CHAPTER4

PRODUCTION EFFICIENCY AND THE ADOPTION BEHAVIOR OF MAIZE AND DAIRY FARMERS

4.1 INTRODUCTION

As conceptual basis for this study, Düvel's behavior analysis model (1987:91) was selected. Its assumed behavior determinants are associated with Lewin's (1951) forces of behavior, but to test or establish their influence, it is essential to first assess the relationship regarding the current production efficiency and the causal behavior or practice adoption. This chapter, therefore, tries to evaluate the current production efficiency and assess the difference in the level of technology use among the various efficiency classes of program participant maize and dairy farmers.

4.2 CURRENT PRODUCTION EFFICIENCY

Successes or failures of extension programs are more often than not assessed by their ultimate outcome or efficiency, which is generally measured in terms of physical (e.g., yield) and/or economical (e.g., profit) indicators. Yield per production unit was used as criteria for evaluating the efficiency of both the maize and dairy farming.

As reported by the respondents themselves, their productivity ranges from a minimum of 0.8 to a maximum of 6 tons per hectare and from 4 to 16 liter per cow. The mode is 4 tons and 10 liters (Fig. 4.1 & 4.2). The productivity of the majority of maize farmers (77.5 percent) falls below the mode with very few farmers achieving higher yields while dairy farmers are relatively evenly distributed across all productivity levels. The mean yield is 3.49 tons per hectare and 10.2 liters per cow, respectively (Table 4.1).

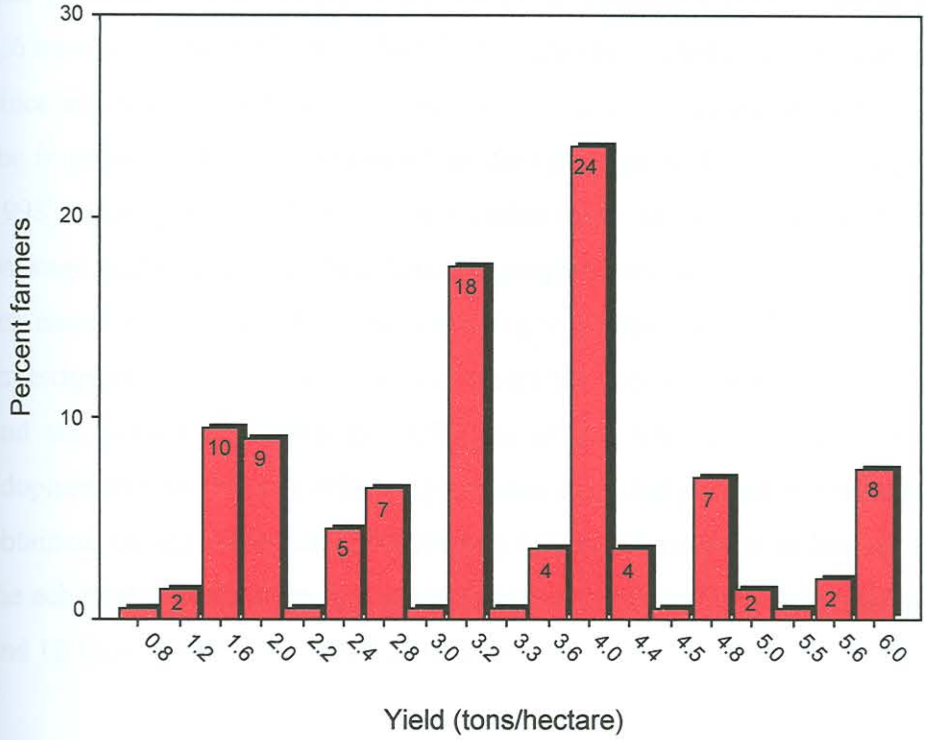

Fig. 4.1 **Percentage distribution of maize farmers according to production efficiency**

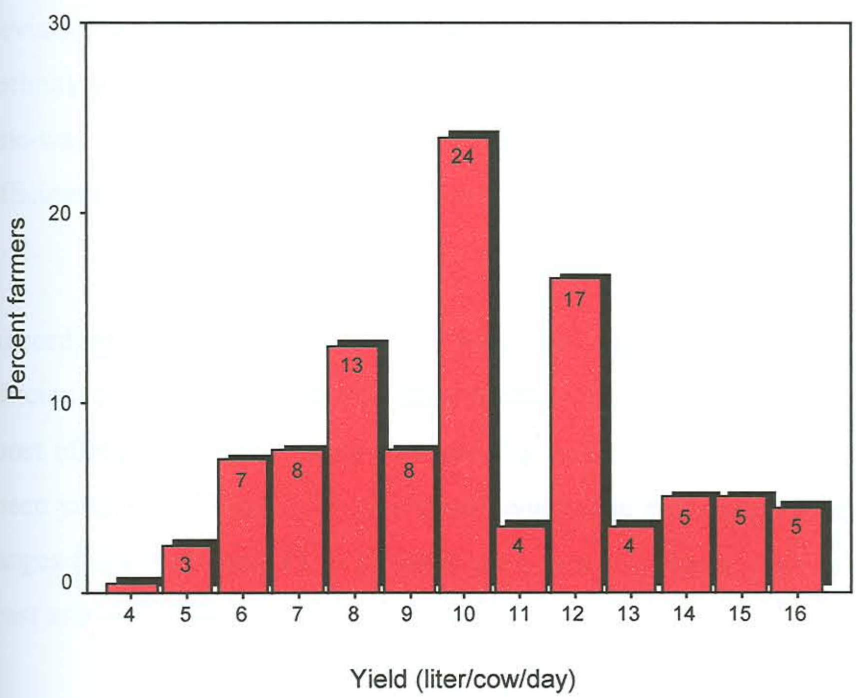

Fig. 4.2 **Percentage distribution of dairy farmers according to production efficiency**

The yield level of maize farmers is very high compared to the national maize average of 1.6 tons per hectare (CSA, 1996/97). It is also suspected that yield can be underestimated since maize is consumed in the area while still green. However, there is still much room for improvement when compared to the optimum yield of 12 tons per hectare (MoA, 1998). This yield is, however, achievable only by using the complete recommended package and in areas like Shashemene (project area) where the agro ecology is favorable for maize production. The reasons for low yields obtained by maize farmers will be investigated in the following section where the focus is on adoption levels. Chapters five and six, which deal with the influence of the situational and intervening factors on adoption and production efficiency are also expected to shed some light on the low yield obtained. On the other hand, the average for dairy farmers is within the expected range as the achievable yield from full adoption of the recommended dairy package is between 10 and 12 liters per cow per day (MoA, 1998).

