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# WHEAT PRODUCTION TECHNOLOGIES IN KENYA: AN ANALYSIS OF THE MAJOR CHARACTERISTICS AND CONSTRAINTS TO PRODUCTIVITY GROWTH

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**ABSTRACT**

A survey of 97 farmers was undertaken in Nakuru, Narok and Uasin Gishu districts to delineate the wheat production technologies and the major characteristics and constraints to productivity growth. The results of the analysis shows that large-scale wheat farming is more productive than small-holder wheat in both high and low zones by 25% and 50%, respectively. However, average yields are higher in low potential than in high potential zones. Wheat faces less competition in low potential areas for land, and, hence, farmers are relatively more specialized and efficient in wheat production. In contrast, wheat has to compete with high value enterprises such as maize and dairy production for high potential land resources. Small-scale farmers have limited access to machinery which results in failure to perform cultural practices at the optimal time, and, hence, the low productivity of small-scale farmers in both regions. Furthermore, their limited access to credit results in low levels of modern input use such as seed, chemical fertilizers, herbicides and pesticides. In both regions, there is a clear yield differential or efficiency gap, between researchers' and farmers' wheat yields. This is mainly a result of deviation from the recommended methods by farmers. Farmers in both high and low potential areas ranked the problems they face in order of seriousness as follows: machine rental costs, fertilizer cost, weeds and credit availability. Their ranking of the problems generally confirmed the findings of this paper, that small-scale farmers have relatively less access to efficient means of production such as mechanization and chemical inputs, and, hence, achieve very low yields. The challenge here seems to be in developing appropriate small-scale technologies suitable for small-holders with limited access to capital as well as developing appropriate and sustainable technologies for the fragile environments of low potential areas.

## INTRODUCTION

Traditionally, wheat had been produced in Kenya under a large-scale system. However, since the attainment of independence in 1963, several institutional reforms have taken place leading to major structural changes in the country's wheat supply sector.

The redistribution of traditional wheat land to new owners has for instance, affected wheat supply in a number of ways. Those parcels transferred intact to new owners have experienced changes in enterprise mixes. This is due to inexperience of the new owners in wheat farming and their greater familiarity with other enterprises such as maize and dairy.

The other parcels that were transferred to a large number of small farmers have gone through similar changes in enterprise mix. In addition to unfamiliarity with wheat farming, maize was the main food staple and hence has been accorded higher priority over wheat. Consequently, maize and dairy, among other enterprises have replaced wheat on substantial areas of the transferred land. The former "Million Acre Scheme" in Kinangop/Nyandarua area is a good example of this major structural change in wheat production. This scheme used to account for 40% of the country's wheat supply in the seventies but now accounts for only 2% after sub-division. Maize production and small-scale dairying have replaced wheat in the small farmers' production systems in the area (WB 1989). Sub-division of the large wheat estates has also led to adapting the large-scale production technologies to suit the economic and technical circumstances of the small to medium size production systems.

Wheat production has also been introduced in non-traditional wheat areas mainly in the marginal lands of Narok/Trans-Mara region. This creates the need for development of new wheat technologies suitable for these marginal areas. In these areas, however, wheat competes with different uses of the land under complex tenure arrangements such as communal grazing and wildlife.

While the wheat supply sector has undergone major structural change, the demand for wheat flour and wheat products continues to outgrow supply due to a fast growing population at 4% per annum, increased income, and an increasing concentration of population into urban areas, which is growing at 7% per annum and where most of the wheat flour and wheat products are consumed. This has led to changing consumption patterns in favor of wheat products relative to the consumption of maize and other traditional staples (GOK 1986). Self-sufficiency in wheat has accordingly dropped from 132% in 1961-65 to 60% in 1983-87 (Byerlee and Morris 1990). The ever widening gap between supply and demand continues to be bridged by imports, which rose from 32808 tons in 1977 to 217900 tons in 1987 accounting for 57% of the consumption requirements in 1987 (WB 1989).

Given the government policy to manage the wheat problem through the supply side (GOK 1986), a comprehensive survey was carried out for the first time in 1990/91 to characterize the wheat production technologies currently employed by small, medium, and large-scale farmers in the different agro-climatic zones and to identify constraints to productivity growth. The result of this study will provide useful information for researchers to develop/adapt technologies suitable to various farmers in different agro-ecological zones and scale categories. This will also help in setting priorities for wheat research in Kenya. Policy makers will also benefit from the result of the study in designing appropriate policies to relax and/or remove constraints hindering increased wheat production.

