary	37
Farm size	Small	50	Small	68
	Medium	94	Medium	67
	Bigger	56	Bigger	65
Organizational participation	Low	75	Low	173
	High	125	High	27
Extension contact	Low	163	Low	190
	High	37	High	10
Media contact	Low	75	Low	66
	High	125	High	134
Attitudinal modernity	Low	74	Low	57
	Medium	72	Medium	71
	High	54	High	72

Needs: According to Witkin and Altsculd (1995:9), need is the gap or discrepancy between the present (what is) and the desired state, future state, or condition (what should be). In this sense a need is problem related. Another type of need relates to need compatibility, which refers to the degree to which a practice or an innovation is compatible with the individual's needs. These variables were measured as follows:

a) Perceived current efficiency (PCE): Based on the experience of Koch (1987:21), both respondents and enumerators (local development agents) were asked to estimate the current efficiency of practice adoption and production efficiency among both maize and

dairy farmers. A five-point scale was used to determine the level of over or under assessment. Respondents were then categorized into those who either under-rate, slightly under rate, had no perception discrepancy, slightly over-rate or overrate their efficiency or level of adoption of a practice as shown in Table 3.2. Problem perception discrepancies were determined in respect of production efficiency and the practices of fertilizer use, spot application of fertilizer, improved seed, and line planting in the case of maize farming. Similarly problem perception discrepancies in respect of production efficiency and the practices regarding breed, housing, medical and feed were determined in the case of dairy.

b) Need tension (NT): The need tension or the perceived problem is referred to as the gap between the existing and the desired situation (Düvel, 1991: 80). Based on this definition, respondents were asked to rate (on the same five-point scale) their present and aspired level of practice adoption and production efficiency. They were then based on the scope of the difference, classified into low, medium and high need tension classes in terms of production efficiency and the already mentioned identified practices in both maize and dairy farming.

c) Need compatibility (NC): Need incompatibility arises when the recommended practice does not fit the life space or need situation of the individual or when it is not perceived as a means of achieving the individual's goal (Düvel, 1998:35). Correspondingly, respondents were asked to estimate the level of production they would have attained if they had used (or not used) the practices or packages as recommended with the aim of assessing the compatibility of each of the individual practices to the goals of the respondents. Respondents were then classified into either the low, medium or high need compatibility classes for each variable as depicted on Table 3.2. This assessment was made in terms of need compatibility-fertilizer, -seed, -spot application, -line planting in maize and need compatibility-breed, -housing, -medical, and -feed in the case of dairy.

Perception of total attributes (PTA): Düvel (1991:80) associates perceptions with the way the attributes of innovations are perceived and he distinguishes between (a) the awareness of relative advantages, (b) awareness or concern about disadvantages, (c) the

overall prominence or relative advantage of innovation (practice) and (d) the compatibility with situational circumstances. The procedure involved to measure perceptions in this survey were as follows:

- A comprehensive list of attributes has been prepared by the researcher based on prepared questionnaire and discussions with specialists in the field and used as a checklist during the actual survey.
- Determining the reason (s) why a respondent had personally considered the adoption or rejection of specific innovation as part of the interview, each reason being recorded as a positive or negative psychological field factor based on the responses of respondents. Interviewers were trained to provoke discussion and stimulate respondents' memory.
- Determining the valences (strength) of each of these perceptions by being them assessed on a five-point scale.
- Computing the total valences for behavior positive and negative psychological field forces to come up with net perception of total technology attributes.

In connection with this procedure, Düvel (1975:9) asserts that when the sum total of positive forces is more than that of negative ones, there is a possibility for positive decision-making in respect of the adoption of innovation.

The perceptions of innovation attributes were assessed in terms of four maize practices (perception of technology attribute-fertilizer, -seed, -spot application of fertilizer, -line planting) and four dairy practices (perceptions of technology attributes-breed, -housing, -medical, -feed).

Table 3.2 Categorization of maize and dairy farmers regarding intervening variables

