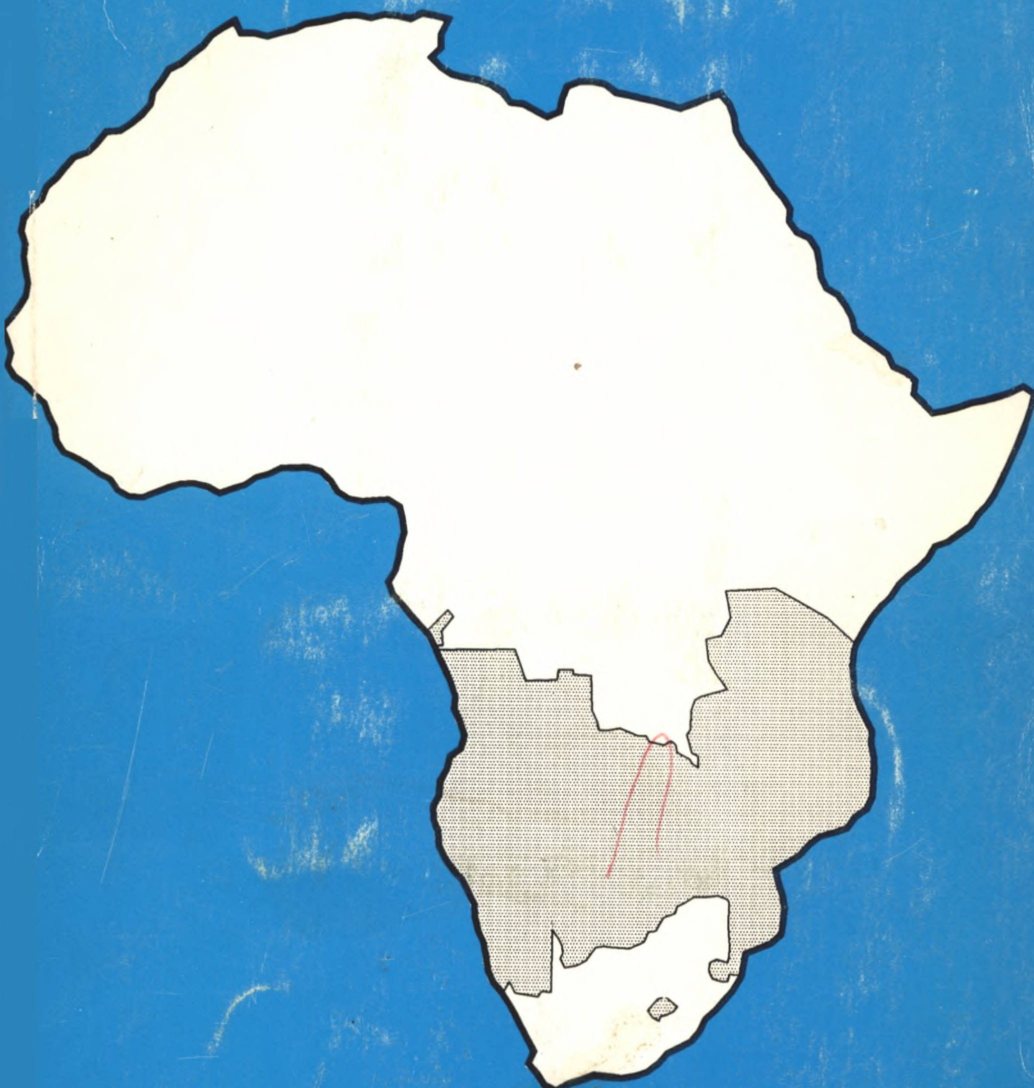
# Market Reforms, Research Policies And SADCC Food Security



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Published by:

UZ/MSU Food Security Research in Southern Africa Project
Department of Agricultural Economics and Extension
University of Zimbabwe
May 1991

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UZ/MSU Food Security Research in Southern Africa Project
Department of Agricultural Economics and Extension
University of Zimbabwe
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Mount Pleasant, Harare, Zimbabwe
Telex 26580 UNIVZ ZW
Fax 263-4-732828
Telephone 303211 Ext.1516

ISBN Number 0-7974-1000-7




Typesetting and page layout:
Daphne Chanakira and Florence Chitepo

Originated by:
Lucas Photolitho

Produced by:
Print Brokers, Box CH 113, Chisipite,
Tel: 796996

SECTION III : GRAIN MARKET POLICY REFORM ISSUES -- THE EVOLVING ROLES OF THE PUBLIC AND PRIVATE SECTORS



SECTION IV : ENHANCING HOUSEHOLD FOOD SECURITY -- ISSUES AND PROSPECTS

# Prospects For Increasing Household Food Security And Income Through Increased Crop Productivity And Diversification In Low Rainfall Areas Of Zimbabwe.

*J. Govereh and G. Mudimu*[1]

## INTRODUCTION

The achievement of communal area farmers in increasing production and marketed output of food and cash crops in the decade of the 1980's has been studied and documented by several researchers (Stanning, 1985; Rohrbach, 1987). In the 1990-91 marketing year, the communal area farming sector contributed 68 percent of the maize marketed, 62 percent of cotton deliveries and 96-98 percent of sunflower deliveries. Despite these spectacular achievements, communal area farmers are still vulnerable to food insecurity. Crop output per farm household remains very low and highly variable due to low and unreliable rainfall. Income levels are low and unevenly distributed (Chopak, 1988; Jackson and Collier, 1988; Shaffer and Chigume, 1989; Stanning, 1988). The incidence of malnutrition and related health problems are unacceptably high.

The task of increasing agricultural output to improve food security and household income remains formidable. There is potential for increasing output and productivity through increased adoption of improved agricultural technologies. Household food security can also be enhanced through crop diversification. The purpose of this paper is to explore the potential for increasing crop productivity and diversification through adoption of improved technology. The paper also examines the prospects of crop diversification arising from increased crop productivity and access to appropriate technologies.

