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## CONTENTS

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# Impact of participatory research on assessment of farming systems on overall adoption of new cropping technology by smallholder farmers in semi-arid area of Zimbabwe

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Participatory rural appraisal (PRA) techniques were used in Matibi II Communal Area in Natural Region V of Zimbabwe in December 1994 to obtain a sound knowledge of the existing cropping systems and crop production constraints. In these PRA farmers were also asked to rank the value of the crops they grow based on researcher defined, but mutually agreed, criteria relating to agronomy, socio-economic, use and production reliability. Major crops in the area were sorghum, maize and sunflower, grown by 83, 92 and 76 percent of the farmers, respectively, and occupied 39, 25 and 20 percent of the land, respectively. Farmers in the area preferred maize for making their traditional dish *(sadza)* and yet realised that sorghum was the most suitable crop for their environment. Farmers realised that sunflower can be grown to generate household income yet its production lagged behind. Major production constraints identified were poor stand establishment, low yields, shortage of household income, seed, draught power, labour, poor and unreliable rainfall, poor infrastructure and market facilities in maize, sorghum and sunlfower.

Farmer managed and farmer implemented participatory on-farm trials were conducted in Matibi II communal area of Zimbabwe during 1994/95 season to compare economic performance of sunflower, sorghum and maize; and to compare local and improved sorghum varieties. Farmers' participation was not easily available until farmers' initial suspicion was overcame. Involvement of extension agents in all aspects improved rapport and farmer participation in technology testing, adapting and adoption. Evaluation of the technologies by farmers involved focus group discussions (FGD), interviews, farm walks, matrix ranking exercises and field days. Farmers used high seed rates than recommended for sorghum and sunflower - perhaps a reflection of their experiences in obtaining poor crop stands. This impacted negatively on the adoption of improved varieties as adoption implied a high cash outlay in the purchase of seed. Improved sorghum varieties showed yield superiority over traditional landraces. Although maize had the

**highest variation in grain yield of all the three species it gave farmers the best return per labour hour - reflecting that maize may be agroecologically unfit but returns to scarce resources may be attractive. If net income is based on official prices, sunflower seemed to perform better than maize and sorghum. During FGD and fields days farmers who participated in this study indicated that they were willing to adopt improved sorghum varieties and were eager to increase area under sunflower in the following seasons. A study conducted after 1995/96 season in Matibi II showed that 40 percent of the sorghum varieties grown by farmers were improved varieties suggesting that farmer participatory approach used in this study was highly effective in allowing farmers to test, adapt and adopt new cropping technologies.**

***Keywords:*** semi-arid, farmer-managed participatory research, sorghum, maize, sunflower.

## Introduction

Smallholder sorghum production systems in semi-arid areas of Zimbabwe are predominantly based on local unimproved varieties. Few farmers in these semi-arid areas have adopted improved varieties, either because seed of improved varieties have not been accessible or farmers have not been exposed to acceptable alternatives to their landraces. It is important to appreciate that smallholder farmers are not inherently conservative or resistant to change. They have shown themselves competent and willing to use new technologies when these suit their needs - rapid uptake of ox-drawn plough and maize hybrids are evidence of this responsiveness (Blackie, 1982). A more productive set of technologies needs to be made available to smallholder farmers. Improved sorghum and drought tolerant sunflower varieties are available and if promoted could improve productivity of these crops. However, improved varieties should be viewed as additions to the portfolio of choices available to the farmers (Chambers, 1989). More often than not researchers advocate complete change in the system while ignoring system interaction. 'Reduced risk' should be the watchword when considering recommendations for improving smallholder farming systems.

Oilseeds are important cash crops for smallholders in semi-arid areas yet the resource devoted by research towards smallholder oilseed improvement and adoption are inadequate. There has been long and often acrimonious debate on the role of cash crops in the African smallholder economy (Blackie, 1994). Frequently, the opposition to cash cropping arises from a concern that it encourages farmers to neglect food needs to the detriment of the nutrition of the families. The evidence from the Southern and Eastern Africa suggests otherwise. Chigume and Jayne (1990) found that communal farmers in Zimbabwe who sold oilseeds had grain surplus. Kenya's encouragement of smallholders to participate in both food and cash crop production and horticultural production has improved incomes and food security amongst smallholders in Kenya (World Bank, 1989). Cotton production has assisted the development of smallholder agriculture in parts of Zimbabwe