The initial step of assessing relationships between variables is to see the variability of data. If a variable has no variability, its influence cannot be assessed (Bernard, 200: 505). Maize and dairy farmers were categorized into five efficiency classes based on the deviation of their score from the overall mean yield to critically assess their variation in technology use and production efficiency as indicated in sections 4.3 and 4.4 below. A one-way analysis of variance procedure was employed to compare the different efficiency groups and to evaluate if they are statistically different from each other (Table 4.1).

According to Table 4.1, there is a very high variability in yield between the different efficiency classes of maize and dairy farmers. In maize, the productivity of the least and most efficient farmers ranges between 0.8 to 2.0 and 4.5 to 6.0 tons per hectare with a mean yield of 1.73 and 5.38 tons respectively. The production efficiency of dairy farmers ranges from 4 to 7 and 13 to 16 liters per cow with a mean yield of 6.23 and 14.58 for the least and most efficient farmers respectively.

Table 4.1 Efficiency categories of maize and dairy farmers

Commodity	Category	N	Yield/unit	Mean ± SED	Std. error	F	P
Dairy	1	35	4.0-7.0	6.23±0.81	0.14	928	0.000
	2	41	8.0-9.0	8.37±0.49	0.01		
	3	48	10.0	10.0	0.0		
	4	40	11.0-12.0	11.83±0.38	0.01		
	5	36	13.0-16.0	14.58±1.02	0.18		
	Total	200	4.0-16.0	10.19±2.80	0.20		
Maize	1	41	0.8-2.0	1.73±0.29	0.45	800	0.000
	2	24	2.2-3.0	2.63±0.23	0.46		
	3	43	3.2-3.6	3.27±0.15	0.23		
	4	54	4.0-4.4	4.06±0.14	0.18		
	5	38	4.5-6.0	5.38±0.57	0.91		
	Total	200	0.8-6.0	3.49±1.26	0.89		

(1 = Least efficient, 5 = Most efficient)

4.3 INFLUENCE OF ADOPTION OF RECOMMENDED MAIZE PRODUCTION PRACTICES ON EFFICIENCY

As it was indicated in Chapter 1, PADETES is involved in promoting technology packages formulated for each commodity or enterprise. The basic components of the current technical package for cereals include recommendations for fertilizers and seeds along with the use of complimentary management practices (Kiflu, 1995:21).

In this section of the thesis, the level of adoption of maize farmers will be evaluated against the five efficiency classes in order to see the differences between them and thereby determine the relationship between adoption and production efficiency.

4.3.1 Influence of fertilizer use on production efficiency

a) Fertilizer type

The two commonly used fertilizers in Ethiopia are diamonium phosphate (DAP) having 46 percent of phosphorus and 18 percent nitrogen and a nitrogenous fertilizer (urea) containing 46 percent nitrogen. In total while 76.5 percent of all farmers use fertilizer, 62 percent use the recommended types. The differences between efficiency classes of maize farmers regarding the type of fertilizer use are highly significant ($\chi^2 = 158$, df = 8, p = 0.000). The difference lies in the fact that with increasing efficiency there is a tendency to use more fertilizer and more of the recommended fertilizer type. For example, in the lowest efficiency category only 4.9 percent of the farmers use both DAP and urea (Table 4.2). This percentage increases in an almost linear fashion to 94.7 percent in the most efficient category. This clear relationship or positive relationship finds expression in the highly significant Cramer's V value (Cramer's V = 0.63, p= 0 .000).

b) Fertilizer rate

Though fertilizer rate recommendations vary from place to place depending on the agro ecology and the soil type, the recommended rate advised by PADETES for the Shashemene area is to use 100 kg of each of DAP and urea.

In total 46 percent of survey farmers apply the recommended rate of fertilizer. The differences between efficiency groups in their rate of fertilizer application are highly significant ($\chi^2 = 161.4$, df = 12, p = 0. 000). The difference lies in the fact that with increasing efficiency there is a tendency to use more fertilizer or the recommended rate of fertilizer. For example, not a single farmer uses the recommended rate of fertilizer in the least efficiency category. The number of farmers applying the recommended rate increases with increasing efficiency to 73.7 percent in the most efficient category. Similarly while 87.8 percent of the least efficient farmers do not use fertilizer, not a single farmer from the most efficient category of maize farmers uses any fertilizer at all. This clear relationship finds expression in the highly significant Cramer's V value (Cramer's V = 0.52, p = 0.000), thereby supporting Hypothesis 1, namely that adoption of the recommended fertilization practice is directly correlated with higher production efficiency.

Table 4.2 Relationships between fertilizer adoption and production efficiency as reflected in percentage distributions and a test of association

	Percentage distribution of farmers per efficiency class*						χ^2		Cramer's V		
	1	2	3	4	5	Total					
Practice	n=41	n=24	n=43	n=54	n=38	N=200	Value	p	Value	p	df
a. Type											
Non	87.8	41.7	-	1.9	-	23.5					
DAP	7.3	33.3	23.3	11.1	5.3	14.5					
Both	4.9	25	76.7	87	94.7	62					
Total	100	100	100	100	100	100	158	0.000	0.63	0.000	8
b. Rate											
Nil	87.8	41.7	-	1.9	-	23.5					
<= 100 kg of one	7.3	33.3	23.3	11.1	5.3	14.5					
50-100 kg each	4.9	-	16.3	27.8	21.1	16					
100 kg each	-	25	60.5	59.3	73.7	46					
Total	100	100	100	100	100	100	161	0.000	0.52	0.000	12
c. Measurement											
Drill	92.7	70.8	30.2	27.8	10.5	43.5					
Estimation	7.3	29.2	69.8	72.2	89.5	56.5					
Total	100	100	100	100	100	100	73	0.000	0.6	0.000	4
d. Method											
Nil	90.2	45.8	9.3	9.3	-	28.5					
With seed	9.8	37.5	53.5	40.7	47.7	38					
Besides seed	-	16.7	37.2	50	52.6	33.5					
Total	100	100	100	100	100	100	118	0.000	0.54	0.000	8

*1 = least efficient, 5 = Most efficient

c) Fertilizer measurement

When farmers decide to apply fertilizer to their fields, they are at first advised to learn how they can apply the exact recommended amount of fertilizer per spot or hill. The recommended amount is to apply 4 gram per spot, using a coca cola cup. Other time, when they become skillful and get adapted with the application of this recommended amount, they are advised to move on to the use of the next more timesaving technique, namely judging or estimating the amount.