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## SOURCES OF DATA

The data for this paper were obtained from surveys undertaken in Mutoko/Mudzi and Buhera communal areas in 1987-88 and 1988-89 as part of the research on household food security in low rainfall areas of Zimbabwe. Current levels of crop production are compared with the potential for Natural Regions III, IV and V. Production levels are based on current technologies that are recommended by the extension and the research systems. The adoption of these technologies is assessed to identify constraints and potential for increased adoption.

The performance of farmers is analysed to identify agronomic and socio-economic practices of farmers achieving higher output levels. The objective is to assess whether there is scope for other farmers to achieve such performance so as to increase household output and income. The profitability of current technologies is measured and a comparative economic analysis of alternative crops is undertaken to determine whether there is scope for farmers to improve household income by increasing production of more profitable crops.

## RESULTS AND DISCUSSION

### Resource Pattern

Household production resources are low in quantity and quality posing a serious challenge to the exploration of avenues that intensify production or increase resource productivity.

#### *Labour Supply*

Family labour is, in most areas, inadequate to meet seasonal demands. Operations like planting and weeding require proper timing and inadequate labour at home and for hire cause operational delays that reduce crop yields. Although average family size is about 9,5 members, only 25 percent are engaged full-time in farming. An equal proportion work as part-time farm workers, Table 1. Non-farm workers are mostly preschool children, those of school going age and family members working in urban areas. The seasonal nature of rain-fed agriculture makes it difficult for household members to earn incomes throughout the year. This, together with low and uncertain rainfall and frequent drought makes farming a risky and low return venture in these marginal areas. This has forced about half of the able bodied farm workers to seek employment outside farming where wages are higher and year round.

**Table 1**
**Zimbabwe: Farm family sizes in Mutoko/Mudzi and Buhera, 1987-88.**

| | Average Number of family Members Per Farm | | | | | |
|---|---|---|---|---|---|---|
| | Adult Males | Adult Females | Children < 15 yrs | Total Size | P-Time Workers | F-Time Workers |
| Mutoko/Mudzi | 2,8 | 3,1 | 3,3 | 9,1 | 2,4 | 2,1 |
| Buhera | 2,7 | 3,2 | 4,2 | 10,1 | 2,6 | 3,5 |
| Average | 2,74 | 3,15 | 3,74 | 9,6 | 2,5 | 2,8 |

Source: Food Security Surveys, 1987-89

### *Land Supply and Quality*

Also, households, particularly in favourable environments, are facing an acute land shortage. For example, the average farm size in Mutoko/Mudzi, Natural Region IV, is ten acres Table 2. The most frequent tenure system is household ownership with few households, 0.5 percent, borrowing in or borrowing out.

**Table 2**
**Zimbabwe: Total land ownership systems (ha.) in Buhera and Mutoko/Mudzi, 1987-88.[a]**

| | Household Owned | Rent In | Rent Out | Share In | Borrow In | Borrow Out |
|---|---|---|---|---|---|---|
| Mutoko/Mudzi | 685,58 (90%) | 0,21 (,5%) | 0,0 (0%) | 3,39 (,5%) | 3,34 (6%) | 4,32 (3%) |
| Buhera | 967,59 (81,5%) | 0,34 (,6%) | 1,0 (,6%) | 0,0 (0%) | 53,56 (15,6%) | 2,34 (1,8%) |
| Average | 826,59 | 0,28 | 0,5 | 1,7 | 28,45 | 3,33 |

[a] Figures in parenthesis represent the proportion to total fields falling in each tenure category.
Source: Food Security Surveys, 1987-89

In Buhera, NR V, farm sizes are relatively larger (17 acres) than in Natural Region (NR) IV. Even if farmers in marginal areas have larger landholdings than their counterparts in favourable areas, the soils are very infertile and fragile, and usually unable to sustain crop production. About 64 percent of the field area in Buhera (NR V) has extremely sandy soils (Ruseya) and about eight percent of the field area is gravelly, Table 3. In contrast, 35 percent of the field area in Mutoko/Mudzi, had vertisols (Gova) and 59 percent of the field area was in light sandy soils (Shapa). Thus, Mutoko/Mudzi farmers have smaller plots but higher quality soils that can sustain intensified crop production. Yet, newly married members of the family expect to get a sub-plot within the parent family's plot because all uncultivated land is grazing area.

**Table 3**
**Zimbabwe: Distribution of arable area by soil type, Mutoko/Mudzi and Buhera, 1987-88.**

| | Mutoko/Mudzi | | Buhera | |
|---|---|---|---|---|
| Soil Type | Mean Area (ha) | % To Total[a] Area | Mean Area (ha) | % to Total[a] Area |
| Light sandy | 3,19 | 58,6 | 4,6 | 5,4 |
| Vertisols | 3,12 | 35,4 | 2,02 | 1,8 |
| Red clays | 4,61 | 1,3 | 3,6 | 13,7 |
| Extremely sandy | 0,0 | 0,0 | 5,58 | 58,3 |
| Gravel | 1,47 | 2,3 | 2,76 | 7,8 |

[a] Column totals do not add up to 100. The remainder represent other minor soil types.
Source: Food Security Surveys, 1987-89.

*Availability of Draft Power*

Draft power for both ploughing and transport is essential for timeliness in performing farm operations. In Mutoko/Mudzi, 48 percent of the farmers owned no draft power compared with 18 percent in Buhera Table 4. Fifteen percent and 37 percent of the farmers had at least the recommended four draft animals in Mutoko/Mudzi and Buhera, respectively. The draft power available was of poor quality and some farmers could not winter plough their fields due to poor animal health.

Although draft animals for hire were available, there were few farmers willing to part with their cattle during periods of land preparation and planting operations. Hired animals were mostly available during the slack periods when not needed by non-draft owners. In Buhera, 35 percent of the sampled farmers borrowed draft animals with 52 percent doing the same in Mutoko/Mudzi. Draft ownership was more skewed in Mutoko/Mudzi than in Buhera because grazing area was relatively less plentiful in the former communal area.

**Table 4**
**Zimbabwe: Distribution of draft power ownership in Mutoko/Mudzi and Buhera 1987-88.**

| Percent of Household Owning Zero to 73 Draft Animals | Mutoko/Mudzi (n = 146) | Buhera (n = 138) |
|---|---|---|
| 0 | 43 | 18 |
| 1 | 13 | 3 |
| 2 | 23 | 29 |
| 3 | 10 | 13 |
| >4 | 15 | 37 |
| Percent borrowing | 52 | 35 |
| Percent loaning | 44 | 16 |

Source: *Food Security Surveys*, 1987-89.