Maize			Dairy		
Variable	Category	Frequency	Variable	Category	Frequency
PCE*-efficiency	Had no discrepancy (ND)	19	PCE-efficiency	Under rate	14
	Slightly over rate (SOR)	108		Slightly under rate	116
	Over rate (OR)	73		Had No discrepancy	70
PCE-fertilizer	Slightly under rate (SUR)	37	PCE-breed	Under rate	95
	Had no discrepancy	133		Had no discrepancy	70
	Over rate	30		Over rate	35
PCE-spot	Slightly under rate	38	PCE-housing	Under rate	32
	Had no discrepancy	137		Had no discrepancy	70
	Over rate	25		Over rate	98
PCE-seed	Slightly under rate	32	PCE-medical	Under rate	74
	Had no discrepancy	168		Had no discrepancy	86
				Over rate	40
PCE-line planting	Slightly under rate	30	PCE-feed	Under rate	66
	Had no discrepancy	130		Had no discrepancy	102
	Over rate	40		Over rate	32
NT*-efficiency	Low	32	NT-efficiency	Low	136
	Medium	107		High	64
	High	61			
NT-fertilizer	Low	63	NT-breed	Low	74
	Medium	61		High	106
	High	75			
NT-spot	Low	72	NT-housing	Low	79
	Medium	59		Medium	92
	High	69		High	29
NT-seed	Low	56	NT-medical	Low	71
	Medium	58		Medium	81
	High	86		High	48
NT-line planting	Low	113	NT-feed	Low	22
	High	87		Medium	138
				High	40
NC*-fertilizer	Low	66	NC-breed	Low	44
	Medium	51		Medium	98
	High	83		High	58
NC-spot	Low	66	NC-housing	Low	99
	Medium	70		Medium	101
	High	64			
NC-seed	Low	56	NC-medical	Low	73
	Medium	86		Medium	90
	High	58		High	37
NC-line planting	Low	67	NC-feed	Low	60
	Medium	61		Medium	77
	High	72		High	54

Table 3.2 Continued...

Maize			Dairy		
Variable	Category	Frequency	Variable	Category	Frequency
PTA*-fertilizer	Low	65	PTA-breed	Low	69
	Medium	63		Medium	65
	High	72		High	66
PTA-spot	Low	67	PTA-housing	Low	67
	Medium	73		Medium	67
	High	60		High	66
PTA-seed	Low	66	PTA-medical	Low	63
	Medium	64		Medium	67
	High	70		High	70
PTA-line planting	Low	71	PTA-feed	Low	56
	Medium	60		Medium	75
	High	69		High	69

* PCE=Perceived current efficiency, NT=Need tension, NC=Need compatibility, PTA=perceived total attributes

3.4.3 The dependent variables

Extension interventions are normally evaluated or focused on the adoption behavior regarding recommended practices for optimizing sustainable production and thus the resulting outcome in terms of physical (e.g., yield) and economic (e.g., profit) success. Adoption or use of recommended practices and production efficiency as measured by the yield of each of the respondents harvested during the previous season were, therefore, the major dependent variables considered in this study.

Based on the deviation of their score from the mean of the total adoption and efficiency score, participants were classified into two, three or four adoption and efficiency categories, i.e. maize farmers were classified into four adoption (non, low, medium and high) and five efficiency (least efficient to most efficient) categories while dairy farmers were classified into three adoption and five efficiency classes (Table 3.3).

Table 3.3 Categorization of maize and dairy farmers according to dependent variables

Maize Farming			Dairy Farming		
Variable	Category*	Frequency	Variable	Category	Frequency
Efficiency	1	41	**Efficiency**	1	35
	2	24		2	41
	3	43		3	48
	4	54		4	40
	5	38		5	36
Adoption (Package)	None	47	**Adoption (Package)**	Low	60
	Low	49		Medium	69
	Medium	47		High	71
	High	57			
Row planting	None	20	**Breed**	Medium	37
	Low	84		High	163
	Medium	61			
	High	35			
Seed	None	102	**Housing**	Low	58
	Low	27		Medium	72
	High	71		High	70
Fertilizer	None	47	**Feed practice**	Low	85
	Low	61		Medium	44
	High	92		High	71
Spot application	None	57	**Medical practice**	Low	62
	Low	78		Medium	52
	High	65		High	86

*1=Least efficient, 5=Most efficient

3.5 STATISTICAL ANALYSIS

The analysis of data involved the use of statistical package for social sciences (SPSS^x version 9). Before analysis, the data was put in a computer readable format which involved coding (making sure that numbers are assigned to each variable and that the labels are correctly measured either at the interval, ordinal or nominal levels), editing (checking the questionnaire repeatedly as complete and error free as possible), data cleansing (running frequency tables and inspect the outputs to check if mistakes were made during entry) and finally modifications regarding the collapse or creation of new variables.

The principal techniques employed for data analysis included: a) frequency distribution together with the use of graphic displays, tables and charts to illustrate data and facilitate analysis b) correlation analysis such as Pearson's product moment correlation, Spearman's correlation, none parametric tests, Chi square (χ^2) test, t-test and one way analysis of variance (ANOVA) to test significance of the differences between two or more independent groups respectively and c) multiple and hierarchical regression analysis to assess the contributions of independent and intervening variables on the dependent variables.

3.5.1 Frequency distribution and graphic analysis

Frequency distributions and some graphical techniques like the histograms, bar charts and line graphs were used to summarize large amounts of information, for example yield, and facilitate presentation and analysis of data and the respective findings.