In general, while 43.5 percent of program participant farmers do not currently use fertilizer at all or drill, the majority (56.5 percent) uses the recommended measurement technique i.e. apply their skill in estimating the recommended amount (Table 4.2). Regarding the relationship of adoption of fertilizer measurement and production efficiency, the differences between the various efficiency classes in terms of their fertilizer estimation technique are highly significant ($\chi^2 = 73$, df = 4, p = 0.000). Again there is a clear and highly significant linear relationship between the fertilizer measurement technique and production efficiency (Cramer's V = 0.60, p = 0.000) thereby providing further evidence in support of Hypothesis 1. This relationship is also evident from the fact that 92.9 percent of the least efficient farmers use no fertilizer at all or drills while amongst the most efficient farmers; only 10.5 percent use this technique. The opposite tendency is evident in the use of the recommended estimation technique. In the lowest efficiency category only 7.3 percent apply the recommended technique. This percentage increases in an almost linear fashion with increasing efficiency to 89.5 percent in the most efficient production category.

d) Fertilizer placement

The recommended method is to place the recommended amount of fertilizer beside the seed in such a way that the fertilizer and the seed do not come in contact.

In general, the method of fertilization placement by maize farmers was not in accord to the recommended one. The great majority (71.5 percent) of farmers either do not apply fertilizer at all or they apply it together with the seed. As far as the relationship of the use of recommended method of fertilizer placement and production efficiency is concerned, there are significant differences between the various efficiency classes ($\chi^2 = 118$, df = 8, p = 0.000). The difference lies in the fact that with increasing efficiency there is a tendency of using the correct method of fertilizer placement. None of the farmers in the lowest efficiency category use the current or recommended fertilizer placement method. The percentage of farmers applying the recommended technique increases with increasing efficiency to as high as 52.6 in the most efficient category. This significant linear relationship finds expression in the highly significant Cramer's V value (Cramer's V = 0.54, p = 0.000) providing further evidence in support of Hypothesis 1.

4.3.2 Influence of improved seed on production efficiency

a) Variety

Farmers have the option to use either or a combination of the recommended open pollinated varieties (e.g., A511, Beletech[2]), or the high yielding hybrids such as BH-660, BH-540, CG-4141, and PHB-3253. Most of the hybrids are the products of the National Research Organization (EARO) and are distributed through the Ethiopian Seed Enterprise. Only PHB-3253 is produced and marketed by a private seed company (Pioneer hybrid Seed Co.).

51 percent of the respondents do not use improved seed at all. Of the remaining percentage, the great majority (33 percent) of the farmers use the product of Pioneer Seed Co., PHB-3253, while the number of farmers who use other varieties (products of government seed agency) is only 16 percent (Table 4.3) despite the fact that the seed price of the private seed company is almost twice as high as that of the government. This is probably due to better marketing services provided by the private company compared

[2] = Presently out of production

to the government agency, which is known for its extended bureaucratic administration in seed marketing.

Table 4.3 Relationships between adoption of seed practices and production efficiency as reflected in percentage distributions and a test of association

	Percentage distribution of farmers per efficiency class*						χ^2		Cramer's V		
Practice	1 n=41	2 n=24	3 n=43	4 n=54	5 n=38	Total N=200	Value	P	Value	P	df
a. Variety											
Local	100	70.8	53.5	29.6	10.5	50.5					
Others	-	25.0	11.6	24.1	21.1	16					
PHB-3253	-	4.2	34.9	46.3	68.4	33.5					
Total	100	100.0	100.0	100.0	100.0	100	86.0	0.000	0.46	0.000	8
b. Area coverage											
Nil	100	75.0	53.5	29.6	10.5	51					
50-75 percent	-	16.7	11.6	11.1	13.2	10					
>75 percent	-	8.3	34.9	59.3	76.3	39					
Total	100	100.0	100.0	100.0	100.0	100	86.0	0.000	0.66	0.000	8
c. Source of seed											
Local	100	79.2	62.8	44.4	18.4	59					
Certified	-	20.8	37.2	55.6	81.6	41					
Total	100	100.0	100.0	100.0	100.0	100	63.4	0.000	0.56	0.000	4
d. Plant spacing											
Broadcast	87.8	79.2	44.2	42.6	23.7	53					
25 cm -1 seed/hill	12.2	20.8	55.8	57.4	76.3	47					
Total	100.0	100.0	100.0	100.0	100.0	100	43.3	0.000	0.47	0.000	4
e. Row spacing											
<50cm-1 seed/hill	95.1	91.7	81.4	74.1	65.8	80.5					
50-80 cm-2 seeds/hill	4.9	8.3	18.6	25.9	34.2	19.5					
Total	100	100	100	100	100	100.0	14.7	0.007	0.27	0.000	4
f. Measurement											
Stick	14.6	4.2	2.3	-	2.6	4.5					
Foot steps	85.4	95.8	97.7	100.0	97.4	95.5					
Total	100	100	100	100	100	100	-	-	-	-	-

* 1 = Least efficient, 5 = Most efficient

According to information obtained from farmers and frontline extension workers during the field survey, which fortunately coincided with the planting time of maize, farmers effectively had only two options, either to plant their own seed or to buy the relatively more expensive PHB-3253 seed. Although maize varieties delivered by the government seed enterprise (A511, BH-660, BH-140, and BH-540) are cheaper in price, they were not available at planting. The extension workers, who are the delegates of the seed enterprise in delivering seeds at the local community levels, were busy working on other issues like the collection of credit repayments for the previous season instead of facilitating seed delivery which, was a burning issue at that time. The second most popular hybrid, BH-660, was grown by 8.5 percent of the respondents.

In general, 49.5 percent of the respondents use improved varieties. As far as the relationships between adoption of improved variety and the production efficiency of maize farmers are concerned, efficient farmers use improved seed than less efficient farmers (χ^2 = 86.1, df = 8, p = 0.000) (Table 4.3). The difference between efficiency groups lies in the fact that with increasing efficiency the percentage of farmers using improved variety tends to increase. For example, while none of the least efficient farmers use improved variety, the percentage of farmers using improved variety increases in an almost linear fashion to as high as 89.5 percent in the most efficient category. This significant linear relationship is manifested in the highly significant Cramer's V value (Cramer's V = 0.46, p = 0.000) lending further evidence in support of Hypothesis 1.

b) Area coverage by improved seed

When farmers lack the confidence of using a recommended variety, they tend to partition their plot and allocate only a portion of it for planting the new variety leaving the rest for local seed. At this stage extension reduces the suspicion by pushing further information or making credit available depending on the source of the problem encountered and encourage them to plant their entire maize plot with improved seed.