*Cropping Patterns*

Marginal areas are predominantly millet producing areas. Maize is increasingly substituting for millets and sorghum particularly in NR IV where it performs well relatively to millets. More than 80 percent of the farmers in both Mutoko/Mudzi and Buhera are producing both maize and bulrush millet (Mudimu *et al*, 1989). Maize and bulrush millet are allocated the same proportion (33 percent) of cropped area in Mutoko/Mudzi. In Buhera, maize is planted to only half of the area (19 percent) allocated to bulrush millet. Other important crops in Mutoko/Mudzi are sunflower and groundnuts in that order for farmers growing the crop. In Buhera, groundnuts, roundnut and sorghum are also grown in that order of importance.

## PRODUCTION TECHNOLOGY EMPLOYED BY FARMERS

Communal farmers in marginal areas obtain lower crop yields than yields obtained by farmers in NR II and III. This section of the paper seeks to highlight:

- the proportion of farmers obtaining higher maize yields;
- factors that determine yield variation across sites; and,
- constraints limiting adoption of yield increasing techniques.

General statistics on the levels of maize yields in Mutoko/Mudzi and Buhera are shown in Table 5. Average maize plot yields in Mutoko/Mudzi (1,282 kg/ha) were double the yields in Buhera. The main reason is low rainfall and poor soils which are more severe in Buhera than in Mutoko/Mudzi. In lower altitude areas of Buhera, annual rainfall was less than 600mm and evaporation rates were high. This makes crop production risky.

**Table 5**
**Zimbabwe: Statistics on maize yields in Mutoko/Mudzi and Buhera, 1988-89.**

| Statistic | Mutoko/Mudzi kg/ha | Buhera kg/ha |
|---|---|---|
| Mean | 1 281,48 | 648,31 |
| Median | 1 033,94 | 516,00 |
| Mode | 1 033,94 | 786,70 |
| Standard deviation | 755,16 | 416,96 |
| Minimum | 129,24 | 98,47 |
| Maximum | 4 135,77 | 1 811,00 |

Source: Food Security Surveys, 1987-89.

About 38 percent of the farmers in Mutoko/Mudzi were getting yields of less than 1000 kgs/ha, Table 6. In Buhera, 82 percent were getting yields below one tonne. A fifth of the farmers sampled obtained yields in excess of 1,8 tonnes/ha in Mutoko/Mudzi compared with only two percent in Buhera. The yield distributions were more even in Mutoko/Mudzi than in Buhera.

**Table 6**
**Zimbabwe: Distribution of farmers by maize yield levels, Mutoko/Mudzi and Buhera, 1988-89.**

| Yield | Mutoko/Mudzi | | Buhera | |
|---|---|---|---|---|
| (kg/ha) | Number | Percentage | Number | Percentage |
| Up to 600 | 21 | 17 | 38 | 56 |
| 601 - 800 | 19 | 16 | 15 | 21 |
| 801 - 1 000 | 4 | 3 | 4 | 5 |
| 1 001 - 1 200 | 19 | 16 | 2 | 2 |
| 1 201 - 1 400 | 9 | 8 | 2 | 2 |
| 1 401 - 1 600 | 19 | 16 | 5 | 7 |
| 1 601 - 1 800 | 5 | 4 | 0 | 0 |
| Above 1 801 | 24 | 21 | 2 | 2 |

Source: Food Security Surveys, 1987-89.

The management factors that influenced maize yields significantly in Mutoko/Mudzi were the seedrate, planting date, weeding intensity and application rates of both basal and top dressing fertilizers. The above factors were highly significant, Table 7, with planting date and top dressing significance levels being 0,0005. Farmers who obtained significantly higher yields weeded twice, winter ploughed, top and basal dressed more than farmers who obtained lower yields. Higher yielding farmers, on average, purchased, from their own savings, seasonal inputs three times the value of those purchased by lower yielders. This implies that higher yielding farmers had more income or at least were willing to spend more for inputs than lower yielding farmers.

Socio-economic factors that were significant and positively related to yields were the farmers' knowledge of recommended maize production techniques, crop income, land and livestock holdings and earnings from livestock sales, Table 7. Use of modern inputs, for example hybrids and fertilizers, required specific management practices to maximise net returns.

**Table 7**
**Zimbabwe: Agronomic practices of low and high yielders in Mutoko/Mudzi, 1988-89.**

| Practice | Low Yielders | High Yielders | Chi-Sq[a] Sig Level |
|---|---|---|---|
| Yield (Kg/ha) | < 1 033 | > 1 033 | |
| Average Group Yield (kg/ha) | 727,74 | 2 025,41 | 0,0005 |
| **Management Factors** | | | |
| Average Seedrate (kg/ha) | 22,96 | 30,50 | 0,001 |
| Average AN Rate (kg/ha) | 38,50 | 146,90 | 0,000 |
| Average Cmpd D Rate (kg/ha) | 53,74 | 152,03 | 0,010 |
| Average Weeding Hours (hr/ha) | 119,66 | 181,70 | 0,045 |
| Average Draft Hours (hr/ha) | 48,19 | 48,40 | 0,982 |
| Average Total Labour (hr/ha)[b] | 468,40 | 635,80 | 0,001 |
| Planting Week (1= mid Sept) | 10,80 | 7,90 | 0,000 |
| Percentage Weeding Twice | 35,00 | 68,00 | 0,0005 |
| Percentage Winter Ploughing | 32,00 | 67,00 | 0,0003 |
| Percentage Top Dressing | 40,00 | 83,00 | 0,0000 |
| Percentage Basal Dressing | 59,00 | 75,00 | 0,0003 |
| **Socio-Economic Factors** | | | |
| Technical Awareness Score (%)[c] | 46,00 | 61,00 | 0,006 |
| Average Value of Annual Purchased Crop Inputs ($) | 48,28 | 133,19 | 0,000 |
| Average Land Holding (ha) | 9,96 | 12,29 | 0,065 |
| Average Livestock Units (LU) | 8,00 | 13,53 | 0,003 |
| Average Crop Income ($) | 1 321,73 | 4 541,82 | 0,016 |
| Average Livestock Sales ($) | 105,92 | 233,03 | 0,084 |
| Average Remittances ($) | 200,61 | 268,56 | 0,266 |
| Average Off-farm Earnings | 176,10 | 267,07 | 0,181 |

[a] For continuous variables, the 2-tail probability value is shown.
[b] Includes both hired + own labour hours.
[c] Scores were obtained from farmers' awareness of a the package of recommendations.
Source: Food Security Surveys, 1987-89.

