# CHAPTER 5

# SELECTED ATTRIBUTES, PATTERN AND SEQUENCE OF ADOPTION OF IMPROVED *TEF* AND WHEAT TECHNOLOGIES

## 5.1 Introduction

This chapter describes selected attributes, pattern and sequence of adoption of *tef* and wheat technologies in the study area. The t*ef* and wheat research programmes have developed a number of t*ef* and wheat technologies that have the potential to increase productivity. However, the pattern and sequence of adoption of these technologies were not known.

In this study, adoption decisions refer to use of new technologies. A farmer is defined as an adopter if he uses at least one of the *tef* or wheat improved varieties with or without fertilizer and herbicide, otherwise a non-adopter. Based on their use of improved varieties farmers were classified as adopters and non-adopters. Adopters were classified again into partial adopters (farmers using improved variety with fertilizer or herbicide) and full adopters (farmers using improved variety with fertilizer and herbicide). Sequence of adoption refers to stepwise use of components of a package of a new technology.

One of the ways farmers learn about the new technologies is by participating in the demonstrations of improved technologies. The year farmers have participated in the demonstration program is considered as information gathering and the period the farmer has used the new technology in successive years after participation in the demonstration is the time for learning from own experience (knowledge). Finally, the decision to continue or abandon is made each year after the farmer had used the improved varieties, i.e., the farmer has gained experience in growing the improved technology. Experience gained in using the new technology (knowledge) is computed as the difference in net benefits between the new and traditional technology for the successive years the farmer has used the new technology (Cameron, 1999).

Risk in growing improved varieties is also defined as the variability in yield for the period the farmer has used the new technology and it is measured as the variance of yield among the same group of farmers in the same selected peasant association for the same period (Just and Pope 1979). Yields vary from location to location and from year to year. To capture yield variability over space and time, the averaged yield variance was computed from the variance of yield of each peasant association (PA) for each growing season over the years of growing period.

The next section presents descriptive analysis of selected economic attributes improved *tef* and wheat technologies. The pattern and sequence of adoption of improved *tef* and wheat technologies are presented in 5.3 and 5.4, respectively.

## 5.2 Comparison of *tef* and wheat farmers

To compare the three farmer groups (non-adopters, partial and full adopters) an average of two or more years data for the same factor were considered for the periods farmers have used improved technologies from 1997 to 2001. This method was used as all sample farmers did not grow the improved varieties for five years as they did not start at the same time since the improved varieties were rationed due to limited supply. Farmers' data on yield, input use, total cost that vary total and net benefits were used in partial budgeting. Sample farmers used the same rate for local and improved seeds. Since local and improved seeds had the same price in the local market, their costs were not included in the partial budgeting analysis. From the partial budgeting, the marginal rate of return was estimated to show the gain in net benefits from non-adoption to partial or full adoption. The marginal rate of return is the change in net benefit divided by the change in cost that varies from non-adoption to adoption (partial or full) expressed as percentage. The minimum returns analysis was used to measure the variability in benefits of the new technologies in comparison with the traditional technology. The minimum returns analysis compares the averages of the lowest net benefits (usually 25%) for the three groups of farmers. It is expected that partial and full adoption of improved technologies

give better average lowest net benefits than non-adoption even in the worst cases (Byerlee and Hesse de Polanco, 1986; CIMMYT, 1988).

### 5.2.1 Comparing *tef* farmers

Comparison was made between the three groups of farmers in terms of resources owned, input use, yield obtained, benefits obtained, costs incurred, and risk faced. Comparison of the three groups of farmers indicated that there were big differences between non-adopters, partial and full adopters in most cases. For instance, non-adopters were significantly different from full adopters in terms of *tef* area, livestock and oxen ownership, family size, and fertilizer obtained on credit (Table 5.1).

**Table 5.1. Selected attributes of *tef* production practices in Northern and Western Shewa zones, (1997-2001)[a]**

| Item | Traditional technology | Improved | technology |
|---|---|---|---|
| | Non -adopters | Partial adopters | Full adopters |
| Farm size (ha) | 2. 8a | 2.6a | 2. 8.a |
| Tef area (ha) | 1.5a | 1.7ab | 2.1b |
| Prop. of improved. Area ( %) | | 0.54a | 0.39b |
| Family size (no) | 6.8a | 7.0ab | 7. 8b |
| Active labour (no) | 2.3a | 2.9b | 2.8b |
| TLU | 5.7a | 6.3ab | 7.5b |
| Oxen, (no) | 2.3a | 2.6ab | 2.9b |
| Wealth index | 2.1a | 2.1a | 2.4a |
| Age (year) | 49.0ab | 53.5bc | 46.0a |
| Fertilizer on credit (kg) | 191a | 181a | 269b |
| Distance to Addis (km) | 86a | 134c | 77b |
| Distance to market (hr) | 1.7a | 2.1b | 1.7a |
| Time to DA office (hr) | 1.2a | 1.5a | 1.4a |
| Frequency of DA visit (no) | 2.1a | 1.5a | 2.3a |

a. Figures in the same row followed by different letters are significantly different from each other at least at 5% level.

Full adopters were younger than partial adopters and the difference was significant. Although non-adopters were significantly closer to Addis and local market, and more frequently visit the development agent (DA) office than partial adopters, they had not adopted the improved *tef* package (improved varieties) because of their colour, which they thought would not fetch good prices. On the other hand, partial and full adopters had

significantly higher active family labour force than non-adopters to help them in the adoption of improved *tef* technology, which is more labour intensive than the traditional *tef* technology.

Comparison of partial and full adopters also showed that full adopters were significantly closer to Addis and local market and more frequently visit the DA office than partial adopters. On the other hand partial and full adopters were not significantly different in their *tef* area at 5% significance level. However, partial adopters allocated significantly more area to improved varieties than full adopters because of the fear of risk incurred in the adoption of full package that would be explained later.