As far as the total farm area of maize growers planted with improved seed is concerned, in general, 49 percent of the farmers participating in the package program had planted their plot with improved seed. While 39 percent of the respondents had planted more than 75 percent of their plot, 10 percent of the respondents planted only 50 to 75 percent of their maize farm. The differences between the various efficiency classes are highly significant ($\chi^2 = 86$, df = 8, p = 0.000). The differences being that with increasing efficiency farmers tend to plant more land with improved seeds. For example, all of the farmers in the least efficient category plant more than 75 percent of their entire field with local seed. The number of farmers who had covered more than 75 percent of their field with improved seed increases with increasing efficiency in an almost linear fashion to 76.3 percent in the most efficient category. This clear and positive relationship finds expression in the highly significant Cramer's V value (Cramer's V = 0.46, p = 0.000) providing more evidence in support of Hypothesis 1.

c) Source of seed

When farmers decide to use improved variety, they are advised to use a certified seed. This becomes especially important regarding hybrids, where failure to follow recommendation will lead to a dramatic decline in yield. In general, 41 percent of respondent farmers use certified seed while the rest of the farmers use either an indigenous variety or own improved seed preserved from previous harvest. As far as the relationship between the source of seed of maize farmers and their production efficiency is concerned, there are significant differences between the various efficiency classes ($\chi^2 = 63.38$, df = 4, p = 0.000). The difference lies in the fact that with increasing efficiency the percentage of farmers using certified seed tends to increase. For example, none of the respondents in the lower efficiency category use certified seed (Table 4.3). The percentage of respondents using certified seed increases in an almost linear manner to 81.6 percent in the most efficiency category. This clear relationship is evident in the highly significant Cramer's V value (Cramer's V = 0.56, p = 0.000), lending further evidence in support of Hypothesis 1, namely that use of certified seed is significantly correlated with higher production efficiency.

d) Plant spacing

Farmers are advised to plant their maize crop in line with a plant (intra row) and a inter row spacing of 50cm and 80cm, respectively. They are expected to plant 2 seeds per hill (spot).

In total, 47 percent of sample farmers follow the recommended plant spacing, namely planting in a row with plant spacing of 25cm-1 seed per hill. The rest of respondent farmers either broadcast or drill their seed. The differences between the various efficiency categories of maize farmers in applying the recommended plant spacing technique are highly significant (χ^2 = 43.3, df = 4, p = 0.000). The difference lies in the fact that more farmers use the recommended plant spacing technique with increase in production efficiency. For example, in the lowest efficiency category only 12.2 percent of the farmers apply the recommended spacing. This percentage increases in an almost linear fashion to 76.3 percent in the highest efficiency category. This apparent relationship is also evident from the highly significant Cramer's V value (Cramer's V = 0 .46, p = 0.000) supporting the hypothesized relationship.

e) Row spacing

The great majority of sample farmers (80.5 percent) either broadcast their seed or they plant it in a row with row spacing of less than 50cm-1 seed per hill. Only 19.5 percent of the respondents apply the recommended spacing. The differences between the various efficiency classes of maize growers in adoption of the recommended spacing are, however, statistically significant (χ^2 = 14.7, df = 4, p = 0.007) though it is not as appreciable as the differences observed in the case of the rest of the practices discussed previously. The difference lies in the fact that with increasing production efficiency more farmers apply the recommended spacing. While only 4.9 percent of the least efficient farmers apply the recommended row spacing this percentage increases in an almost linear fashion with increasing efficiency to 34.2 percent in the most efficient category. These clear differences amongst the various efficiency classes together with a significantly higher correlation (Cramer's V = 0.27 p = 0.007) further validates the hypothesized association namely that adoption of row spacing practice is significantly related with production efficiency.

f) Measurement

Once farmers decide to plant their maize in line, the next problem towards implementing their decision has to do with measurement. They are, therefore, advised to use a 50 and 80 cm stick to keep the respective recommended plant and raw spacing at the initial stage. However, as this method is indeed very tiresome and tedious, they are pushed to move away from it and try the next best method, the use of footsteps. Once they have developed confidence on the use of these two methods, they are subsequently encouraged to use their own judgment as an alternative and best measurement scale.

The lack of normality in the distribution of scores does not allow successful assessment of the relationships. An indispensable measurement scale practiced by the entire maize farmers was the use of footsteps. While 95.5 percent of the respondents opted for this measurement technique, the percentage is obviously high both in the least efficiency (84.4 percent) and in the most efficiency (95.5 percent) categories. However, from the distribution, the fact that 14.6 percent of the least efficient farmers use the stick against only 4.5 percent of the most efficient farmers is an indication of a likely positive relationship.

In conclusion, the assessment indicates that there is a significant difference in the adoption behavior of the various efficiency categories of program participant maize growers regarding the nine out of the ten recommended maize technology practices in the Shashemene district. This together with the highly significant and positive association suggests that as far as production per unit area is concerned, the use of recommended practices is profitable. The finding disproves the claim that all program participant farmers are equally poor in their production efficiency and consequently have rejected or withdrawn form using the recommended practices. In addition, the fact that about 40 to 50 percent of respondent farmers have accepted and continued using them implies that the package-based extension program is successful, and leads to the conclusion that the negative claims associated with this program are unfounded.

4.4 INFLUENCE OF ADOPTION OF RECOMMENDED DAIRY PRODUCTION PRACTICES ON EFFICIENCY

The basic components of the current technical package for dairy production include, among other things, recommendations for breeds, improved housing or barn management practice, medical and different feeding recommendations (MoA, 1998).

Unlike maize farmers, the relationships between production efficiency and the adoption behavior of dairy farmers of ALWDADPMA are not found to be significant regarding all of the dairy production practices except breed. An assessment of the remaining three practices i.e. housing, feed and medical practices indicates that the use of these practices is almost similar between the least efficient and most efficient classes. The detail is provided as follows.