Farm incomes were very critical in the adoption of techniques that required farmers to disburse some cash. Because of the limited access to credit faced by communal farmers, use of modern techniques was potentially constrained by access to cash.

In Buhera, the management factors that influenced yields were the intensity of weeding and seed rates, Table 8. Maize plot sizes were relatively larger in Buhera than in Mutoko/Mudzi, (Mudimu *et al*, 1989) and this potentially constrained weed management in Buhera. However, high yielding farmers weeded as frequently as low yielding farmers. No farmer used fertilizer in Buhera. The planting week (early December) was, on average, almost the same for both high and low yielders. Ridging (using a plough at weeding) was done significantly more often by high yielders than low yielders. The ridging operation at weeding substituted ox-power for labour and offered a micro-environment that trapped and conserved moisture.

Important socio-economic factors included the knowledge of recommended production practices, crop income and land holding, Table 8. Farmers without a sound awareness of the modern use of inputs were disadvantaged.

## PROFITABILITY OF MAIZE PRODUCTION TECHNOLOGIES

Several management and socio-economic factors have been identified as significantly influencing maize yields in both Mutoko/Mudzi and Buhera. This section studies the profitability of maize production by low and high yielding farmers in order to establish whether there are better returns to production resources.

Mutoko/Mudzi farmers were high input users relative to farmers in Buhera. Low yielding farmers were using fertilizers but at low levels. The low production costs and low yields resulted in the gross margins, including own labour, being negative. Even the returns to cash expenditures were negative, Table 9. Although the gross margin, excluding own labour, was positive, the returns to own labour ($0,09) was below the local hiring wage of $0,39. This indicates that low yielding farmers would earn better returns by hiring out than producing their own maize. However, when higher fertilizer and seed rates were used, the gross margin, including own labour was only slightly negative. In addition, higher input rates improved returns to own labour ($0,36), close to the hiring wage.

**Table 8**
**Zimbabwe: Agronomic practices of low and high yielders in Buhera, 1988-89.**

| Practice | Low Yielders | High Yielders | Chi-Sq[a] Sig Level |
|---|---|---|---|
| Median Yield (Kg/ha) | < 516 | > 516 | |
| Average Group Yield (kg/ha) | 339,94 | 936,5 | 0,000 |
| **Management Factors** | | | |
| Average Seedrate (kg/ha) | 42,90 | 63,00 | 0,557 |
| Average Weeding Hours (hr/ha) | 119,66 | 181,70 | 0,095 |
| Average Draft Hours (hr/ha) | 43,22 | 79,76 | 0,008 |
| Average Total Labour (hr/ha)[b] | 261,49 | 396,17 | 0,065 |
| Planting Week (1 = mid | 10,90 | 10,50 | 0,580 |
| Percentage Weeding Twice | 53,00 | 71,00 | 0,2121 |
| Percentage Winter Ploughing | 29,00 | 41,00 | 0,6082 |
| Percentage Manuring | 10,00 | 14,00 | 1,0000 |
| Percentage Ridging | 42,00 | 87,50 | 0,0482 |
| **Socio-Economic Factors** | | | |
| Technical Awareness Score (%)[c] | 28,00 | 49,00 | 0,007 |
| Average Value of Annual Purchased Crop Inputs ($) | 27,55 | 54,70 | 0,011 |
| Average Land Holding (acres) | 15,16 | 21,47 | 0,026 |
| Average Livestock Units (LU) | 18,28 | 22,38 | 0,361 |
| Average Crop Income ($) | 588,53 | 978,05 | 0,013 |
| Average Livestock Sales ($) | 530,04 | 283,56 | 0,215 |
| Average Remittances ($) | 104,32 | 192,25 | 0,130 |
| Average Off-farm Earnings ($) | 228,68 | 343,15 | 0,415 |

[a] For continuous variables, the 2-tail probability value is shown.
[b] Includes both hired + own labour hours.
[c] Scores were obtained from farmers' awareness of a the package of recommendations.
Source: Food Security Surveys, 1987-89.

**Table 9**
**Zimbabwe: Maize budget per hectare for low and high yielders in Mutoko/Mudzi, 1988-89[a]**

| | Low Yielders ($) | High Yielders ($) |
|---|---|---|
| 1.Labour[b] (Hired+Own) @ $0.39/hr/ha[c] | 182,68 | 247,96 |
| 2.Draft at 30,45/ha[c] | 30,45 | 30,45 |
| 3.Seed Cost @ $1,09/kg[c] | 25,03 | 33,25 |
| 4.Ammonium Nitrate @ $0,53/kg[c] | 20,41 | 77,86 |
| 5.Compound D @ $0,53/kg[c] | 25,79 | 72,97 |
| 6.Total Variable Costs (1+2+3+4+5) | 284,36 | 462,49 |
| 7.Gross Product @ $0,22/kg[d] | 160,10 | 445,59 |
| 8.Gross Margin (7-6) | -124,26 | -16,90 |
| 9.Gross Margin (% of Gross Income) | -43,70 | -9,60 |
| 10.Returns per $ of Purchased inputs ((8/(6-2-1)) | -1,75 | -0,09 |
| 11. Gross Margin ($/ha) (exc own labour) | 38,12 | 175,96 |
| 12. Own Labour hours (hrs/ha) | 416,36 | 494,50 |
| 13. Returns to own labour ($/hr) | 0,09 | 0,36 |

[a] Average input amounts are obtained from Table 6.
[b] Labour hours do not include transportation from field to homestead and secondary harvesting.
[c] The rate was the average used by the Farm Management Research Section, Ministry of Lands, Agriculture and Rural Resettlement, 1988-89.
[d] This is the local/field price for a kg of maize.
Source: Food Security Surveys, 1987-89.