## RESEARCH DESIGN AND METHODOLOGY

Data were collected from a survey of wheat farmers in the major wheat producing areas in Kenya. Given resources and time available for this research a sample of 100 farmers was selected for a two

visit survey during the 1990 season. Information compiled from secondary sources and pilot informal surveys were used to design a multi-stage stratified random sample of wheat farmers. The survey covered three districts: Narok, Nakuru and Uasin Gishu, where more than 80% of Kenya wheat is produced (KARI 1989). Secondary data were used to divide the three districts according to agro-climatic conditions into high and low potential regions. High potential areas were defined as those receiving an average annual rainfall of more than 900 mm at altitudes between 2000 and 2400 m. The low potential region, on the other hand, includes areas of annual rainfall not more than 800 mm and elevations between 1600 and 2000 m. Farmers in these agro-climatic zones were then classified into large, medium and small-scale producers (Table 1). A multi-stage random sampling procedure was used to select a sample representing the various agro-climatic and scale strata in each of the three districts.

Table 1 shows the distribution of the sampled farmers across zones and size groups. Total size of the sample dropped to 97 due to 3 irrecoverable non-response cases. The table shows that 68% of the sampled farmers came from the small and medium size compared to 32% large-scale farmers. The sample is split between high and low potential zones at about 60 and 40%, respectively. The table also shows average farm size by zone and scale group. While the average size of holding for small-scale farmers in high potential zones (22 acres) is more than double the average size in the low potential region (10 acres), the opposite is true for large-scale farmers. This indicates that inequality in land distribution among wheat farmers is sharper in marginal areas compared to high potential lands. This data set is used in the following sections to characterize wheat production technologies employed by small and large-scale farmers in the various zones defined above. The study also attempts to identify problems of wheat production and obstacles to higher productivity in these farming systems.

## PATTERNS OF LAND USE AND COMPETITION FOR FARM RESOURCES

The competition wheat faces from alternative crop and livestock (dairy) enterprises vary across agro-ecological zones. Table 2 presents data on yield and proportion of land under the various enterprises competing with wheat. The table indicates that large-scale wheat farming gave higher yields than small-holder wheat, in both high and low zones, by 25 and 50%, respectively. Contrary to expectations, however, average yields are higher in low potential than in high potential areas. On the other hand, wheat occupies above 90% of the land in marginal areas, whereas most of the land (67%) is devoted to other uses such as maize and dairying in the high potential zone. This indicates that wheat in low potential regions faces less competition for land, and, hence, farmers are relatively more specialized and efficient in wheat production. In contrast, wheat has to compete with high value enterprises such as maize and dairy production for high potential land. The high competition between wheat and other enterprises as well as their substitutability has been observed elsewhere (Kere *et al.* 1986).

Table 2 also shows that high potential zone maize generates yield levels (1.4 t/ha) that are twice those of low potential land (0.7 t/ha). This indicates that while maize does not compete with wheat in low potential lands, it has a yield advantage over wheat in high potential areas. The biggest competition for wheat in the high potential zone, however, comes from dairying which uses 57% of the land resources compared to only 27% in the low potential zone. The results indicate the high potential for wheat production in the marginal areas of Kenya, if one considers the high gain in wheat productivity required to compete dairying and maize on high potential areas.

## LARGE- AND SMALL-SCALE WHEAT TECHNOLOGIES

In this section, production technologies employed by large and small wheat producers are analyzed. Practices followed by the two farmer groups are also compared to research recommendations for the two agro-climatic zones. Causes of the high efficiency gap between large and small-scale farmers, and between potential and current farmers' yields are accordingly identified. The analysis then defines areas for further research into increased wheat production efficiency.

## WHEAT GROWING SEASON AND TIMING OF OPERATIONS

Recommendations released by the National Plant Breeding Research Center (NPBRC) at Njoro, suggest that the optimal time for land preparation should start within two months after harvesting (NPBRC 1990). Table 3 summarizes information on the crop calendar followed in the sampled areas. According to Table 3, only 24% of the farmers begin land preparation within the recommended time. This is certainly one important reason behind the productivity gap between research and farmers' fields.