#### 5.2.1.1 Profitability of the *tef* technology

Table 5.2 presents selected indicators of the profitability of the traditional and improved *tef* technologies. The traditional technology produced significantly lower yields than the improved *tef* technology. Full adopters also obtained significantly higher yield than partial adopters due to the use of herbicide. Fertilizers and herbicide uses were common in both traditional and improved technologies with differences in the rate of application. As it is depicted in Table 5.2 partial and full adopters used significantly higher rates of inputs (fertilizer and/or herbicide) than non-adopters. However, partial and full adopters were not significantly different in their fertilizer application although full adopters used slightly higher rate. Besides, both partial and full adopters applied the recommended rate of fertilizer on average. Application of herbicide was lower than the recommended rate for non-adopters and full adopters. Besides, none of the partial adopters used herbicide with the improved variety (Table 5.2). In the study area the use of improved variety with herbicide is not a common practice and not included in the analysis.

In terms of labour utilization[1], non-adopters, partial and full adopters differ significantly in the amount of family labour used in the production of *tef*. In terms of draft power

[1] The labour data for weeding, harvesting and threshing and oxen data for threshing were obtained from farmers' recall, which is based on estimation not actual data.

requirement, as expected full adopters of the package of improved *tef* technology used significantly higher draft power than the traditional technology and partial adopters (Tables 5.2).

**Table 5.2. Selected indicators and profitability of *tef* technologies in Northern and Western Shewa zones (1997-2001)[a]**

| Item | Traditional technology | Improved technology | |
|---|---|---|---|
| | Non -adopters | Partial adopters | Full adopters |
| Yield, kg/ha | 6.2a | 10.1b | 12.3c |
| | | | |
| Fertilizer, kg/ha | 136a | 158b | 166b |
| Herbicide, l/ha | 381a | none | 525b |
| Labour use (man-days/ha) | 31.1a | 50.4b | 61.8c |
| Draft (oxen-day/ha) | 6.9a | 11.2b | 13.5c |
| | | | |
| Total benefits, Birr[2]/ha | 1871.40a | 2954.65b | 3724.45c |
| Total cost that vary, Birr/ha | 480.00a | 631.80b | 738.85c |
| Net benefits, Birr/ha | 1391.40a | 2322.85b | 2986.1c |
| | | | |
| MRR[1] (%), non to partial adoption | | 614 | 616 |
| MRR (%), partial to full | | | 620 |
| | | | |
| Risk (yield variance) | 7.7a | 18.7b | 21.14c |
| Knowledge, Birr/ha | | 1268.25a | 1212.70a |

a. Figures in the same row followed by different letters are significantly different from each other at least at 5% level.

[1] Marginal rate of return (MRR) on investment in the adoption of improved *tef* technology i.e., marginal net benefit (the change in net benefit) divided by the marginal cost (the change in costs) and expressed as percentage

In this study total benefit from the production of *tef* or wheat (grain and straw) was considered for any year that the farmer had planted *tef* or wheat in Northern and Western Shewa zones. Prices of output, and cost of inputs in each zone for each year the farmer had planted the two crops were also considered in the estimation of total benefits and costs that vary, respectively. Cost of transportation of inputs and outputs were also considered in the estimations. In this study average benefit of farmers who were using the old technology was considered for farmers who have used only the new technology (Cameroon, 1999).

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[2] 1 US $ = 8.5 Ethiopian Birr at the time of the study

In terms of benefit, partial and full adopters obtained significantly higher total benefits than non-adopters. Besides, the costs that vary were significantly different for the three groups of farmers. On the other hand partial and full adopters had significantly higher net benefits than non-adopters, and full adopters had significantly higher net benefits than partial adopters due to significant yield differences (Table 5.2).

The marginal rate of return (MRR) was used to show the benefit obtained in changing from non-adoption to partial or full adoption, and from partial to full adoption. The results indicated that adoption of the improved *tef* technology provided acceptable return on investment in the improved *tef* technology over the five years (Table 5.2). Based on experience and empirical evidence, in most cases, the minimum acceptable rate of return to farmers is from 50% to 100% (CIMMYT, 1988). Thus, both the change from traditional to partial adoption or full adoption; and from partial to full adoption fulfills this criterion. This implies that farmers should have continued adoption of the improved *tef* technology in 2001 crop season. In 2001 crop season, however, 58% of sample farmers reported that they have discontinued adoption of the improved *tef* varieties due to their colour because they were afraid of lack of market. The new varieties provided significantly higher net benefits and the MRR indicates that investment in the new varieties still provided acceptable rate of return as shown in Table 5.2.

To assess the riskiness of the improved *tef* technology, two approaches (comparison of yield variance and comparison of 25% of lowest net benefits) were used. To determine minimum return analysis, the average of the bottom 25% net benefits of traditional technology (non-adoption) was compared to the averages of lowest 25% net benefits of improved technology (partial and full adoption). The one with the higher lowest net benefit is considered less risky even in worst cases. Thus, comparison of the 25% lowest net benefits for the three groups of *tef* farmers showed that full adoption of the improved *tef* technology gave higher lowest net benefits (1852.35 Birr/ha) followed by partial adoption (1339.7 Birr/ha) than non-adoption (695.3 Birr/ha). This implies that partial and full adoptions are less risky than non-adoption and full adoption is less riskier than partial adoption. On the other hand, the variance of yield analysis indicated that full adoption

was significantly the most risky (highest variance) option followed by partial adoption (Table 5.2). This result contradicts the minimum returns analysis which does not consider variability and dispersion.

Finally, comparison was made between partial and full adopters in terms of experience they had gained, average profit differential of the five years period (1997 – 2001). Surprisingly partial adopters and full adopters were not significantly different in their experience of growing the improved *tef* varieties (Table 5.2) In fact full adopters were significantly younger than partial adopters, which means they were better to learn from their own experience in growing improved varieties. As Table 5.2 showed, comparisons among the three groups of farmers resulted in superiority of partial and full adoption over non-adoption and full adoption over partial adoption but with higher yield variances (more risky) for partial and full adoption than non-adoption. These results did not support most farmers' choice of non-adoption due to fear of improved varieties do not fetch good prices. Both partial and full adoption of improved varieties were more productive, beneficial and even gave better lowest net benefits than non-adoption even under worse conditions although yield variances were high for partial and full adoption. This could be improved as partial and full adopters gain more experience in growing improved varieties in the future.