Maize appears to be unprofitable for surplus production among both low and high yielding farmers in Mutoko/Mudzi. Reasons farmers did not adopt the recommended inputs and management were many but lack of cash was the most limiting (Govereh, Forthcoming).

Variable input expenses indicate that farmers in Buhera bought only hybrid seed. Neither fertilizers nor chemicals were used. Low yielders had negative returns to their cash, Table 10. The returns to own labour ($0,23) were close to the hiring wage of $0,26, but these low yielding farmers could still earn slightly better returns from being hired than producing their own maize. The returns to each dollar spent on inputs were as high as $5,79 for high yielders. In Buhera, improving management of weeds and increasing seed rates increased profitability and returns to own labour tremendously.

Cash returns were relatively higher in Buhera than in Mutoko/Mudzi but Buhera farmers were not buying fertilizers. More than 80 percent were aware of fertilizer use but only ten percent tried fertilizers. Only four percent adopted its use (Govereh, Forthcoming). Farmers in Buhera did not try or adopt fertilizer probably because of its unavailability, unprofitability, riskiness and lack of cash. The return per additional unit of labour was improved when better management practices, such as timely and intensive weeding, were adopted.

Maize production was economic when improved management practices were adopted. In Mutoko/Mudzi, higher levels of fertilizer and seed resulted in improved returns to own labour.

**Table 10**
**Zimbabwe: Maize budget per hectare for low and high yielders in Buhera, 1988-89[a]**

| | Low Yielders ($) | High Yielders ($) |
|---|---|---|
| 1.Labour[b] (Hired+Own) @ $0,26/hr/ha[c] | 67,99 | 103,10 |
| 2.Draft at 30,45/hac | 30,45 | 30,45 |
| 3.Seed Cost @ $1,09/kgc | 20,06 | 25,94 |
| 4.Total Variable Costs (1+2+3) | 118,50 | 159,39 |
| 5.Gross Product @ $0,33/kg[d] | 112,07 | 309,50 |
| 6.Gross Margin (5-4) | -6,43 | 150,11 |
| 7.Gross Margin (% of Gross Income) | -5,70 | 48,50 |
| 8.Returns per $ of Purchased inputs(6/3) | -0,32 | 5,79 |
| 9. Gross Margin ($/ha) (exc own labour) | 54,00 | 230,22 |
| 10. Own Labour hours (hrs/ha) | 232,44 | 308,13 |
| 11. Returns to Own Labour ($/hr) | 0,23 | 0,75 |

[a] Average input amounts are obtained from Table 6.
[b] Labour hours do not include transportation from field to homestead.
[c] The rate was the average used by the Farm Management Research Section, Ministry of Lands, Agriculture and Rural Resettlement, 1988-89.
[d] This the local/field price for a kg of maize.

## COMPARATIVE ECONOMICS OF MAIZE PRODUCTION VERSUS OTHER CROPS

Work in Mudzi by Mudhara (1990) showed that even if maize was not recommended for production in Natural Regions IV and V, farmers were rational in producing maize. A comparative economic analysis gave the following results:

- pearl millet and sunflower did not show significantly higher returns than maize;
- maize gave higher returns to land and family labour than millets;
- alternative crops gave consistently, through not significantly, higher returns to cash investment as compared to maize; and,
- under the assumption of risk averseness, maize was preferred to sunflower.

The conclusion derived from the above is that maize is a viable crop compared to alternative crops in low rainfall areas. However, the comparative advantage of maize did not exist when rainfall and planting were late.

## CONSTRAINTS TO ADOPTION OF TECHNOLOGIES

This paper hypothesizes that farmers in marginal areas, in general, have low incomes, do not qualify for credit, have inadequate information on recommendations, and find most technologies unprofitable due to high input prices and uncertain weather conditions.

### Farmer Perception of Maize Recommendations

Farmers were asked to give the advantages and disadvantages of several recommendations. The following results are presented as a frequency distribution of the responses, Table 11 and 12.

#### *Short Season Maize Varieties*

The major advantages of using short season maize varieties in Mutoko/Mudzi, as seen by the farmers, were that they were early-maturing, high-yielding and had a high germination percentage. In Buhera, farmers reported these varieties were also high-yielding, had a high germination percentage and produced a healthy crop stand. The main drawbacks of using these varieties in Mutoko/Mudzi were that to plant hybrid seed, farmers needed cash to purchase the seed and fertilizer, and the seed was difficult to find when farmers needed it. The only disadvantage which farmers in Buhera mentioned was that when rainfall was below average, the hybrids yielded poorly.

#### *Plant Spacing*

Following recommended plant spacing gave a healthy crop stand in Mutoko/Mudzi and Buhera. In Buhera, farmers reported they also got high yields when they followed this spacing. The major disincentive in both Mutoko/Mudzi and Buhera was that it was difficult to accurately measure and maintain the recommended spacing.

#### *Single Superphosphate*

Farmers agreed that applying Single Superphosphate fertilizer gives rise to high yields and a healthy crop stand in both Mutoko/Mudzi and Buhera. The major drawback in Mutoko/Mudzi was cash to buy the input and difficulty sourcing the fertilizer locally. Buhera farmers reported that the input was expensive and, given the uncertain weather patterns, investment in single superphosphate was unprofitable.

*Compound D*

Advantages farmers gave for following the recommended application levels of Compound D fertilizer in Mutoko/Mudzi were mostly high yields and a good crop stand (in that order). But in Buhera, the order was reversed. The major drawbacks in Mutoko/Mudzi were the need to have cash on hand, the potential loss if rainfall was poor and the difficulty in finding this fertilizer. In Buhera, farmers reported that local input prices were very high and input application risky when seasonal rainfall was below average.

*Ammonium Nitrate*

The benefits reported for following recommended application levels of ammonium nitrate fertilizer were high yields and a good crop stand (in that order) for Buhera farmers. In Mutoko/Mudzi, the order was reversed. The main disadvantages reported in Mutoko/Mudzi were the riskiness of this practice when the rainfall was below average, the need to have cash and the difficulty in finding this input. In Buhera, the input was very expensive and risky to apply, resulting in negative economic returns.