Table 3 also shows that the ability to perform timely operations varies in direct proportion to the size of the farm. While none of the small-scale farmers were able to prepare land at the recommended date, the proportion of farmers performing timely land preparation increases with farm size in both zones. Small farmers are also the last to plow, plant, and harvest wheat, which indicates that medium and large-scale farmers have better access to machinery services. While almost all small-scale farmers hire machine services (except 2 farmers in the high and one in the low potential zones), most of the large-scale producers use their own farm machinery to prepare the land (94 and 86% for high and low zones, respectively). Moreover, the rental market for machinery discriminates against small farmers as profit maximizing machine owners tend to exploit scale economies (or prepare their own land first) before small-holders' demands become attractive (Longmire and Lugogo 1989; KARI 1989). These results suggest that limited access to machinery services and absence of alternative small-holder technologies are reasons for failure to perform cultural practices at the optimal time, and hence the low productivity of small-scale farmers in both regions. The fact that the proportion of farmers preparing land at the optimal date in low potential areas is higher on average (30%) than high potential zone farmers (20%) might to some extent explain the yield differential between the two regions.

## IMPROVED SEED AND SOWING TECHNOLOGY

All farmers were found to use improved wheat varieties. Significant variations, however, exist between farmers with regard to the source of their seed, seeding rate and method. Table 4 shows that 50% of the farmers produce their own seed. Only 15% of those who bought seeds for cash (5.7% of total) acquired them directly from the Kenya Seed Company (KSC), whereas the rest bought from seed merchants and other farmers. Accordingly, one can say that only 17.7% of the farmers used the recommended, clean and certified seed (12% by credit and 5.7% in cash), as no one is certain about the quality of seeds provided by merchants and other farmers. This might be another reason for the productivity gap between potential and farmers' yields.

As shown in Table 4 most of the small-scale farmers do not use certified seed and have no access to seed credit. However, the population of farmers using certified seed by cash or credit increases with farm size in both zones. Limited access to quality improved seed is, therefore, one more reason for the yield differential between small and large-scale farmers.

Research recommendations on seeding rate vary by variety and viability of the seed. The recommended rate, however, averages 42 kg/acre (NPBRC 1990). Table 4 indicates that farmers use

twice as much seed as recommended, on average, with small farmers applying higher rates than large producers. This is probably related to the low quality (viability) of seed used by farmers as indicated by source or method of seeding. The agronomic implications of this practice need to be studied. Table 4 also shows that almost all farmers in the high potential zone plant by machine, whereas the majority of the small farmers in low potential zone (89%) broadcast seed manually and hence use higher seed rate.

## COMMON VARIETIES

Sampled farmers were found to use eight varieties. The proportions of farmers using these varieties are given in Table 5. The most commonly used varieties were Fahari, Tembo, Nyangumi, Nungu and Popo. Except for the variety Fahari, this is consistent to a large extent with the ranking based on percent of national wheat area reported at the bottom of Table 5. Unpublished data of the National Plant Breeding Research Center (NPBRC) suggest that area under Fahari is less than 5% of the national wheat area, whereas this survey indicates that it is the most used, in sole and in combination, on about 39% of the land. While the variety Tembo is not grown in low potential lands, it ranks top in the high potential regions in terms of percent of farmers using it as sole. Paka is the oldest variety with respect to year of release (1974), and is the least used in both zones. Amongst the latest three varieties released by NPBRC, only Mbuni is being used (the other two are Kware and K. Tausi).

Table 6 presents data on source of seed, price, yields, seeding rate and productivity gap of the eight varieties reported in Table 5. Variety Nungu registered the lowest yield (0.44 t/acre). This indicates the significant influence of the seed source on productivity as all farmers (100%) using Nungu retained seed from their own previous harvest. Highest average yields (lowest productivity gap), on the other hand, were achieved by the varieties Popo, Kongoni and Mbuni. The variety that enjoyed the highest credit share is Nyangumi, where about one third of those who used it obtained the seed through credit. Table 5 shows that Mbuni, the most recently released (1978), is the most expensive variety of all.