4.4.1 Influence of use of improved breeds on production efficiency

The general or blanket recommendation for livestock farmers in Ethiopia is to raise animals with an exotic blood level of 50 percent with a rationale of combining the best traits i.e. the production efficiency potential of exotic breeds with harsh environment survival ability of local breeds. It is customary, however, that in most commercial dairy farms (specialized private dairy farms, college farms, Government enterprises) to raise pure breed dairy animals usually Holstein Frisian.

The number of cross breed animas owned and their level of exotic blood are the two parameters considered in this study to evaluate the breed adoption behavior of dairy farmers.

Member farmers of ALWDDPMA are on the cross rod of transformation from a subsistence-small to a medium-commercial scale dairy farm. Inline with this, their level of adoption regarding improved breed animals in terms of both number and blood level is quite high compared to that of a common traditional small-scale dairy farmer.

a) Number of cross breed animals

As far as the number of crossbred animals is concerned, the great majority (81.5 percent) of the respondents belong to the category where more than 75 percent of their animals are crossbreeds. There are also significant differences between the various efficiency categories of dairy farmers ($\chi^2 = 9.75$, df = 4, p = 0.045). The differences lie in the fact that with increasing efficiency there is a tendency to use more number of cross breed animals. For example, in the lowest efficiency category only 65.7 percent have a herd of more than 75 percent cross breed animals (Table 4.4). This percentage increases with increasing production efficiency in an almost linear trend to 91.7 percent in the most efficiency category. This clear relationship finds expression in the highly significant Cramer's V value (Cramer's V = 0.22, p = 0.05), which supports Hypothesis 1, namely that use of more number of cross breed animals is directly correlated with the production efficiency.

b) Number of cross breed animals (more than 50 percent exotic blood level)

More than 75 percent of the herd of the great majority (80 percent) dairy farmers has an exotic blood level of more than 50 percent. There are again significant differences between the various efficiency categories in adopting crossbreed animals having more than 50 percent exotic blood ($\chi^2 = 8.09$, df = 4, p = 0.088). While more than 75 percent of the herd of only 68.6 percent of the least efficient dairy farmers have an exotic blood level of more than 50 percent, this figure increases to 94.4 percent in the most efficient groups indicating a linear positive relationship. This clear relationship is again manifested in the highly significant Cramer's V value (Cramer's V = 0.20, p = 0.09), which once again provides supportive evidence for the validity of the hypothesized relationship.

c) Number of cross breed animals (more than 62.5 percent exotic blood level)

In general about the entire herd of 48.5 percent of the respondents has an exotic blood level of more than 62.5 percent. From the remaining percentage, 22.5 percent, 19.5 percent and 9.5 percent of the respondents, respectively own a herd where a quarter, a half or a three quarter of the animals have an exotic blood level of more than 62.5 percent (Table 4.4). There are again significant differences between the various efficiency categories of dairy farmers in adopting more than 62.5 percent exotic blood level animals (χ^2 = 23.92, df = 12, p = 0.021). The difference lies in the fact that with increasing efficiency, there is a tendency to raise more crossbreed animals with more than 62.5 percent exotic blood in the herd. For example, the number of farmers with an entire herd having an exotic blood level of more than 62.5 percent in the lowest efficiency category is only 37.1 percent. This percentage increases gently or gradually to 48.5 percent in the most efficiency category. This relationship, although, not as strong as in the case of the former two breed practices, finds expression in the significantly higher Cramer's V value (Cramer's V = 0.20, p = 0.020), which supports Hypothesis 1.

Table 4.4 Relationships between adoption of breeding practices and production efficiency as reflected in percentage distributions and a test of association

	Percentage distribution of farmers per efficiency class*						χ^2		Cramer's V		
	1	2	3	4	5	Total	Value	P	Value	P	df
Practice	n=35	n=41	n=48	n=40	n=36	N=200					
a. Number of cross breeds											
<75	34.3	22.0	12.5	17.5	8.3	18.5					
>75	65.7	78.0	87.5	82.5	91.7	81.5					
Total	100	100	100	100	100	100	9.75	0.045	0.22	0.05	4
b. Number of c. b (>50 percent exotic)											
<75 percent	31.4	24.4	18.8	20.0	5.6	20					
>75 percent	68.6	75.6	81.3	80.0	94.4	80					
Total	100	100	100	100	100	100	8.09	0.088	0.20	0.09	4
c. Number of c. b (>62.5 percent exotic)											
1/4 of heard	45.7	17.1	22.9	17.5	11.1	22.5					
Half	5.7	26.8	29.2	12.5	19.4	19.5					
3/4 of heard	11.4	9.8	4.2	12.5	11.1	9.5					
About all	37.1	46.3	43.8	57.5	58.3	48.5					
Total	100	100	100	100	100	100	23.92	0.021	0.20	0.02	12

*1= Least efficient, 5= Most efficient

4.4.2 Influence of improved housing practices on production efficiency

Significant differences are not found among the various efficiency categories of dairy farmers regarding all of the recommended housing practices (Table 4.5). There is, however an indication that farmers in the most efficient category use most of the recommended practices more than the least efficient farmers suggesting a positive relationship between adoption and production efficiency as expected (Hypothesis 1). Regarding the adoption of one of the housing practices, recommended floor type, for example, the majority of farmers (85 percent) have either a poor (52 percent) or moderate (33 percent) condition floor and only 15 percent have a good condition floor. But 62.9 percent of the least efficient farmers have a poor condition floor while the number of the most efficient farmers with poor condition floor is only 44.4 percent. The relationship, however, is not significant ($\chi^2 = 5.79$, df = 8, p = 0.067; Cramer's V= 0.12, P = 0.670).