### 5.2.2. Comparing wheat farmers

Similarly wheat growers were compared in the same manner. Non-adopters of improved wheat varieties were not significantly different than partial and full adopters in many cases such as farm size, family size, livestock and oxen ownership, wealth, age, fertilizer obtained on credit and frequency of development agent (DA) visit. Moreover, non-adopters had significantly more labor force but slightly less than full adopters, and were closer to Addis than partial adopters (Table 5.3). Although full adopters were younger than non-adopters and partial adopters, the difference was not significant.

On the other hand, partial adopters were significantly closer to local market and travel less distance to DA office than non-adopters and full adopters. However, this did not make significant difference in their frequency of visit to DA office between the three groups of farmers in 2001 crop season.

In terms of wheat area, full adopters had significantly larger areas than partial and non-adopters. However, partial adopters allocated significantly larger area to improved varieties than full adopters although they had significantly lower active labour force than full adopters (Table 5.3). This could be due to significantly shorter distances partial adopters travel to DA office than full adopters to get updated information about improved varieties.

**Table 5.3. Selected attributes of wheat production practices in Northern and Western Shewa zones, (1997-2001)[a]**

| Item | Traditional technology | Improved | technology |
|---|---|---|---|
| | Non -adopters | Partial adopters | Full adopters |
| Farm size (ha) | 2. 8a | 3.0a | 2.6a |
| Wheat area (ha) | 0.83a | 0.75a | 0.98b |
| Prop. of improved area (%) | | 98a | 88b |
| Family size (no) | 7.5a | 7.4a | 7.8a |
| Active labour (no) | 3.6a | 2.2b | 4.2a |
| TLU | 5.4a | 5.6a | 6.4a |
| Oxen (no) | 2.1a | 2.2a | 2.4a |
| Wealth index | 2.1a | 2.2a | 2.1a |
| Age (year) | 46.4a | 47.0a | 44.7a |
| Fertilizer on credit (kg) | 145a | 73.5b | 166a |
| Distance to Addis (km) | 88a | 122b | 101a |
| Distance to market (hr) | 2.1a | 0.8b | 1.6c |
| Time to DA office (hr) | 1.8a | 0.6b | 1.6a |
| Frequency of DA visit (no) | 1.2a | 1.6a | 1.2a |

a. Figures in the same row followed by different letters are significantly different from each other at least at 5% level.

### 5.2.2.1 Profitability of the wheat technology

As expected full adoption of the improved wheat technology gave the highest yield followed by partial adoption of the wheat technology. However, the difference in yield between non-adopters and partial adopters was not significant (Table 5.4). In terms of

input use (fertilizer and herbicide), full adopters used significantly higher rates of fertilizers than partial and non-adopters whereas fertilizer rates were not significantly different for non-adopters and partial adopters. Besides, non-adopters used the lowest rate of herbicide and the difference between non-adopters and full adopters was significant. Only four farmers used herbicide with improved wheat varieties as a package. The rates of herbicide used were lower than the recommended rate while only full adopters on the average used the recommended rate of fertilizers (Table 5.4)

In terms of labour and oxen utilization, as expected, partial and full adopters used significantly more labour in the production of wheat than non-adopters whereas partial adopters also used significantly more labour than full adopters in the production of wheat. This could be attributed to the fact that partial adopters used labour for weeding while full adopters used herbicide for weed control. Full adopters also used significantly more draft power for threshing than non-adopters and partial adopters whereas non-adopters and partial adopters were not significantly different in their draft power requirement for threshing wheat due to yield obtained (Table 5.4).

In terms of benefit, non-adopters had the lowest total and net benefit among wheat growers. Non-adopters got significantly lower total benefit than full adopters. The difference in total benefit between non-adopters and partial adopters, and partial and full adopters was significant at 10% level. Full adopters had significantly higher costs that vary than non-adopters and partial adopters (Table 5.4) due to significantly higher rates of fertilizers, herbicide and draft power utilization in threshing. The difference in cost that vary between non-adopters and partial adopters was also significant at 10% level due to significantly higher utilization of family labour by partial adopters for different operations. In terms of net benefit, non-adopters had significantly lower net benefit than full adopters whereas the difference between partial and non-adopters was not significant.

The marginal rate of return (MRR) was estimated for changing from traditional to partial and full adoption, and from partial to full adoption. The MRR for changing from non-adoption to partial and full adoption, and from partial to full package adoption provided

acceptable return on investment in the adoption of the wheat technology (Table 5.4). Based on experience and empirical evidence, both the change from traditional to partial and full adoption, and from partial to full adoption provided the minimum acceptable rate of return to farmers on improved wheat production.

**Table 5.4. Selected indicators and profitability of wheat technologies in Northern and Western Shewa zones (1997-2001)[a]**

| Item | Traditional technology | Improved | technology |
|---|---|---|---|
| | Non -adopters | Partial adopters | Full adopters |
| Yield, kg/ha | 8.0a | 8. 8a | 11.5b |
| | | | |
| Fertilizer, kg/ha | 106a | 111a | 156b |
| Herbicide, l/ha | 330a | 650b[b] | 507b |
| Labour use (man-days/ha) | 25.4a | 42.8b | 35.0c |
| Draft (oxen-day/ha) | 8.7a | 9.9a | 12.9b |
| | | | |
| Total benefit, Birr/ha3 | 1219.10a | 1440.90ab | 1701.20b |
| Total cost that vary, Birr/ha | 428.50a | 490.40a | 597.55b |
| Net benefit, Birr/ha | 790.60a | 950.50ab | 1103.65b |
| | | | |
| MRR[1] (%) | | 258 | 292 |
| MRR (%), partial to full | | | 143 |
| | | | |
| Risk (yield variance) | 12.2a | 28.9b | 35.9c |
| knowledge, Birr/ha | | 939.2a | 347.35b |

a. Figures in the same row followed by different letters are significantly different from each other at least at 5% level

b. Only four farmers used herbicide with improved varieties as a package.