## CHEMICAL NUTRIENT AND PROTECTION TECHNOLOGIES

Diammonium phosphate (DAP 18:46:0) is the chemical fertilizer most commonly used by the sampled farmers. Table 7 shows that 88% of the farmers use nitrogen and phosphorus in the form of DAP, whereas very few farmers apply phosphorus separately (4% on average). Soil analysis results indicate that wheat growing areas in Kenya are deficient in nitrogen and phosphorus. It is, therefore, recommended that farmers apply DAP (18:46:0) at the rate of 45kg/acre, on lands planted to wheat for three consecutive years (NPBRC 1990). Table 7 indicates that 60 kg/acre of DAP is applied by farmers which is above the research recommendation. Small farmers, however, applied lower fertilizer rates compared to large-scale producers in both zones. According to Table 7, 55% of the large-scale farmers obtained fertilizer through credit compared to only 14% of the small-holder wheat farmers in low potential lands. None of the small farmers in high potential areas obtained fertilizer credit compared to 19% of the large farmers.

While almost all farmers in high potential areas applied fertilizer mechanically, only 18% of the small-scale farmers used mechanical means compared to 100% of the large farmers in the low potential zone (Table 7). These results indicate the relatively poor access of small-scale farmers to credit, machinery services, and adequate levels of modern inputs.

Table 8 presents data on the weed and pest control technologies employed by wheat farmers in Kenya. The table shows that the proportion of farmers who use manual or zero weeding is higher the smaller the size of the farm. The opposite is true for the percent of farmers using herbicides.

Similarly, the proportion of farmers who use chemicals to control crop pests and diseases increases with farm size in both zones. Furthermore, most of the large-scale producers spray pesticides by machine, whereas the majority of the small farmers do not. Table 8 also shows that only large-scale farmers in high potential lands acquired pesticide through credit (40%). The most commonly used chemical by sampled farmers on the average is Tilt, followed by Ambush with Dipterex and Dimecron about the same as shown by the percent of farmers using the material (Table 8). The results of Table 7 and 8 confirm the previous finding that limited access to modern means of efficient wheat production is the most important factor hindering productivity growth among small-scale farmers.

## WHEAT PRODUCTION PROBLEMS

Sampled farmers were asked to rank problems they face in producing wheat on the scale of most serious (1) to least serious (6). This ranking is presented in Table 9. The table shows that, machine rental costs, followed by fertilizer cost, weeds, and credit availability are the most serious problems of wheat production as perceived by farmers. There is some variation, however, as to how serious these problems are for different regions and size groups. The high cost of machinery services ranked top in both regions, whereas it was less serious for large farmers compared to small producers particularly in the low potential region. As expected weed infestation ranked second in high potential lands, whereas it was less serious in low potential lands. Fertilizer cost is the second most serious problem for low potential areas and third in the high potential zone. Availability of credit is a less serious problem the larger the farm size. Farmers in both regions did not think that seed availability is a serious problem. These results, however, in general confirm the finding of previous sections, that small-scale farmers have relatively less access to means of wheat production such as mechanization and chemical inputs.

## SUMMARY

This paper has shown that large-scale wheat farmers achieve higher yields compared to small-holders, in both high and low potential areas. However, average yields are higher in low potential than in high potential zones. Wheat faces less competition in low potential areas for land, and, hence, farmers are relatively more specialized and efficient in wheat production. In contrast, wheat has to compete with high value enterprises such as maize and dairy production for high potential land resources.

Small-scale farmers have limited access to machinery services and this coupled with lack of alternative small-holder wheat technologies result in failure to perform cultural practices at the optimal time, which might be one reason for the low yield realized by small-scale farmers in both regions. Furthermore, their limited access to credit result in low level of modern input use such as certified seed, chemical fertilizers, herbicides and pesticides.

In both regions, there is clear yield differential or efficiency gap between researchers' and farmers' wheat yields. Farmers in high and low potential areas ranked the problems they face in order of seriousness as follows: machine rental costs, fertilizer cost, weeds and credit availability. Farmers in both regions did not think that seed availability is a serious problem. As it is the case with most farmers, seeds may be available from the previous crop harvest. Nevertheless, farmers' ranking of the problems they face in wheat production, generally confirmed the findings in this paper, that small-scale farmers have relatively less access to efficient means of wheat production such as mechanization and chemical inputs, and, hence, achieve very low yields.