Table 4.5 Relationship between adoption of housing practices and production efficiency as reflected in percentage distributions and a test of association

Practice	Percentage distribution of farmers per efficiency class* 1 n=35	2 n=41	3 n=48	4 n=40	5 n=36	Total N=200	χ^2 Value	P	Cramer's V Value	P	df
a. Condition of feed trough											
No	14.3	9.8	12.5	17.5	16.7	14.0					
Poor	45.7	43.9	47.9	40.0	25.0	41.0					
Moderate	22.9	29.3	22.9	22.5	47.2	28.5					
Good	17.1	17.1	16.7	20.0	11.1	16.5					
Total	100	100	100	100	100	100	11.03	0.526	0.14	0.526	12
b. Condition of gutter											
No	20.0	7.3	18.8	20.0	11.1	15.5					
Poor	51.4	56.1	43.8	47.5	50.0	49.5					
Moderate	28.6	36.6	37.5	32.5	38.9	35.0					
Total	100	100	100	100	100	100	5.02	0.755	0.11	0.755	8
c. Condition of floor											
Poor	62.9	41.5	56.3	55.0	44.4	52.0					
Moderate	25.7	39.0	31.3	27.5	41.7	33.0					
Good	11.4	19.5	12.5	17.5	13.9	15.0					
Total	100	100	100	100	100	100	5.79	0.67	0.12	0.670	8
d. Condition of roof & side wall											
Poor	51.4	41.5	52.1	57.5	52.8	51.0					
Moderate	31.4	36.6	35.4	32.5	38.9	35.0					
Good	17.1	22.0	12.5	10.0	8.3	14.0					
Total	100	100	100	100	100	100	4.99	0.764	0.11	0.764	8
e. Stall partition											
No	77.1	65.9	58.3	67.5	63.9	66.0					
Poor	17.1	19.5	22.9	20.0	27.8	21.5					
Moderate	5.7	14.6	18.8	12.5	8.3	12.5					
Total	100	100	100	100	100	100	5.69	0.682	0.12	0.682	8

*1= Least efficient, 5= Most efficient

4.4.3 Influence of recommended feed practices on production efficiency

The three major feed practices recommended for dairy herders, on top of the natural pasture and hay, are the use of industrial byproducts, products of feed processing plants and forage legumes (Table 4.6). The feed supply status of dairy farmers of ALWDADPMA is far below the recommended level both in the case of the most efficient and least efficient dairy farmers suggesting insignificant relationship between adoption of recommended feed practices and production efficiency. Many farmers feed their animals only with some of the recommended feed types or if they feed all of the recommended feed types, the supply is not regular. Although the relationship is not significant, the distribution indicates a positive relationship between adoption of recommended feed practices and production efficiency as expected.

Regarding the use of recommended forage legumes for example, 61 percent of all herders do not feed their animals with forage legumes at all. Only 12 percent of them feed regularly but with only some of the forage legumes recommended. The fact that 11.1 percent of the most efficient dairy farmers regularly feed their herd with the recommended forage legumes against only 5.7 percent of the least efficient ones suggests a likely positive relationship. The relationship is not, however, statistically significant ($\chi^2 = 13.91$, df = 8, p = 0.084; Cramer's V= 0.19, P = 0.084).

Table 4.6 Relationships between adoption of feed practices and production efficiency as reflected in percentage distributions and a test of association

	Percentage distribution of farmers per efficiency class*						χ^2		Cramer's V		
	1	2	3	4	5	Total	Value	P	Value	P	
Practice	n=35	n=41	n=48	n=40	n=36	N=200					df
a. Industrial byproducts											
Some times	17.1	14.6	20.8	7.5	11.1	14.5					
Regularly (Some)	68.6	61.0	70.8	82.5	66.7	70.0					
Regularly (All)	14.3	24.4	8.3	10.0	22.2	15.5					
Total	100	100	100	100	100	100	10.1	0.256	0.16	0.257	8
b. Feed processing plant											
Some	11.4	19.5	25.0	17.5	13.9	18.0					
Regularly (Some)	62.9	41.5	50.0	52.5	47.2	50.5					
Regularly (Most)	25.7	39.0	25.0	30.0	38.9	31.5					
Total	100	100	100	100	100	100	6.78	0.561	0.13	0.561	8
c. Forage legume											
Not at all	71.4	58.5	45.8	57.5	77.8	61.0					
Sometimes	22.9	31.7	33.3	32.5	11.1	27.0					
Regularly (Some of them)	5.7	9.8	20.8	10.0	11.1	12.0					
Total	100	100	100	100	100	100	13.91	0.084	0.19	0.084	8

*1= Least efficient, 5= Most efficient

4.4.4 Influence of recommended medical practices on production efficiency

Vaccination of the entire herd against the deadly diseases of anthrax, black leg and rinder pest and treatment against internal and external parasites are the five major medical practices advised for farmers to apply them before hand when they establish a dairy farm. Adoption of medical practices is evaluated based on the use of these practices by each herder.

The assessment indicates that the adoption levels of recommended medical practices are relatively very good. But the absence of variability among the various efficiency classes of dairy herders do not allow to effectively test the hypothesized relationship. Most herders (96 percent) had vaccinated their animals against anthrax, black leg and rinder pest. Variations are observed only in their use of control measures of internal and external parasites, nevertheless, the inter-efficiency class difference among dairy farmers of ALWDDPMA is not found to be statistically significant even regarding these two practices (Table 4.7).

In conclusion, out of the four dairy production practices, breed and medical practices are better adopted than feed and housing practices. While the relationships between adoption of breeding practices and production efficiency is found to be highly significant, the lack of normal distribution in the adoption behavior of dairy farmers regarding medical practices associated with vaccination (96 percent adoption rate) does not allow to sufficiently test the hypothesized relationships.

Table 4.7 Relationships between adoption of medical practices and production efficiency as reflected in percentage distributions and a test of association

Practice	Percentage distribution of farmers per efficiency class* 1 n=35	2 n=41	3 n=48	4 n=40	5 n=36	Total N=200	χ^2 Value	P	Cramer's V Value	P	df
a. Anthrax											
<100 percent	8.6	2.4	2.1	7.5	-	4.0					
100 percent	91.4	97.6	97.9	92.5	100.0	96.0					
Total	100	100	100	100	100	100	NC				
b. Black leg											
<100 percent	8.6	2.4	2.1	7.5	-	4.0					
100 percent	91.4	97.6	97.9	92.5	100.0	96.0					
Total	100	100	100	100	100	100	NC				
c. Render pest											
<100 percent	8.6	2.4	2.1	7.5	-	4.0					
100 percent	91.4	97.6	97.9	92.5	100.0	96.0					
Total	100	100	100	100	100	100	NC				
d. Ecto parasite											
Not at all	62.9	46.3	54.2	45.0	47.2	51.0					
100 percent	37.1	53.7	45.8	55.0	52.8	49.0					
Total	100	100	100	100	100	100	3.3	0.509	0.128	0.509	4
e. Indo parasite											
Not at all	40	24.4	27.1	15	30.56	27					
<100percent	11.4	12.2	14.6	17.5	5.6	12.5					
100percent	48.6	63.4	58.3	67.5	63.9	60.5					
Total	100	100	100	100	100	100	8.3	0.455	0.144	0.405	8