[1] Marginal rate of return (MRR) on investment in the adoption of improved wheat technology., i.e., marginal net benefit (the change in net benefit) divided by the marginal cost (the change in costs) and expressed as percentage

Comparisons of yield variance of the three groups of farmers to assess the riskiness of the wheat technologies indicated that full adoption was significantly the most risky package followed by partial adoption of the package (Table 5.4). On the other hand comparison of the lowest 25% net benefits confirmed that full adoption was the most risky option. Non-adoption, partial and full adoption of improved wheat gave on average the lowest net benefit of 317.7, 500.30 and 365.70 Birr/ha, respectively. This implies that partial adoption is less risky than full adoption because it gave better lowest net benefit than full adoption. Thus, partial adoption was selected than full adoption because the net benefits

[3] 1 US $ = 8.5 Ethiopian Birr at the time of the study

were not significantly different and partial adoption gave acceptable MRR of 258% over non-adoption (Table 5.4). This could be due to higher cost of full adoption as the result of significantly higher utilization of fertilizers, herbicides, family labour and oxen power than partial adoption.

Comparison of partial and full adopters in terms of experience (average profit differential) they had gained over the five years period (1997 – 2001) indicated that surprisingly partial adopters were found more experienced than full adopters and the difference was significant at 1% level (Table 5.4). This was due to high variability of yield obtained by full adopters than partial adopters over the years and the net benefits obtained were not significantly different.

## 5.3 Pattern of adoption of *tef* and wheat technologies

In the pattern of adoption, percentages of farmers adopting the *tef* and wheat technologies were estimated for each year the farmers had adopted the improved technologies from 1997 to 2001. The majority of t*ef* farmers (65%) discontinued adoption of improved t*ef* varieties and planted local varieties in 2001 crop season. The major reasons for discontinuation were unwanted grain colour (32%), shortage of fertilizers (30%), seed expensive (15%), and shortage of land as reported by about 6% of farmers who discontinued growing improved t*ef* varieties. In the case of wheat, unlike *tef*, about 84% of farmers continued adopting the improved wheat varieties in 2001 crop season, which indicated that farmers have liked the varieties. The reasons given for discontinuing improved wheat varieties were seed becoming more expensive (36%), compared to grain price, low yield in the past (10%), shortage of land (10%), and shortage of fertilizers as reported by 9% of wheat farmers.

### 5.3.1 Pattern of adoption of wheat technology

Figures 5.1 present pattern of wheat technology adoption in the study area from 1997-2001. Adopters were further classified as partial adopters at the recommended (padopr)

and not at the recommended rates (padop), and full adopters at the recommended (fadopr) and not at the recommended rates (fadop). This classification helped to show not only who was adopting the improved wheat technologies but also who was adopting at the recommended rate or not. In the subsequent sections, the following categories of adoption patterns are used:

adopters - farmers using improved varieties

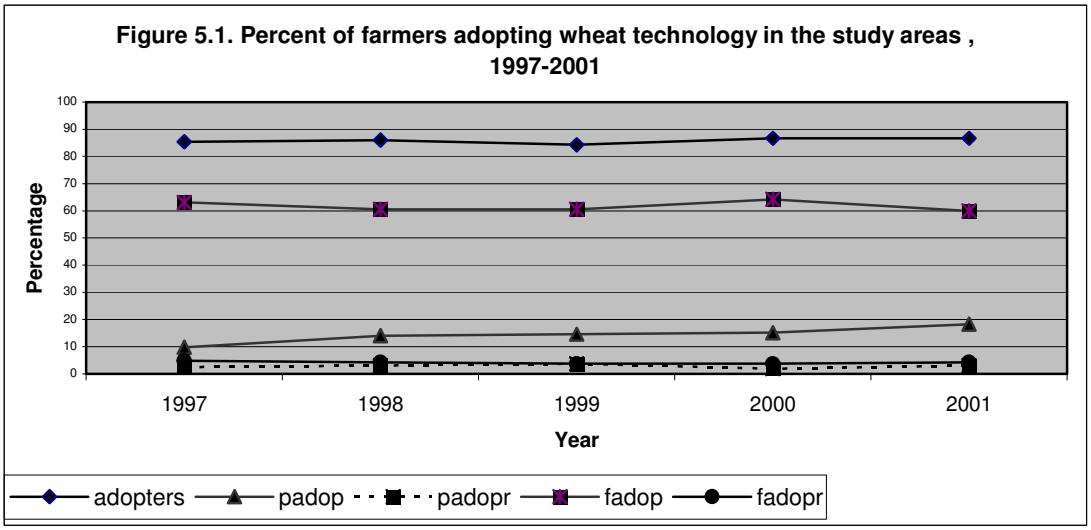
padop - use part of the package (V+F) not at the recommended rates,