The findings of this paper indicate clearly that researchers and policy makers should establish priorities for research and development to increase wheat production in low potential areas. This calls especially for development of appropriate technologies for this fragile environment as well as

sorting out various conflicting land tenure arrangements. Small-holders have the biggest yield gap, and, hence, potential for productivity improvement. The challenge here seems to be in developing appropriate small-scale technologies suitable for small-holders with limited access to capital. There is also a need for policy reforms and institutional arrangements (cooperatives, credit, etc.) to improve access and availability of modern means of production for small-scale farmers.

## ACKNOWLEDGMENT

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Table 1. Distribution of the sampled wheat farmers by agro-ecological zone and farm size.

| | Small (<40 acres) | Medium (41-100 acres) | Large (>100 acres) | Total |
|---|---|---|---|---|
| **A. High Potential** | | | | |
| Number of farmers | 24 | 18 | 17 | 59 |
| % of row total | 41% | 30% | 29% | 100% |
| % of column total | 57% | 75% | 55% | 61% |
| Average farm size (acres) | 22 | 61 | 812 | 262 |
| **B. Low Potential** | | | | |
| Number of farmers | 18 | 6 | 14 | 38 |
| % of row total | 47% | 16% | 37% | 100% |
| % of column total | 43% | 25% | 45% | 39% |
| Average farm size (acres) | 10 | 61 | 1615 | 609 |
| **C. Total** | | | | |
| Number of farmers | 42 | 24 | 31 | 97 |
| % of row total | 43% | 25% | 32% | 100% |
| % of column total | 100% | 100% | 100% | 100% |
| Average farm size (acres) | 17 | 61 | 1175 | 398 |

Table 2. Wheat and maize yield levels and patterns of land use in sampled wheat producing regions.

| | Wheat yield (t/a) | Farm size (a) | Proportion of land under wheat (%) | Proportion of land under maize (%) | Proportion of land under dairy (%) | Proportion of land under maize and dairy (%) | Maize yield (t/a) | % of farmers raising livestock |
|---|---|---|---|---|---|---|---|---|
| **1. High Potential** | | | | | | | | |
| Small | .67 | 22 | 20 | 15 | 35 | 50 | 1.7 | 79 |
| Medium | .73 | 61 | 23 | 11 | 51 | 62 | 1.4 | 95 |
| Large | .84 | 812 | 27 | 9 | 54 | 63 | 1.2 | 94 |
| Average | .73 | 262 | 27 | 10 | 57 | 67 | 1.4 | 88 |
| **2. Low Potential** | | | | | | | | |
| Small | .68 | 10 | 63 | 21 | 14 | 35 | .8 | 33 |
| Medium | .39 | 61 | 50 | 12 | 16 | 28 | .7 | 50 |
| Large | 1.02 | 1615 | 93 | 1 | 1.3 | 2.3 | .8 | 14 |
| Average | .76 | 609 | 92 | 1 | 1.3 | 2.3 | .7 | 29 |
| Average | .74 | 398 | 66 | 5 | 27 | 32 | 1.2 | 65 |

Table 3. The wheat crop calendar and growing season in sampled areas.

| | Land preparation | | | | | |
|---|---|---|---|---|---|---|
| | Date preparation begins | % within recommended date | % using own machine | Date sowing begins | Date Harvesting ends | Average growing season (days) |
| **A. High Potential:** | | | | | | |
| Small | March(1)[a] | 0 | 8 | June(3) | December(2) | 146 |
| Medium | February(1) | 16 | 28 | June(1) | December(1) | 154 |
| Large | December(4) | 52 | 94 | May(1) | November(3) | 157 |
| Average | January(4) | 20 | 39 | May(3) | December(1) | 150 |
| **B. Low Potential:** | | | | | | |
| Small | January(4) | 0 | 6 | March(4) | October(4) | 142 |
| Medium | December(3) | 24 | 40 | March(4) | October(3) | 142 |
| Large | December(1) | 68 | 86 | March(3) | October(2) | 140 |
| Average | December(4) | 30 | 41 | March(4) | October(3) | 140 |
| Average | | 24 | 41 | | | 146 |

[a] numbers in brackets refer to the week (e.g. first, second, ... fourth) of the month.