*Crop Rotation*

The advantages reported for following the recommended crop rotations in Mutoko/Mudzi were the achievement of a healthy stand, high yields and maintaining soil fertility. In Buhera the benefits were high yields, a healthy crop stand and a reduction in the incidence of diseases and weed parasites. The main disincentive for farmers in both Buhera and Mutoko/Mudzi was that the amount of crop land was too small to make crop rotation feasible.

*Timing of Superphosphate and Compound D*

The benefits reported for applying compound D at planting in Mutoko/Mudzi were a healthy crop stand and high efficiency of utilising fertilizer (in that order). In Buhera, the benefits were reversed in order. The major drawback in both Mutoko/Mudzi and Buhera was the riskiness when the start of the season was delayed. Riskiness further deterred farmers from applying what they already considered a high priced input.

**Table 11**
**Benefits from Following Maize Management Recommendations in Mutoko/Mudzi (M) and Buhera (B), 1987-88, Zimbabwe[a]**

| | BENEFITS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Higher Yields | | Healthy Crop Stand | | High Germination Rate | | Early Maturing | | Less Disease | | Soil Remains Fertile | | High Fertilizer Efficiency | |
| Recommendations | M | B | M | B | M | B | M | B | M | B | M | B | M | B |
| | PERCENT OF GROWERS | | | | | | | | | | | | | |
| 1 | 29 | 39 | 8 | 23 | 29 | 27 | 33 | 8 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 7 | 22 | 83 | 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 64 | 15 | 0 | 85 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 78 | 31 | 11 | 67 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 27 | 15 | 51 | 85 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 25 | 48 | 30 | 25 | 7 | 0 | 0 | 0 | 0 | 25 | 0 | 23 | 0 | 0 |
| 7 | 7 | 14 | 53 | 27 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 41 |
| 8 | 38 | 30 | 23 | 58 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 51 | 28 | 38 | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 42 | 13 | 12 | 23 | 0 | 0 | 0 | 0 | 29 | 63 | 0 | 0 | 0 | 0 |

[a] Sample size in Buhera (B) was 105 and in Mutoko/Mudzi (M) 147. These responses were obtained only from farmers growing maize. The row values for each location (*e.g.*, B) do not necessarily add up to 100 percent because less frequent responses are not shown.
Source: Food Security Surveys, 1987-89

**Maize Recommendations:**

1. Plant variety R201 mostly, R215 and R200.
2. Space between rows 90cm and 30cm within row.
3. Apply 25kg/acre Single Superphosphate
4. Apply 33kg/acre Compound D
5. Apply 33kg/acre Ammonium Nitrate.
6. Plant legumes before planting maize in the same plot.
7. Apply Compound D in rows or per station before planting.
8. Apply 2/3 of AN at knee height(4-6 weeks) and
9. Apply the remaining 1/3 at tasseling( 8-10 weeks ).
10. Prevent stalkborer by applying Dipterex or Thiodin(1-2 kg/acre).

**Table 12**
**Disadvantages of following maize management recommendations in Mutoko/Mudzi (M) and Buhera (B), 1987-88, Zimbabwe.[a]**

| | DISADVANTAGES | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Risky Due to Poor Rains | | Very Low Return | | Hard to Find | | Requires Cash | | Requires More Land | | Hard to Measure /Follow | |
| Recommendations | M | B | M | B | M | B | M | B | M | B | M | B |
| | PERCENTAGE OF GROWERS | | | | | | | | | | | |
| 1 | 7 | 92 | 0 | 0 | 10 | 0 | 42 | 6 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 69 | 50 |
| 3 | 8 | 43 | 0 | 11 | 38 | 6 | 48 | 37 | 0 | 0 | 0 | 0 |
| 4 | 23 | 32 | 0 | 20 | 19 | 12 | 36 | 16 | 0 | 0 | 0 | 0 |
| 5 | 32 | 19 | 0 | 13 | 20 | 10 | 24 | 37 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 76 | 34 | 21 |
| 7 | 54 | 30 | 0 | 18 | 5 | 8 | 16 | 17 | 0 | 0 | 0 | 13 |
| 8 | 43 | 26 | 0 | 10 | 0 | 0 | 26 | 39 | 0 | 0 | 0 | 12 |
| 9 | 35 | 21 | 0 | 8 | 18 | 0 | 29 | 33 | 0 | 0 | 0 | 17 |
| 10 | 0 | 0 | 11 | 0 | 17 | 0 | 50 | 0 | 0 | 0 | 0 | 0 |

[a] Sample size in Buhera was 105 and in Mutoko/Mudzi 147. These responses were obtained only from farmers growing maize.
The row values for each location (*e.g.*, B) do not necessarily add up to 100 percent because less frequent responses are not appearing.
Source: Food Security Surveys, 1987-89

## Maize Recommendations

1. Plant variety R201 mostly, R215 and R200.
2. Space between rows 90cm and 30cm within row.
3. Apply 25kg/acre Single Superphosphate
4. Apply 33kg/acre Compound D
5. Apply 33kg/acre Ammonium Nitrate.
6. Plant legumes before planting maize in the same plot.
7. Apply Compound D in rows or per station before planting.
8. Apply 2/3 of AN at knee height(4-6 weeks) and
9. Apply the remaining 1/3 at tasseling( 8-10 weeks ).
10. Prevent stalkborer by applying Dipterex or Thiodin(1-2 kg/acre).

### *Ammonium Nitrate Timing*

Following the recommended timing for ammonium nitrate application gave rise to high yields and a good crop stand in both Mutoko/Mudzi and Buhera. The main drawbacks were the uncertain weather patterns and the need to have cash on hand in both Mutoko/Mudzi and Buhera. This input was expensive in Buhera, lowering its profitability.

### *Insecticide*

The benefits reported for using Dipterex for controlling stalk-borer were higher yields and reduction in the incidence of this pest. In Buhera, the advantages were curtailing the incidence of this pest and giving a healthy crop stand. The major disincentives in both Mutoko/Mudzi and Buhera were the very high input price, the difficulty in finding the input and the need to have cash on hand. Overall, given their resource and crop environment, farmers had rational reasons for not adopting many of the recommended practices.