padopr - use part of the package (V+F) at the recommended rates

fadop - use full package (V+F+H) not at the recommended rates

fadopr - use full package (V+F+H) at the recommended rates

**Figure 5.1. Percent of farmers adopting wheat technology in the study areas , 1997-2001**

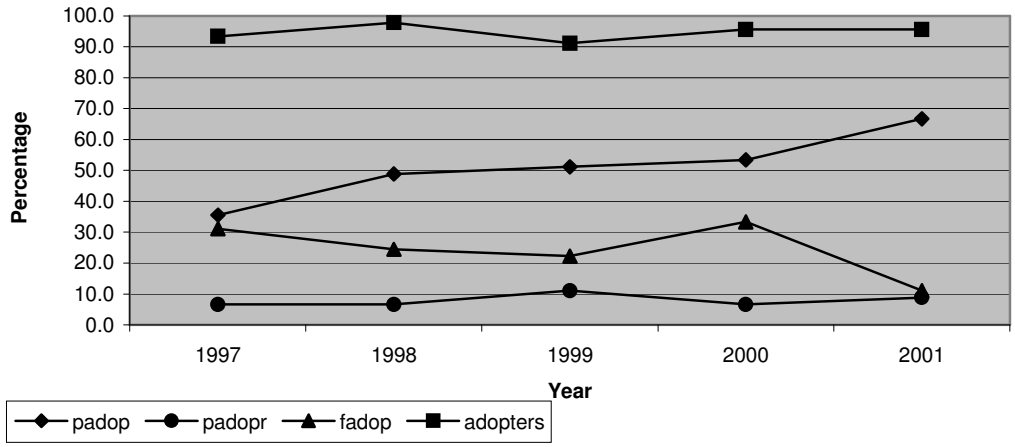



Most of sample farmers (more than 80%) have adopted the improved varieties from 1997 to 2001 (adopters). However, 60% of sample farmers adopted the full package (improved varieties with fertilizer and herbicide) at less than recommended rates (fadop) while only less than 5% adopted full package (improved varieties with fertilizer and herbicide) at recommended rates (fadopr). Farmers adopting part of the package (improved varieties with fertilizer) at less than the recommended rates (padop) ranged from 10% in 1997 to 18% in 2001 whereas farmers adopting part of the package (V+F) at the recommended rates (padopr) were less than 4%. Farmers adopting the full package were significantly more educated than farmers adopting the partial package. Generally, farmers adopting the

full package (V+F+H) at less than the recommended rates remained the same (60%) where as farmers adopting part of the package (V+F) at less than the recommended rates increased from about 10% to 18% over the years.

On the other hand patterns of adoption of improved wheat technology in medium (North Shewa) and high potential (West Shewa) growing areas are presented in Figures 5.2 and 5.3, respectively. More than 90% and 80% of farmers adopted the improved varieties (adopters) in medium and high potential growing areas, respectively from 1997-2001. In medium potential growing areas, more than 35% of sample farmers adopted part of the package (improved varieties with fertilizer) at less than the recommended rates (padop) while less than 35% adopted the full package (improved varieties with fertilizer and herbicides) at less than the recommended rates (fadop). The sharp decline in the number of farmers adopting full package followed by concurrent increase of farmers adopting part of the package at less than the recommended rates from 2000 to 2001 indicates farmers' rationale of not using herbicide in medium potential areas to minimize risk and to use the available family labour force. Besides, less than 10% of farmers adopted the partial package (padopr) while less than 1% adopted the full package at the recommended rates.

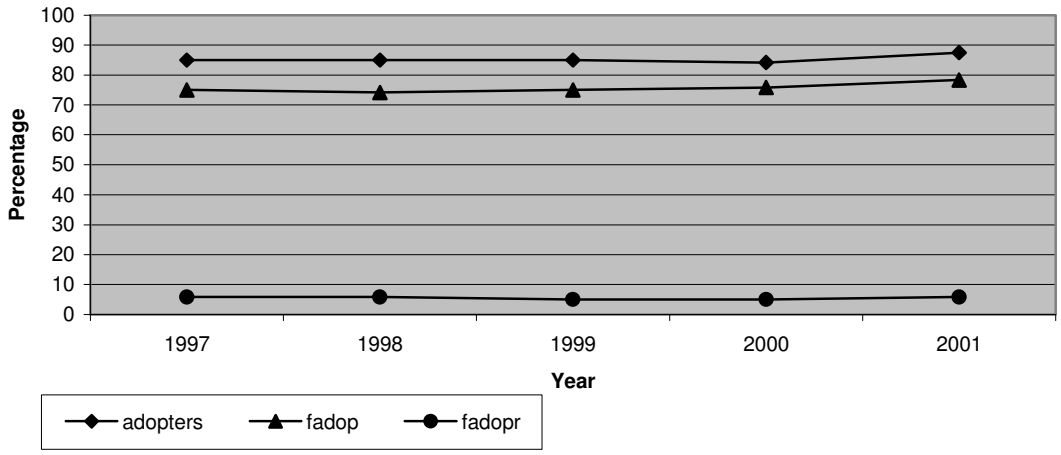
**Figure 5.2. Percentage of farmers adopting wheat technology in North Shewa zone, 1997-2001**



The trend in medium potential growing areas indicated an increasing shift from full adoption to partial adoption at less than the recommended rates while partial adoption at the recommended rate more or less remained the same.

In high potential growing areas (West Shewa), more than 70% of farmers adopted the full package at less than the recommended rates (fadop) while 5% adopted at the recommended rates (fadopr) from 1997 to 2001. Besides, farmers adopting the partial package were less than 1%. Figures 5.2 and 5.3 revealed that in high potential growing areas most farmers adopt full package at less than the recommended rates while in medium potential growing areas most farmers adopt partial package at less than the recommended rates.

**Figure 5.3. Percent of farmers adopting wheat technology in West Shewa Zone, 1997-2001**



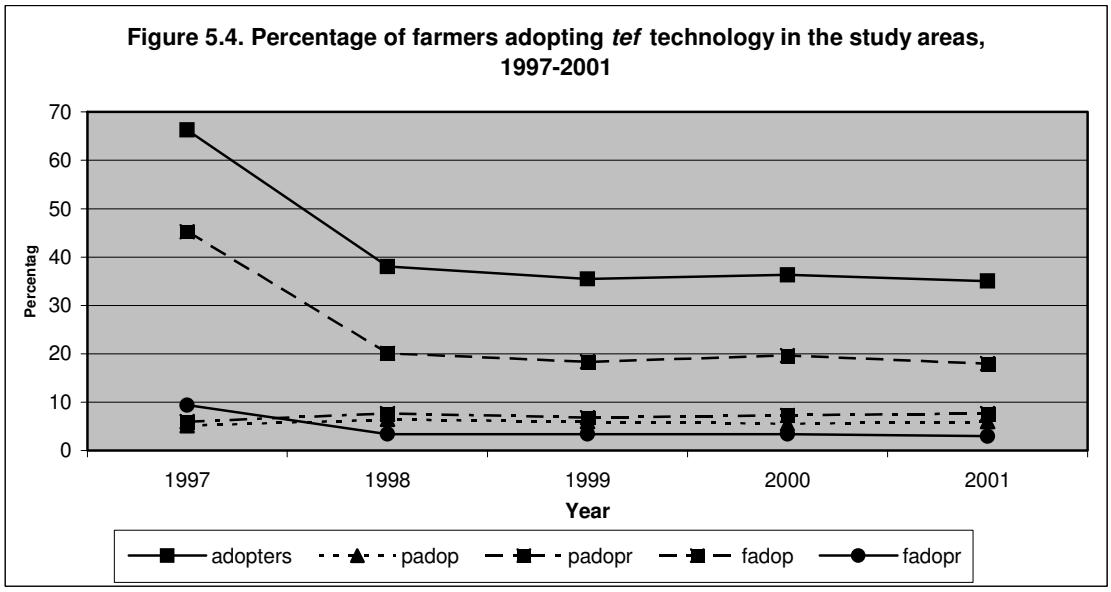

The trend in high potential growing areas remained the same for full adoption both at less than the recommended rates and recommended rates from 1997 to 2001.