Table 4. Source of seed, average yield, seeding rate, and method of planting by agro-climatic zone and farm size.

| | Seed source (%) | | | | | |
|---|---|---|---|---|---|---|
| | | Bought | | Average yield | Seeding rate | Mechanical |
| | Own | Cash | Credit | (t/a) | (kg/a) | sowing |
| **A. High Potential:** | | | | | | |
| Small farms | 46 | 54 | 0 | .67 | 88 | 92 |
| Medium farms | 50 | 39 | 11 | .73 | 88 | 100 |
| Large farms | 35 | 41 | 24 | .84 | 76 | 100 |
| Average | 44 | 46 | 10 | .73 | 84 | 95 |
| **B. Low Potential:** | | | | | | |
| Small farms | 72 | 22 | 6 | .68 | 99 | 11 |
| Medium farms | 33 | 50 | 17 | .39 | 85 | 83 |
| Large farms | 50 | 21 | 28 | 1.02 | 93 | 93 |
| Average | 58 | 26 | 16 | .76 | 83 | 53 |
| Average | 50 | 38 | 12 | .74 | 84 | 78 |

Table 5. Percent of farmers using improved varieties by agro-climatic zone.

| Varieties | Fahari | Tembo | gumi | Nyan-Nungu | Popo | Kong-oni | Paka | Mbuni | Combin-ations | Don't know |
|---|---|---|---|---|---|---|---|---|---|---|
| **A. High Potential:** | | | | | | | | | | |
| % of farmers using as sole | 15 | 22 | 7 | 0 | 3 | 5 | 3 | 2 | 19 | 24 |
| % of farmers using in combinations[a] | 17 | 5 | 9 | 2 | 7 | 3 | 5 | 7 | -- | -- |
| % of farmers using both sole and in combination[a] | 32 | 27 | 16 | 2 | 10 | 8 | 8 | 9 | -- | -- |
| **B. Low Potential:** | | | | | | | | | | |
| % of farmers using as sole | 18 | 0 | 8 | 11 | 5 | 0 | 0 | 0 | 13 | 45 |
| % of farmers using in combination[a] | 5 | 8 | 10 | 5 | 3 | 3 | 0 | 8 | -- | -- |
| % of farmers using both sole | 23 | 8 | 18 | 16 | 8 | 3 | 0 | 8 | -- | -- |
| **C. Total Sample:** | | | | | | | | | | |
| % of farmers using as sole | 17 | 13 | 7 | 4 | 4 | 3 | 2 | 1 | 17 | 32 |
| % of farmers using in combinations[a] | 12 | 6 | 9 | 3 | 5 | 2 | 5 | 7 | -- | -- |
| % of farmers using as both sole and in combination[a] | 29 | 19 | 16 | 7 | 9 | 5 | 7 | 8 | -- | -- |
| Proportion of land under variety (%) | 38.7 | 15 | 18 | 12 | 10 | 3 | 2 | 1 | -- | -- |
| Year released | 1976 | 1975 | 1979 | 1975 | 1982 | 1981 | 1974 | 1987 | | |
| National area under variety (%)[b] | 4.8 | 15.7 | 10.9 | 6.1 | 16.9 | 6.5 | 2.8 | 5.7 | | |

[a] percentages in these rows do not add to 100 because combinations of varieties are not mutually exclusive.

[b] compiled by authors from various sources, basically the NPBRC, Njoro, Kenya.

Table 6. Source of seed, average seed price, yield and seeding rate and productivity gap by variety.

| | Source of seed (%) | | | Average price (Ksh/kg) | Average yield (t/a) | Average seeding rate (kg/a) | Product-ivity gap |
|---|---|---|---|---|---|---|---|
| | Own | Cash | Bought Credit | | | | |
| Fahari | 31 | 63 | 6 | 7.3 | .70 | 91 | .26 |
| Tembo | 54 | 38 | 8 | 8.9 | .72 | 84 | .30 |
| Nyangumi | 43 | 29 | 28 | 8.8 | .65 | 84 | .29 |
| Nungu | 100 | 0 | 0 | -- | .44 | 74 | .42 |
| Popo | 67 | 33 | -- | 8.2 | .96 | 79 | .17 |
| Kongoni | 67 | 33 | -- | 10.6 | .93 | 77 | .11 |
| Paka | 50 | 50 | -- | -- | .77 | 120 | .17 |
| Mbuni | 50 | 50 | -- | 12.5 | .93 | 55 | .33 |
| Combinations | 38 | 38 | 24 | 9.6 | .74 | 77 | -- |
| Don't know | 58 | 35 | 7 | 8.5 | .78 | 85 | -- |
| Average | 50 | 38 | 12 | 8.4 | .74 | 84 | .26 |