## Adoption of the Recommendations

Mutoko/Mudzi farmers had tried and adopted more of the recommendations than their counterparts in Buhera, Table 13. Recommended seed varieties, plant spacings and crop rotations were widely accepted by farmers in Buhera.

## Reasons and Alternatives to not Adopting Recommendations

### *Fertilizer Levels*

Farmers in Mutoko/Mudzi reported they did not try recommended levels of Compound D (83 percent) and Ammonium nitrate (90 percent) because they could not afford this input, Table 14. Some farmers select parcels with a high percentage of clay for maize and apply lower levels of compound D (71 percent), provided they could buy it. Others do not apply the fertilizer, Table 15. Instead of applying recommended levels of top dressing, farmers either applied manure (53 percent) or lowered their application rates (42 percent). In Buhera, after initially adopting fertilizer, some farmers did not continue to use basal (79 percent) and top dressing (85 percent) fertilizers.

**Table 13**
**Pattern of Maize Recommendations Awareness, Trial and Adoption in Mutoko/Mudzi and Buhera, 1987-88, Zimbabwe[a]**

| | Awareness | | Trial | | Adoption | |
|---|---|---|---|---|---|---|
| | M/M | B | M/M | B | M/M | B |
| Recommendations | PERCENT OF GROWERS | | | | | |
| 1 | 93 | 98 | 85 | 92 | 85 | 91 |
| 2 | 49 | 34 | 31 | 29 | 26 | 26 |
| 3 | b | b | b | b | b | b |
| 4 | 38 | 20 | 22 | b | b | b |
| 5 | 41 | 20 | 25 | b | 23 | b |
| 6 | 50 | 48 | 37 | 45 | 31 | 43 |
| 7 | 60 | 27 | 47 | b | 40 | b |
| 8 | 58 | 25 | 40 | b | 29 | b |
| 9 | 46 | b | 25 | b | b | b |
| 10 | 73 | b | 36 | b | 37 | b |

[a] Farmers who planted maize in Buhera were 105 and in Mutoko/Mudzi 147
[b] < 20%.
Source: Food Security Surveys, 1987-89

**Recommended Cropping Practices Maize**

1. Plant variety R201 mostly, R215 and R200.
2. Space between rows 90cm and 30cm within row.
3. Apply 25kg/acre Single Superphosphate
4. Apply 33kg/acre Compound D
5. Apply 33kg/acre Ammonium Nitrate.
6. Plant legumes before planting maize in the same plot.
7. Apply Compound D in rows or per station before planting.
8. Apply 2/3 of AN at knee height(4-6 weeks)
9. Apply the remaining 1/3 at tasseling( 8-10 weeks ).
10. Prevent stalkborer by applying Dipterex or Thiodin(1-2 kg/acre).

**Table 14**
**Farmers' reasons for not following maize recommendations, in Mutoko/Mudzi (M) and Buhera (B), 1987-88, Zimbabwe.**

| | RECOMMENDATIONS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reasons | 2 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 |
| | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M |
| | PERCENT OF NON-USERS | | | | | | | | | | | | | | |
| No Money | 0 | 0 | 83 | 79 | 90 | 85 | 0 | 0 | 66 | 64 | 76 | 47 | 60 | 0 | 86 |
| Difficult to Obtain | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 14 | 20 | 21 | 33 | 0 | 0 |
| Fields are Small | 0 | 0 | 18 | 0 | 0 | 0 | 69 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Difficult to Follow | 69 | 71 | 0 | 14 | 0 | 0 | 17 | 0 | 10 | 14 | 0 | 21 | 0 | 0 | 0 |

[a] The percentages are based on the proportion of farmers who had tried but did not continually follow the practice, (*i.e.* % trial - % adoption = % that did not follow, from Table 3)
The column values for each location (*e.g.*, B) do not necessarily add up to 100% because other less frequent responses are not appearing.
Source: Food Security Surveys, 1987-89

## Recommended Cropping Practices : Maize

1. Plant variety R201 mostly, R215 and R200.
2. Space between rows 90cm and 30cm within row.
3. Apply 25kg/acre Single Superphosphate
4. Apply 33kg/acre Compound D
5. Apply 33kg/acre Ammonium Nitrate.
6. Plant legumes before planting maize in the same plot.
7. Apply Compound D in rows or per station before planting.
8. Apply 2/3 of AN at knee height(4-6 weeks)
9. Apply the remaining 1/3 at tasseling( 8-10 weeks ).
10. Prevent stalkborer by applying Dipterex or Thiodin(1-2 kg/acre).

**Table 15**
**Farmers' alternatives to following maize recommendations, in Mutoko/Mudzi (M) and Buhera (B), 1987-88, Zimbabwe.**

| | RECOMMENDATIONS | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alternatives | 2 | | 4 | | 5 | | 6 | | 7 | | 8 | | 9 | | 10 |
| | M | B | M | B | M | B | M | B | M | B | M | B | M | B | M |
| | PERCENT OF NON-USERS | | | | | | | | | | | | | | |
| Nothing | 0 | 0 | 29 | 61 | 0 | 15 | 100 | 0 | 10 | 39 | 93 | 32 | 0 | 0 | 100 |
| Lower levels | 20 | 0 | 71 | 0 | 42 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Use feet to measure | 66 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Apply manure | 0 | 0 | 0 | 39 | 53 | 85 | 0 | 0 | 31 | 62 | 0 | 68 | 0 | 0 | 0 |
| Apply after planting | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59 | 0 | 0 | 0 | 0 | 0 | 0 |
| Apply once | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| Dribble behind plough | 0 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

Source: Food Security Surveys, 1987-89

**Recommended Cropping Practices : Maize**

1. Plant variety R201 mostly, R215 and R200.
2. Space between rows 90cm and 30cm within row.
3. Apply 25kg/acre Single Superphosphate
4. Apply 33kg/acre Compound D
5. Apply 33kg/acre Ammonium Nitrate.
6. Plant legumes before planting maize in the same plot.
7. Apply Compound D in rows or per station before planting.
8. Apply 2/3 of AN at knee height(4-6 weeks)
9. Apply the remaining 1/3 at tasseling( 8-10 weeks ).
10. Prevent stalkborer by applying Dipterex or Thiodin(1-2 kg/acre).