## 5.3.2 Pattern of *tef* technology adoption

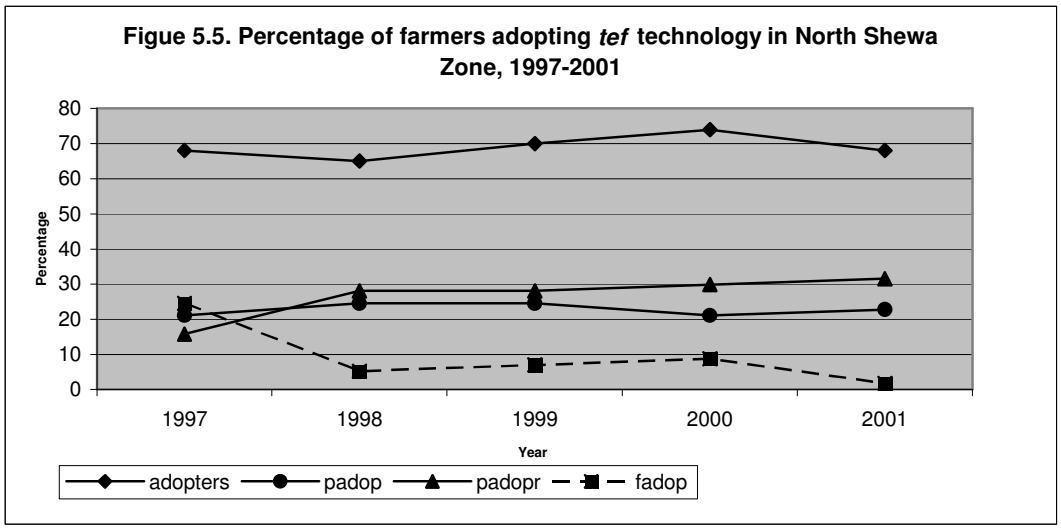
The percent of farmers who adopted improved *tef* seeds (adopters) declined from 66% in 1997 to 35% in 2001 (Figure 5.4). This indicates that only 35% gained knowledge and

continued adoption while 31% of farmers discontinued because of the unwanted colour. Similarly farmers who used full package (fadop) dropped from 45% in 1997 to 18% in 2001. Very few farmers (less than 5%) adopted the full package (fadopr) except in 1997 where 9% adopted immediately after demonstration and dropped to 3% starting 1998 and remained the same until 2001. On the other hand, farmers adopting partial package (padop and padopr) were less than 10% (Figure 5.4).

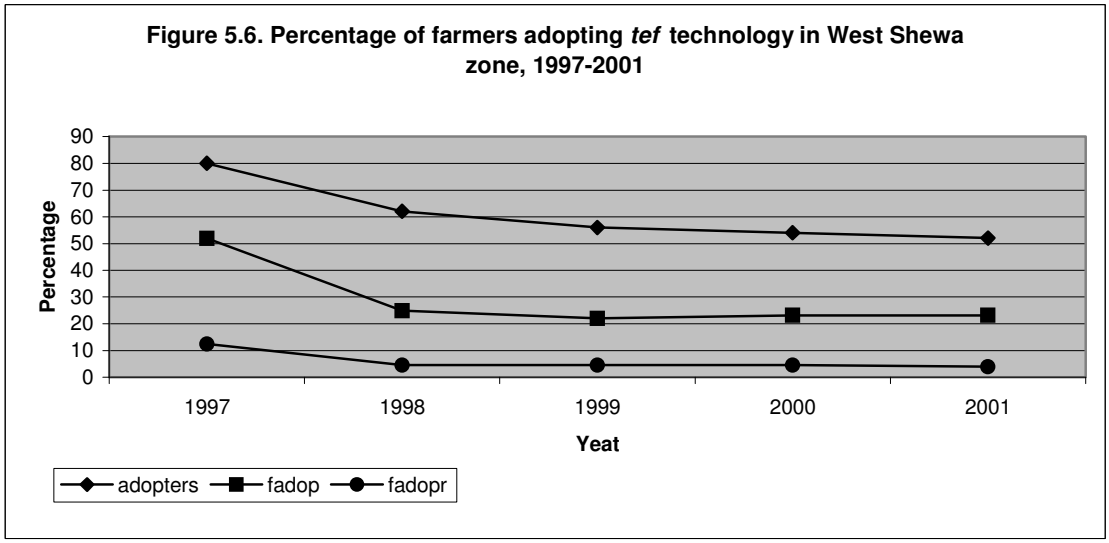
**Figure 5.4. Percentage of farmers adopting *tef* technology in the study areas, 1997-2001**




In medium potential growing areas, more than 65% of farmers adopted the improved *tef* varieties (adopters) from 1997-2001 (Figure 5.5). However, more farmers adopted the partial package (padop and padopr) rather than the full package (fadop) because of the risk involved in adopting the full package. Unlike wheat, out of the partial adopters more farmers adopted at the recommended rates except in 1997 due to the gained experience. Besides, adoption of full package (fadop) dropped from 25% in 1997 to 2% in 2001 while partial package adoption (padopr) increased from 16% in 1997 to 32% in 2001 (Figure 5.5).




In the high potential growing zone, improved *tef* variety adoption (adopters) decreased from 80% in 1997 to 52% in 2001 (Figure 5.6) because farmers did not like the varieties. In these areas only less than 1% adopted the partial package whereas more than 20 % adopted the full package (faop) at less than the recommended rates. However, the number of farmers adopted the full package at less than the recommended rates (fadop) decreased from 52% in 1997 to 23% in 2001. Similarly farmers who adopted the full package at the recommended rate (fadopr) also dropped from 12% to 4% for the same period (Figure 5.6).