3.5.2 Correlation analysis and significant tests

Bivariate correlation analysis, a contingency table analysis procedure and mean comparison methods (independent samples t-test and one way ANOVA) were employed to compute the Pearson product moment correlation coefficient, the χ^2 and the F values respectively depending on the nature of the variable under investigation. The aim has been to assess the existence and magnitude of associations between the independent and the dependent variables and identify the appropriate variables that could be included for further analyses and test the existence of significant difference between the various statistical groups.

3.5.3 Multiple regression analysis

Multiple regression analysis (ordinary list squares) is a statistical technique that can be used to analyze relationships between a single dependent (criterion) variable and several independent (predictor) variables with the object of using the independent variables

whose values are known to predict the single dependent value (Hair *et al,* 1998: 148). Standard and hierarchical multiple regression analysis procedures were employed for testing relationships hypothesized in this study and make comparisons between the effects of the set of independent and intervening variables on the criterion variable. Path analyses were also employed in some cases based on regressed values to determine indirect effects.

According to Tabachnick and Fidell (2001:111), the regression equation takes the form:

$$\hat{y} = A+B_1X_1+B_2X_2+\ldots+B_kX_{ky}$$

Where $\hat{y}$ is the predicted value on the dependent variable, A is the Y intercept, the Xs represent the various independent variables (of which there are k), and the Bs are the coefficients assigned to each of the independent variables during regression.

According to Field (200:127), for a regression model to be valid it has to be ensured that the underlying assumptions have been met so that the likelihood of similarity between population parameters and results of the sample model will be high. The test should be conducted both in univariate and multivariate analyses. Testing for the assumptions of univariate analysis involves obtaining descriptive statistics such as the mean, standard deviation, range, skewness and kurtosis to see the normality of the distribution of scores and the absence of outliers.

Preliminary analyses were made to check for the aforesaid two assumptions. Analyses of the distribution of scores (skewness and kurtosis) on the independent, intervening and dependent variables both in maize and dairy farmers showed that there is no serious violation of the assumption of normality. Although the skewness and kurtosis values of some variables tended a little above 1 and below –1, the fact that the sample size, both for the dairy and maize farmers, is quite large, reduces the effects of peaked and unsymmetrical distribution on model results. According to Tabachnick & Fidell, (2001:74) with reasonably large samples (200 or more cases), skewness and kurtosis will not make a substantive difference in the analysis.

Univariate outliers are observations with a unique combination of characteristics identifiable as distinctly different from other observations (Hair *et al,* 1998:64). Descriptive statistics showed that the five percent trimmed mean is lower than the mean for need compatibility regarding production efficiency in the cases of both the two commodities. The box plot analysis also produced similar results. This observation was, however, retained for further analyses after revaluating it to a lesser extreme value as suggested by Hair, *et al,* (1998:66) and Pallant (2001:62).

With multivariate analyses, the existence of a high pair-wise correlation (in excess of 0.8) among regressors indicates a serious degree of multicollinearity (Gujarati, 2003:359). By multicollinearity, is meant that it may not be possible to tell the difference of one independent variable free from the influence of the other independent variables with which it is correlated (Bernard, 2000: 632). Most obvious means of identifying collinearity is an examination of the correlation matrix of the independent variables (Hair *et al,* 1998:191). Tabachnick & Fidell (2001:84) suggest the omission of one of two variables if they are found to have a bivariate correlation of more than 0.7. Farming experience and literacy were accordingly omitted from adoption and efficiency models of maize farmers whereas their respective covariance age and education were retained. In dairy, only literacy was omitted for purposes of multicollinearity problem (Tables 3.4 and 3.5 below). As illustrated in Table 3.4, in maize, the correlation between literacy and education is 0.939, while the correlation value of age and farming experience is 0.913. In the same way Table 3.4 illustrates that in dairy the variable literacy has a bivariate correlation value of 0.854 with education.

Concerning psychological factors, the causal variables need compatibility relating to seed is found to be multicollinear with need compatibility of fertilizer rate and spot application. Need compatibility relating to line planting is also multicollinear with need compatibility of seed, fertilizer, and spot application (Table 3.6). The variable need compatibility of fertilizer rate is, therefore, the one considered in the regression analysis. There was no multicollinearity problem concerning the intervening factors regarding dairy farming.