Because of cash constraints, Table 14. Some farmers (85 percent), however, use kraal manure, Table 15. Others (15 percent) did not add any nutrient to their fields for fear of losing the crop. Biological evidence has proved the need for a minimum amount of moisture in the soil to allow survival of organisms responsible for making the nutrients available from kraal manure. In some parts of Buhera, soil moisture levels were very low because of low rainfall and high evaporation rates.

*Timing of Top Dressing*

In Mutoko/Mudzi, cash constraints (68 percent) limited some farmers ability to apply a split application of ammonium nitrate at knee height and at tasseling stages. Other farmers (25 percent) were limited by the lack of available fertilizer. Farmers who purchased fertilizer applied only at knee height stage (100 percent). Farmers who were unable to purchase fertilizer to apply at the knee height stage (4-6 weeks) also could not apply it at the tasseling stage (8-10 weeks). In Buhera, farmers reported that they did not have cash to purchase the required levels of fertilizer (47 percent). Furthermore, the fertilizer was not available for purchase (41 percent). The strategies available to farmers were to either apply manure before planting (61 percent) or apply no additional nutrient (39 percent).

*Timing of Basal Dressing*

Application of basal dressing was delayed by farmers in Mutoko/Mudzi because they did not have the cash to purchase fertilizer when planting took place (66 percent). Even if they had the cash, the fertilizer was not available to purchase (24 percent). The alternative strategies available were to apply it after germination (59 percent) or to apply manure before planting (31 percent). In Buhera, farmers did not have money (64 percent) to purchase fertilizer and it was not available for purchase (28 percent). Some farmers' strategy was to apply manure before planting (61 percent). Other farmers did not add any nutrient (39 percent).

*Rotation*

Farmers in Mutoko/Mudzi found rotations difficult to follow because their landholding was small (69 percent). Also, the ability to rotate was limited by the farmers' lack of knowledge on how to rotate the multiple crops they grew. Farmers had no alternative strategy and planted crops with limited rotation. In Buhera, farmers have adopted crop rotation with ease because of significantly larger landholdings and less land size constraints than farmers in Mutoko/Mudzi.

*Plant Spacing*

In Mutoko/Mudzi, farmers found it difficult (69 percent) to maintain the recommended spacing precisely but they relied on using their feet to maintain uniform spacing (66 percent). In Buhera, farmers also had difficulty (72 percent) maintaining the required spacing but their strategy was to dribble the seed behind the plough (34 percent).

*Stalkborer Prevention*

Farmers in Mutoko/Mudzi were not applying dipterex to control stalkborer because of cash constraints (86 percent). They had no alternative preventative measure except to lose part of their yields to the stalkborer. In Buhera, few farmers ( <20 percent ) were aware of the need to prevent the effects of the stalkborer. To the majority of farmers, use of Dipterex was still a recent technology. Even if farmers tried certain technologies, they only continued some of the techniques because of their resource circumstances. Farmers adopted techniques that suited their resource levels, environmental conditions and the existing institutions. Although there were potentially high returns to adopting some techniques, farmers were unable to exploit these to their advantage.

Because of the resource-poor nature of most farmers, adoption was successful only for selected techniques. This might indicate that farmers were seeking those techniques maximising returns to their inputs -- not necessarily those that maximise output. Farmers could achieve maximum output from adopting all recommendations for a particular crop but they were unlikely to maximise profits by adopting the complete package.

## CONCLUDING REMARKS

This paper has highlighted the major constraints to improving crop productivity in marginal areas. Household resources were low and of poor quality. The supply of labour was limited by the high numbers of household members going to school and absent migrant labourers. Few farmers had adequate draft power and equipment, while the majority had none or inadequate draft power. The potential of increasing herd size in the communal areas was limited and alternative forms of draft power need to be sought.

Household income levels were relatively low and dependent on crop production. Resource productivity in cropping was reduced by the low environmental potential. Farmers in marginal areas depended less on crop income than farmers in favourable conditions. In the event of a drought, households relying mostly on cropping were usually unable to manage their normal expenditures. Farmers in marginal areas already were diversifying out of farming into other income generating activities which normally supplement crop income and are affected less by drought conditions.

Access to land was generally a less serious problem in the study areas because the distribution was relatively even. However, access to good crop land was a major problem, particularly for young families because the soil fertility status of most communal soils was deteriorating.

Management skills were generally low among household heads. Skills were potentially limited by the low literacy, years in school, male absenteeism and limited exposure to extension meetings. Given the low resource levels of most communal farmers, few technologies were adopted. Very few techniques were new to farmers but only a few of these were tried and successfully adopted. Farmers draft power, labour, savings and land resource levels were limiting adoption of techniques that required additional resources. Also, inputs were not available when farmers wanted to purchase them and farmers attitude toward risk influenced their production decisions.

The study identified the major factors limiting productivity as levels of input application, rainfall characteristics of the natural regions and the quality of input application. Important inputs were seed, fertilizer and hours of weeding labour. Therefore, there is need to; (i) determine the most economic levels of input application in low rainfall areas to improve the efficiency of input use and (ii) determine ways of improving response to input application in low rainfall areas (NR V).

Important management variables were the planting date and the level of technical knowledge of the manager. Strategies that bring the planting date forward should be supported and farmers awareness of management techniques should be strengthened to improve the quality of input application.

Crop production techniques need to be fine tuned to suit the environmental conditions where adoption is anticipated. Natural region can reliably be used for generating and testing technologies for appropriateness.

Technology generating institutions have had a biased focus towards more favourable areas at the expense of marginal areas. The technologies generated to date are inappropriate for very dry areas which are more livestock than crop based. Farmers technical knowledge about modern crop practices declines with decreases in relative cropping potential. The focus of research institutions in marginal areas needs to be directed toward the existing potential of these areas to generate techniques that extension workers can successfully extend to farmers.

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