## 5.4 Sequential adoption of improved technologies

In the sequence of adoption, farmers adopting partially and fully, and non-adopting were first identified. Then for each group, farmers adding or dropping components, and maintaining the same components they used to do were identified for the successive years after 1997.

Mostly development agents persuaded farmers to adopt the whole package of improved technologies (improved seed, fertilizer and herbicide) to take full advantage of the highest gains in profit due to the complementarity of components of the improved technologies. However, farmers often choose not to use the whole package but only some of its components in sequential manner i.e., improved variety with fertilizer first, then adopt herbicide later, etc. (Byerlee and de Polanco, 1986; Leaters and Smale, 1991). Farmers' sequential adoptions of components of the improved technology are influenced by the gains realized from using various components.

For sequential adoption, farmers were grouped into non-adopters (no use of improved varieties), partial adopters (farmers adopting improved seed with fertilizers) and full adopters (farmers adopting improved seed with fertilizers and herbicide). Then data on these three groups of farmers were examined separately from 1997 up to 2001 on their use of components of the improved *tef* and wheat technologies. Farmers using only improved seed without fertilizers and herbicide, and farmers using improved seed with herbicides were dropped from this analyses since their number was less than five.

In 1997, 14% of wheat growers were non-adopters while 18% and 68% were partial and full adopters, respectively. Wheat growers' were significantly different in their education levels (Table 5.5).

**Table 5.5. Education level of wheat growers in Northern and Western Shewa Zones in 1997.**

| Type of wheat Growers | Number | Percentage | Education level, percentage | | |
|---|---|---|---|---|---|
| | | | Illiterate | Literate | Formal |
| Non-adopters | 24 | 14 | 30 | 33 | 37 |
| Partial adopters | 29 | 18 | 65 | 4 | 31 |
| Full adopters | 112 | 68 | 30 | 25 | 45 |

Source: Own survey

Table 5.6 presents the sequence of adoption of components of wheat technology by non-adopters (24) from 1997 to 2001. Out of the non-adopters in 1997, 54% remained as non-adopters while 4% and 42% became partial adopters and full adopters, respectively, in 2001. Out of the non-adopters more farmers (37%) became full adopters rather than partial adopters from 1998 to 2001 due to their better education.

**Table 5.6 Sequential adoptions of components of wheat technology by non-adopters in Northern and Western Shewa Zones, 1997-2001.**

| Item | Percent of farmers adopting as of 1997 | | | |
|---|---|---|---|---|
| | 1998 | 1999 | 2000 | 2001 |
| Non-adopters | 71 | 67 | 50 | 54 |
| Partial adopters | 4 | 0 | 0 | 4 |
| Full adopters | 25 | 33 | 50 | 42 |

Source: own survey

In the case of partial adopters (29), 3% became non-adopters while 90% remained as partial adopters and 7% added the herbicide component and became full adopters in 2001 (Table 5.7). Most farmers (more than 79%) remained as partial adopters while less than 5% became non-adopters and less than 17% became full adopters form 1998 to 2001.

**Table 5.7 Sequential adoptions of components of wheat technology by partial adopters in Northern and Western Shewa Zones, 1997-2001.**

| Item | Percent of 1998 | farmers 1999 | adopting, as 2000 | of 1997 2001 |
|---|---|---|---|---|
| Non-adopters | 3 | 4 | 4 | 3 |
| Partial adopters | 79 | 86 | 79 | 90 |
| Full adopters | 7 | 10 | 17 | 7 |

Source: own survey

On the other hand, out of those farmers (112) who were full adopters in 1997, 7% became non-adopters, while 9% dropped the herbicide component and became partial adopters whereas 84% remained as full adopters in 2001. Most farmers (more than 80%) remained as full adopters while less than 10% and 12% became non-adopters and partial adopters, respectively, from 1998 to 2001 (Table 5.8). Full adopters were significantly better educated than non-adopters and partial adopters.

**Table 5.8 Sequential adoptions of components of wheat technology by full adopters in Northern and Western Shewa Zones, 1997-2001.**

| Item | Percent of 1998 | Farmers 1999 | adopting, as 2000 | of 1997 2001 |
|---|---|---|---|---|
| Non-adopters | 4 | 8 | 8 | 7 |
| Partial adopters | 9 | 12 | 8 | 9 |
| Full adopters | 87 | 80 | 84 | 84 |

Source: own survey

Similarly, the sequences of adoption of components of t*ef* technology were observed from 1997 to 2001. In 1997, 34% of t*ef* growers were non-adopters while 13% and 53% were partial and full adopters, respectively. Table 5.9 presents the sequences of adoption of components of t*ef* technology by non-adopters from 1997 to 2001. Out of non-adopters (80) in 1997, 89% remained as non-adopters whereas 1% and 10% became partial and

full adopters, respectively in 2001 (Table 5.9). More than 89% of farmers also remained as non-adopters from 1998 to 2001.

**Table 5.9 Sequential adoptions of components of *tef* technology by non-adopters in Northern and Western Shewa Zones, 1997-2001.**

| Item | Percent of farmers adopting, as of 1997 | | | |
|---|---|---|---|---|
| | **1998** | **1999** | **2000** | **2001** |
| Non-adopters | 90 | 94 | 91 | 89 |
| Partial adopters | 0 | 0 | 0 | 1 |
| Full adopters | 10 | 6 | 6 | 10 |

Source: own survey

In the case of farmers who were partial adopters (30) in 1997, 40% dropped the improved t*ef* varieties and became non-adopters while 60% remained as partial adopters and none became full adopters in 2001 (Table 5.10). From 1998 to 2001, more than 53% remained as partial adopters while more than 33% became non-adopters because they did not like the colour of the varieties and they were older.