*1= Least efficient, 5= Most efficient

The level of adoption regarding the rest two practices (housing and feed) is quite low and the relationship with production efficiency is not found to be significant. Possible reasons for low adoption of these practices will be further investigated in chapter five and six where the influence of the intervening and independent variables will be discussed in a greater detail. Moreover, we had a general impression felt at the time of the survey that the main cause for low adoption or use of feeds especially concerning the use of forage legumes could probably be attributed to the lack of land for growing green legumes. All of the herders were urban dwellers and local authorities do not yet consider their application for land. There was also a high shortage in the supply of industrial byproducts and products of feed processing plants. On the other hand, the reason for low adoption concerning housing practices could probably be associated with the absence of favorable perception towards improved housing. The two traditionally highly valued technologies by herders are only the use of improved breeds "yefernje lam"[3] and medical interventions. As far as housing is concerned, in a country where a small iron roofed single room house is perceived to be appropriate to shelter the people themselves, it shall not be surprising for farmers not giving sufficient attention for the housing of their animals.

4.5 Contribution of adoption of maize and dairy production practices to production efficiency variance

Ordinary Least Squares (OLS) method was employed to assess the contributions of adoption of maize and dairy practices on production efficiency of respondent farmers. According to Tabachnick & Fidell (2001:7), discrete variables composed of qualitatively different categories are analyzed after being changed into a number of dichotomous variables known as dummy variables. The different categories of maize and dairy practices (measured on a nominal and ordinal scale) were accordingly changed into a series of dummy variables for further analysis although differences are not observed in the R^2 values when the dummy variables are used (0.555 verses 0.556). According to Table 4.8, which shows the multiple regression estimates of the effects of recommended technology practices on production efficiency, the overall impact is more significant in maize farming (55.6 percent) than in dairy. The different efficiency classes of dairy farmers do not show significant variation in their adoption behavior of three practices (housing, feed and medical). However, the reason why adoption of dairy breeds, where significant variation is revealed, does not influence production efficiency is not clear. The situation is not however, unusual. A study conducted by Düvel and Vander Merwe (1989:34), shows that the adoption behavior of table grape farmers in Hex river valley of South Africa is not related at the less than 0.05 level of significance with their production efficiency. Demeke (1989:229) also found no significant relationship between adoption

[3] Technology of the white man

of improved seeds and fertilizer and the production efficiency of farmers and surprisingly enough, he reported that the relationships are negative.

In maize, use of fertilizer explains more of the variation in production efficiency. The use of 100-200 kg or a little lesser amount of DAP and urea fertilizers increases yield by about 1.3 tons per hectare against an increase of only 0.2 tons by using improved variety, which is regarded as one of the high yielding technologies in maize production.

Table 4.8 Multiple regression estimates of the effects of technology adoption on production efficiency

Commodity	Variable	Beta	t	p
Maize	(Constant)	19.241	15.131	0.057
	Improved variety dummy: 1 represents any improved variety	2.136	0.814	0.417
	Area coverage dummy: 1 represents > 75 percent coverage	3.660	1.481	0.140
	Certified seed dummy: 1 represents certified	1.327	0.500	0.618
	Plant spacing dummy: 1 represent 25 cm-1 seed/hill	1.767	0.932	0.353
	Row spacing dummy: 1 represents 50-80 cm-2 seeds/hill	-1.516	-0.699	0.485
	Fertilizer type-1 dummy: 1 represents DAP + urea	3.236	1.316	0.190
	Fertilizer type-2 dummy: 1 represents any type	12.723	5.837	0.000
	Fertilizer rate dummy: 1 represents 100 kg each	0.563	0.246	0.806
	Fertilizer measurement dummy: 1 represents own skill	-0.061	-0.027	0.979
	Method of fertilization dummy: 1 represents spot	0.377	0.156	0.876
Dairy				
	(Constant)	8.73	17.97	0.046
	Cross breed dummy: 1 represents >75 percent of herd	0.94	1.29	0.199
	>50 percent exotic blood dummy: >75 percent of herd	0.52	0.71	0.479
	>62.5 percent exotic blood dummy: >50 percent of herd	0.50	1.19	0.234

R^2 = .556 (maize), 0.053 (dairy)

4.6 Current status of adoption of maize and dairy production technology package

The adoption of the recommended maize and dairy production practices were individually evaluated in the previous sections. The adoption status of maize and dairy farmers regarding the respective packages will be assessed here.

Adoption is a decision to make full use of an innovation as best appropriate course of action available (Rogers, 1983:176). For multiple practices (package), there are two options of measuring adoption; (i) adoption index: measures the adoption or rejection at the time of the survey or (ii) adoption quotient: measure the degree or extent of use with reference to the optimum possible without taking time into consideration. In this study, the second option was employed. Accordingly, each practice was valued and an aggregate adoption quotient was determined as indicated in Tables 4.9 and 4.11 to evaluate the level of package adoption attained by respondents.

Table 4.9 Practices encompassing the recommended maize production package and its adoption quotient

Practice	Score	Practice	Score
1 Seed		**3 Fertilization**	
1.1 Percent Improved cultivars grown		3.1 Type of fertilizer	
• All local	0	• Non	0
• <50 percent	1	• UREA	1
• 50-75 percent	2	• DAP	2
• >75 percent	3	• Both	3
1.2 Source of seed		3.2 Rate of fertilization	
• Local	0	• Nil	0
• Own improved seed	1	• <100 kg of 1 type	1
• Own + certified	2	• 50-100 kg of each	2
• Certified	3	• 100 kg of each	3
1.3 Total cultivars adoption Score		3.3 Total Practice adoption score	
• Minimum	0	• Minimum	0
• Maximum	6	• Maximum	6
2 Method of Planting		**4 Spot Application**	
2.1 Plant spacing		4.1 Measurement	
• Broadcast	0	• Broad cast	0
• <25 cm/drill	1	• Coca cola cup	1
• 25 cm-1seed/hill	2	• Imagination	2
• 25-50 cm-2 seeds/hill	3	4.2 Placement of seed	
2.2 Row pacing		• Broadcast	0
• Broadcast	0	• Together with fertilizer	1
• <50 cm-1 seed/hill	1	• Besides	2
• 50-79 cm-2 seeds/hill	2	4.3 Total Practice adoption score	
• 80 cm-2 seeds/hill	3	• Minimum	0
2.3 Spacing measurement		• Maximum	4
• Broadcast	0	**5 Total Package adoption score**	
• Stick	1	• Minimum	0
• Foot steps	2	• Maximum	25
• Imagination	3		
2.4 Total planting adoption Score			
• Minimum	0		
• Maximum	9		

4.6.1 Current status of adoption of maize production technology package

As far as maize farming is concerned, the possible achievable score (adoption quotient) ranges between a minimum of 0 points to a maximum of 25. The actual total adoption score achieved by program participant farmers ranges between 4 and 25, upon which respondents were classified into four package adoption categories based on the deviation of their score from the mean total adoption score (Tables 4.10). One-way ANOVA was employed to test if the various groups were statistically different in their adoption score or level of adoption.