Table 3.4 The correlation matrix of independent variables affecting the production efficiency of maize growers

	1	2	3	4	5	6	7	8	9	10
1 Ecology	1.000									
2 Age	-.194	1.000								
3 Education	.060	-.534	1.000							
4 Literacy	.024	-.555	.939*	1.000						
5 Farm size	-.565	.115	-.078	-.061	1.000					
6 Experience	-.161	.913*	-.514	-.543	.097	1.000				
7 Agent contact	.060	-.004	.111	.132	-.159	-.015	1.000			
8 Media	.183	-.333	.509	.509	-.199	-.37	.368	1.000		
9 Modernity	-.039	-.210	.414	.403	-.171	-.212	.414	.495	1.000	
10 Efficiency	.244	-.300	.349	.359	.023	-.284	-.018	.336	.05	1.000

*=Multicollinear

Table 3.5 The correlation matrix of independent variables affecting the production efficiency of dairy farmers

	1	2	3	4	5	6	7	8	9
1 Age	1.000								
2 Education	-.196	1.000							
3 Literacy	.214	.854*	1.000						
4 Gender	-.096	.319	.354	1.000					
5 Farm size	.172	.07	.083	.008	1.000				
6 Experience	.314	-.195	-.129	-.155	.154	1.000			
7 Media	-.166	.456	.451	.217	-.020	.024	1.000		
8 Modernity	-.204	.541	.473	.227	.041	-.294	.203	1.000	
9 Efficiency	.158	.265	.228	.032	.324	.042	.023	.177	1.000

*=Multicollinear

Tale 3.6 Inter correlations of intervening factors affecting production efficiency (Maize)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 PCE*-Efficiency	1.000																		
2 NT* -Efficiency	-.508	1.000																	
3 PTA*-fertilizer	.067	-.233	1.000																
4 PTA-spot application	.059	-.038	-.104	1.000															
5 PCE-seed	-.120	.051	.220	.120	1.000														
6 PTA-line planting	.132	-.071	-.190	.632	-.110	1.000													
7 PCE-Fertilizer	-.065	.110	.122	-.422	-.119	-.312	1.000												
8 PCE-spot application	-.107	.149	-.005	-.484	-.060	-.363	.342	1.000											
9 PCE-Seed	-.076	.091	.031	-.218	-.004	-.210	.384	.269	1.000										
10 PCE-line planting	-.020	.044	.087	-.302	-.108	-.178	.258	.343	.189	1.000									
11 NT-Fertilizer	-.095	.469	-.018	-.096	-.014	-.133	.046	.165	.159	.123	1.000								
12 NT-spot application	.031	.177	.139	.004	.056	.010	.075	-.137	.232	.011	.606	1.000							
13 NT-seed	-.091	.329	.155	-.236	-.062	-.261	.309	.083	.183	.101	.559	.442	1.000						
14 NT-line planting	-.257	.425	-.188	.247	.128	.125	-.132	.036	-.174	-.177	.251	.080	.080	1.000					
15 NC*-fertilizer	-.076	-.277	-.087	-.109	.043	-.003	-.094	.040	-.106	-.009	-.416	-.414	-.463	-.131	1.000				
16 NC-spot application	-.087	-.332	-.107	-.039	.080	.034	-.131	-.043	-.170	-.035	-.610	-.463	-.495	-.117	.896*	1.000			
17 NC-seed	-.092	-.320	-.061	-.090	.077	-.022	-.066	-.039	-.120	-.017	-.581	-.438	-.356	-.134	.880*	.971*	1.000		
18 NC-line planting	-.115	-.268	-.162	.013	.079	.064	-.150	-.029	-.210	-.031	-.649	-.584	-.552	-.059	.856$	.960$	.926$	1.000	
19 Adoption package	.110	-.348	-.155	.144	.044	.180	-.282	-.125	-.338	-.136	-.785	-.738	-.747	-.157	.563	.677	.590	.754	1.000

*PCE=Perceived current efficiency, NT=Need tension, NC=Need compatibility, PTA=Perceived total attributes

Multivariate assumptions of normality, homoscedasticity, linearity and absence of outliers can be checked from the standardized residual scatter and normal probability plots, which are generated as part of the multiple regression procedure (Pallant, 2001:137). Both the normal probability and the scatter plot yielded a reasonably straight diagonal line with roughly rectangularly distributed residuals for all of the four maize and dairy behavior models except for the dairy efficiency model, which shows a little deviation. This suggests that there is no serious violation concerning the assumption of normality and linearity. Homoscedasticity refers to the assumption that dependent variables exhibit equal level of variance across the range of predictor variables (Hair, et al, 1998:73). Uniform diagonal distribution of sample data over the scatter plot for both dairy and maize farmers' adoption and efficiency models revealed that homoscedasticity is not a cause for concern.

Multivariate outliers are observations with a unique combination of characteristics identifiable as distinctly different from other observations (Hair, *et al,* 1998:64). Tabachnick & Fidell (2001:122) maintain that outliers are cases that have a standardized residual value of more than 3.3 or less than –3.3. The distribution of the values of residuals in all the developed behavior change models ranges between 3 and –3, most of them falling between 2 and -2. This suggests that the assumption is not broken in any way.