**Table 5.10 Sequential adoptions of components of *tef* technology by partial adopters in Northern and Western Shewa Zones, 1997-2001.**

| Item | Percent of farmers adopting, as of 1997 | | | |
|---|---|---|---|---|
| | **1998** | **1999** | **2000** | **2001** |
| Non-adopters | 33 | 37 | 37 | 40 |
| Partial adopters | 57 | 60 | 53 | 60 |
| Full adopters | 10 | 3 | 10 | 0 |

Source: own survey

On the other hand, out of full adopters in 1997(124), 55% dropped the t*ef* varieties and became non-adopters while 12% dropped only the herbicide component and became partial adopters whereas 33% remained as full adopters in 2001 (Table 5.11). The majority of farmers (more than 50%) became non-adopters since they did not like the

colour of the varieties while 13% became partial adopters and more than 33% remained as full adopters from 1998 to 2001.

**Table 5.11 Sequential adoptions of components of *tef* technology by full adopters in Northern and Western Shewa Zones, 1997-2001.**

| Item | Percent of farmers adopting, as of 1997 | | | |
|---|---|---|---|---|
| | **1998** | **1999** | **2000** | **2001** |
| Non-adopters | 51 | 53 | 53 | 55 |
| Partial adopters | 13 | 13 | 13 | 12 |
| Full adopters | 36 | 34 | 34 | 33 |

Source: own survey

## 5.5 Summary and Conclusion

Comparison of the three groups of farmers (non-adopters, partial and full adopters) both for *tef* and wheat production indicated that non-adopters, partial and full adopters were significantly different in many respects such as crop area, active labour force, fertilizer obtained on credit, distance to Addis Abeba and distance to market. Their major differences were in input use, yield and returns. For instance, the majority of *tef* farmers did not like the new varieties because of their colour thinking that they will not fetch good prices and discontinued production. However, the partial budgeting showed that the improved varieties were profitable and provided acceptable returns on investment. The marginal rate of return (MRR) for changing from non-adoption to partial and full package adoption was more than 600%, i.e., for every *Birr* the farmer spends in *tef* technology he/she gets back six additional *Birr*. Unfortunately, about 62% of farmers discontinued growing the improved *tef* varieties after demonstration due to their undesirable color while the remaining (38%) realized the yield advantage and continued growing although the improved varieties were more risky (high yield variance) than the local ones in the past growing seasons. Partial and full adopters had on the average yield variances of 18.7 and 21.4, respectively, which are 143% and 174% higher than average variance of yield of non-adopters, respectively. Thus, partial adoption was found more acceptable than full

adoption in terms of its less riskiness and providing acceptable return on investment in the technology.

In the case of wheat, the majority of farmers had continued adopting the improved wheat varieties realizing the benefits obtained in the past. The MRR for changing from non-adoption to partial and full package adoption resulted in more than 200% additional income. However, for wheat partial adoption was found as profitable and provided acceptable rate of return on investment (258%) as full adoption, and less risky than full adoption. Partial adopters of improved wheat varieties also gained more experience than full adopters because of high variability of yield in full adoption. That could be the main reason why small farmers adhere to partial adoption rather than full adoption because of fear of debt as a result of inputs taken on credit and high variability in yield.

Sample farmers were asked their use of improved varieties of *tef* and wheat with fertilizers and herbicides after participating in the demonstration programmes form 1997 to 2001. Pattern of adoption was determined by percentage of farmers using the components of improved technologies (seed, fertilizers and herbicide). The pattern of adoption of improved varieties with fertilizer and herbicide from 1997-2001 indicated that most of the sample farmers adopted the full package (three components) at less than the recommended rates simultaneously both for *tef* and wheat. The patterns of adoption of *tef* and wheat technologies in high and medium potential growing areas vary because of risk. In medium potential growing areas both *tef* and wheat growers adopted the partial package and partial adoption was increasing from 1997-2001. On the other hand, in high potential growing areas full adoption dominated for both *tef* and wheat production. Moreover, percentage of wheat farmers adopting the full package remained the same from 1997 to 2000 and slightly increased in 2001. For *tef*, percentage of farmers adopting the full package decreased from 50% to 20% from 1997 to 2001 indicating that farmers did not like the *tef* varieties that were demonstrated to them although they were profitable and provided acceptable rate of return (MRR) as indicated in Table 5.2.

In the sequence of adoption of components of *tef* and wheat technologies, most of the group members remained where they belonged in 1997. In the case of wheat growers, out

of the non-adopters (24) in 1997, 54% remained as non-adopters where as 4% and 42% became partial and full adopters, respectively, in 2001. Most of the non-adopters were better educated and that is why 42% became partial adopters after five years. Out of the partial adopters (29), 3% and 7% became non-adopters and full adopters, respectively, while 90% remained as partial adopters in 2001. Partial adopters were the least educated among wheat growers. Out of full adopters (112) in 1997, 7% and 9% became non-adopters and partial adopters, respectively, while 84% remained as full adopters in 2001. Full adopters were significantly the most educated among wheat growers and the youngest although the difference was not significant. That is why a few dropped the improved varieties.

In the case of *tef* growers, out of non-adopters (80) in 1997, 89% remained as non-adopters whereas 1% and 10% became partial and full adopters, respectively, in 2001. Non-adopters were not significant in their education level and age. However, they were the youngest of all. Out of the partial adopters (30), 40% became non-adopters while 60% remained as partial adopters in 2001. Partial adopters were the oldest of all and were significantly different from non-adopters in terms of age and wealth. On the other hand out of full adopters (124) in 1997, 55% and 12%became non-adopters and partial adopters, respectively, whereas 33% remained as full adopters in 2001. Most of full adopters dropped the improved *tef* varieties because of the high risk.

Generally, the sequence of adoption of wheat technologies indicated that out of non-adopters in 1997, 42% became full adopters in 2001 while 3% and 7% of partial and full adopters, respectively, became non-adopters during the same period. In the case of *tef* growers, out of the non-adopters in 1997, 89% remained as non-adopters and 10% became full adopters in 2001 while 40% and 55% of partial and full adopter, respectively, dropped the improved varieties since they did not like the varieties. This implies farmers adopt components of a technology sequentially when they found them useful and drop when they found them unacceptable.