Table 7. Types, levels and method of fertilizer application by zone and size.

| | | DAP | | | Phosphorus | | | |
|---|---|---|---|---|---|---|---|---|
| | | kg/a | % using | % through credit | kg/a | % using | % through credit | % applying mechanically |
| A. | **High Potential:** | | | | | | | |
| | Small | 63 | 92 | 0 | 4 | 4 | 0 | 100 |
| | Medium | 67 | 94 | 19 | 4 | 6 | 0 | 100 |
| | Large | 75 | 94 | 19 | 5 | 6 | 0 | 95 |
| | Average | 68 | 93 | 10 | 4 | 5 | 0 | 98 |
| B. | **Low Potential:** | | | | | | | |
| | Small | 44 | 56 | 14 | 0 | 0 | -- | 18 |
| | Medium | 50 | 100 | 33 | 0 | 0 | -- | 83 |
| | Large | 51 | 100 | 55 | 0 | 0 | -- | 100 |
| | Average | 49 | 76 | 32 | 0 | 0 | -- | 67 |
| | Average | 60 | 88 | 19 | 2.5 | 4 | 0 | 87 |

Table 8. Pest and weed control practices of wheat farmers by zone and size.

| | Weed control | | | Pest control | | | Type of chemical | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | % no weeding | % using herbicide | % manual weeding | % using pesticide | % applying mechanically | % acquire through credit | % using Tilt | % using Ambush | % using Dipterex | % using Dimecron |
| **A. High Potential:** | | | | | | | | | | |
| Small | 33 | 50 | 17 | 13 | 0 | 0 | 33 | 0 | 33 | 0 |
| Medium | 28 | 66 | 6 | 18 | 33 | 0 | 100 | 0 | 0 | 0 |
| Large | 12 | 88 | 0 | 21 | 75 | 0 | 75 | 0 | 0 | 0 |
| Average | 26 | 66 | 8 | 16 | 44 | 0 | 67 | 0 | 11 | 0 |
| **B. Low Potential:** | | | | | | | | | | |
| Small | 44 | 17 | 28 | 22 | 25 | 0 | 0 | 75 | 0 | 0 |
| Medium | 0 | 67 | 17 | 45 | 50 | 0 | 25 | 0 | 0 | 0 |
| High | 14 | 79 | 0 | 86 | 100 | 40 | 60 | 0 | 10 | 20 |
| Average | 26 | 59 | 11 | 29 | 67 | 17 | 48 | 12 | 8 | 8 |

Table 9. Farmers' Ranking of wheat production problems in terms of seriousness by farmers in various zone and size groups[a].

| | Weeds | Pests | Diseases | Seed availability | Machine rental cost | Credit availability | Fertilizers cost | Rains |
|---|---|---|---|---|---|---|---|---|
| **A. High Potential:** | | | | | | | | |
| Small | 2 | 6 | 5 | 6 | 1 | 3 | 4 | 6 |
| Medium | 4 | 5 | 3 | 6 | 1 | 6 | 2 | 6 |
| Large | 2 | 6 | 5 | 6 | 2 | 6 | 3 | 4 |
| Average | 2 | 6 | 4 | 6 | 1 | 5 | 3 | 6 |
| **B. Low Potential:** | | | | | | | | |
| Small | 4 | 6 | 6 | 5 | 1 | 2 | 3 | 6 |
| Medium | 6 | 5 | 6 | 6 | 1 | 3 | 2 | 4 |
| Large | 3 | 1 | 2 | 6 | 6 | 6 | 5 | 4 |
| Average | 4 | 4 | 5 | 6 | 1 | 3 | 2 | 6 |
| Average | 3 | 5 | 5 | 6 | 1 | 4 | 2 | 6 |

[a] A ranking scale that assigns the value of 1 to "most serious" and value of 6 to "least serious" was used. This was based on the percentage of farmers in each response category.