Table 4.10 Package adoption categories of maize producers

Adoption category	N	Adoption score	Mean	SD	F	P
Non-adopters	47	4.0-8.0	6.5	1.5	1241	0.000
Low adopters	49	10-16	13.3	2.0		
Medium adopters	47	17-22	20.0	1.9		
High adopters	57	23-25	24.0	0.9		

As clearly shown in Table 4.10, the number of adopters and non-adopters is nearly equal. 96 (48 percent) of the respondents, who scored between 4 and 16 out of the total adoption score of 25, fall under the non-and low adoption category while 104 farmers (52 percent) fall under the high and medium adoption category. Only 57 farmers (28.5 percent) fall under the high adoption category. The cause for the low yield or production efficiency achieved by some maize farmers could, therefore, be attributed to this low level of adoption. The reasons for low adoption will be investigated in chapters 5 and 6 where the influence of the human and situational factors will be analyzed in a greater depth.

4.6.2 Current status of adoption of dairy production technology package

In the same way to maize, the package adoption status of dairy farmers was assessed by the degree or extent of use of each practice with reference to the optimum or recommended level. Adoption quotient was, therefore, developed (Table 4.11) to measure dairy production practices incorporated into the package namely breed, housing, medical and feeding practices. As shown in Table 4.11, adoption quotient of dairy farmers or the possible minimum and maximum score to be achieved by program participant dairy farmers ranges between 0 (where no single practice is adopted) and 40 (where all of the practices are adopted).

The actual adoption score of respondent dairy farmers ranges between 9 and 38. As their score is very high (minimum = 9) they were categorized into only three classes (low, medium and high) based on the deviation of their score from the mean total adoption score ignoring non-adoption. Table 4.12 indicates the number of farmers falling under each package adoption category and their mean adoption score. Out of the total score of 40, 60 and 69 farmers who scored between 9 and 20 and 21 and 25 were categorized under the low and medium adoption categories, respectively while the rest 71 farmers with the highest adoption score of 26-38, were grouped into the higher adopter category.

The three-adopter classes are significantly different in their level of adoption as tested by one-way ANOVA procedure.

Table 4.11 Practices encompassing the recommended dairy production package and its adoption quotient

Practice and adoption scale	Score	Practice and adoption scale	Score
1 Breed		2.5 Stall (partition, width)	
1.1 Number of dairy heard owned with blood level of 50 percent and above (percent)		• No	0
• Nil	0	• Poor	1
• <50 percent	1	• Moderate	2
• 50-75 percent	2	• Good	3
• >75 percent	3	2.6 Total adoption score	
1.3 Adoption Score breed		• Minimum	0
• Minimum	0	• Maximum	15
• Maximum	3	**3 Medical practices**	
2 Housing practices		3.1 Vaccination (anthrax)	
2.1 Feed trough (width, depth, smoothness)		• Not at all	0
• No	0	• <100 percent	1
• Poor	1	• 100 percent	2
• Moderate	2	3.2 Vaccination (black leg)	
• Good	3	• Not at all	0
		• <100 percent	1
2.2 Gutters (slope, width, depth, smoothness)		• 100 percent	2
• No	0	3.3 Vaccination (render pest)	
• Poor	1	• Not at all	0
• Moderate	2	• <100 percent	1
• Good	3	• 100 percent	2
2.3 Floor (slope, smoothness)		3.4 Spray (accaricide)	
• No	0	• Not at all	0
• Poor	1	• <100 percent	1
• Moderate	2	• 100 percent	2
• Good	3	3.5 Use of antehelmintics	
2.4 Roof and side walls (Ventilation, draft, construction material)		• Not at all	0
• No	0	• <100 percent	1
• Poor	1	• 100 percent	2
• Moderate	2	3.6 Total adoption Score	
• Good	3	• Minimum	0
		• Maximum	10

Table 4.11 continued...

Practice and adoption scale	Score	Practice and adoption scale	Score
4 **Feed practices**		4.4 Total practice adoption score	
4.1 Use of industrial by products		• Minimum	0
• Not at all	0	• Maximum	12
• Rarely	1	4.5 Total Package adoption score	
• Sometimes	2	• Minimum	0
• Regularly (some of them)	3	• Maximum	40
• Regularly (most of them)	4		
4.2 Use of feeds from feed factory			
• Not at all	0		
• Rarely	1		
• Sometimes	2		
• Regularly (some of them)	3		
• Regularly (most of them)	4		
4.3 Use of forage legume			
• Not at all	0		
• Rarely	1		
• Sometimes	2		
• Regularly (some of them)	3		
• Regularly (most of them)	4		

Table 4.12 Number of dairy producers by package adoption category

Adoption category	N	Adoption score	Mean	SD	F	P
Low adopters	60	9-20	17.3	2.07	476	0.000
Medium adopters	69	21-25	22.8	1.36		
High adopters	71	26-38	28.9	2.74		

4.7 RELATIONSHIPS BETWEEN ADOPTION OF RECOMMENDED PACKAGES AND EFFICIENCY

The relationships between technology practices included in both maize and dairy packages and production efficiency was assessed in previous sections. It is here tried to evaluate the aggregate influence of the packages on the respective production efficiencies of maize and dairy farmers. As can be seen in Table 4.13, in the same manner to the relationships found between efficiency and adoption of maize and dairy practices, significant relationship is found only regarding adoption of maize package ($R^2 = 0.51$). This R^2 value is a little less than that of the influence of separate practices ($R^2 = 0.55$) probably due to rounding of numbers.

Table 4.13 Multiple regression estimates of the influence of package adoption on production efficiency

Variable	Beta	t	p
Constant		2.7	0.007
Maize package	0.72	14.45	0.000
Constant		16.0	0.000
Dairy package	0.072	1.01	0.312

$R^2 = 0.51$ (maize); 0.005 (dairy)