(Mariga, 1994). In dry areas, such as Matibi II, sunflower could be expected to generate cash income for the household, whilst food stability could be ensured by growing improved sorghum. The encouragement of cash cropping should be an essential component of the development of communal areas in Zimbabwe. Results from Chiredzi District indicated that sorghum and maize occupy more than 90 percent of arable land (Mazvimavi *et al.*, 1994). Sorghum could help stabilise food production in marginal areas. However, with high frequency of drought, it is economic and risk minimising to compliment short season improved sorghum production by growing sunflower hybrids for sell and purchase maize from areas with surplus.

A greater chance of enhancing adoption of technologies which arise from agricultural research is to involve farmers in the research process in a participatory approach. Farmers only adopt technologies which they see as suitable and they are much more likely to respond to ideas if their own views are respected and differences are reconciled through debate (Mettrick, 1995). Farmer participation involves more than respect for indigenous knowledge but a sharing of ways of knowing (Sriskandarajah *et al.*, 1989). Traditionally, the evaluation of crop varieties has been the task of the agronomists, often at research stations, and farmers are merely recommended for adoption by the extension staff. This study considered a participatory approach to address the problem of limited technology adoption by smallholder farmers. The objectives of the study were: to obtain a sound knowledge of the existing cropping systems and production constraints; to involve farmers and extensionists in all aspects of on-farm research; to compare economic performance of sunflower, sorghum and maize, and compare performance of local and improved sorghum varieties and to assess impact of participatory research on technology uptake.

## Materials and Methods

*The study area*

The study was carried out in Chiredzi District in Matibi II Communal Area during 1994/95 season. The district is in Natural Region V (NR V) of the country. Rainfall is low, highly variable within and between seasons. Average annual rainfall is less than 475 mm, with a mean median length of growing season of 96 days. Temperatures are high (38 to 42 °C) throughout the growing season, resulting in high evaporation rates in excess of 2 000 mm per year (Vincent and Thomas, 1960). Soils are moderately deep to deep, dark brown to black vertisols with appreciable water soluble salts.

*Participatory rural appraisals*

Key informants were targeted during the informal survey in collaboration with the extension workers of the areas. Participatory rural appraisals (PRA) were conducted by Focus Group Discussions (FGDs). These PRAs were conducted in Matibi II's Dzinzela, Chichingwe and Mukuwini wards (administrative units in a District) early December 1994 prior to the conduct of formal survey and field trials. Matrix ranking techniques were employed for farmer preference of crops based on various

categories (see Table 1 for the details of the categories used). The FGDs were conducted by the researchers and extension staff who were closely involved with this study. The FGDs were with groups of 5 - 30 farmers, both male and female and usually all the socio-economic classes perceived by the researcher and extension staff were represented adequately.

**Table 1: Farmer preference of crops based on various ranking criteria**

| Ranking Criteria | Rank | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Making sadza* | Maize | White sorghum | Pearl millet | Red sorghum |
| Brewing beer | Finger millet | Red sorghum | Pearl millet | White sorghum |
| Profitability | Sunflower | Groundnuts | Maize | Sunflower |
| Least labour | Sunflower | Groundnuts | Maize | Sunflower |
| Access to credit | Maize | Sunflower | Groundnuts | Sorghum |
| Access to market | Maize | Sunflower | Sorghum | Groundnuts |
| Seed availability | Sorghum | Sunflower | Maize | Groundnuts |
| Production reliability | Sorghum | Maize | Groundnuts | Sunflower |

* Staple diet

*Formal survey*

The PRAs were followed by detailed questionnaires for individual households in Matibi II communal area in December 1994. Eighty-four farmers (42 from Chichingwe and Dzinzela, and 42 from Mukuwini) were sampled at random using a list of farmers compiled by the extension workers. Interviews were conducted by the researchers with the assistance of extension workers. Sampled farmers were asked to provide information on existing cropping systems, crops grown, agronomic practices, crop production constraints, crop establishment problems, farmers' perceptions of the importance of cash crops and farmers' coping strategies to production constraints.

*Proposed solutions*

The researchers used the results of the PRAs and survey to formulate some hypotheses. Some of the possible solutions were improved sorghum varieties that were perceived to yield higher than the farmers' traditional unimproved varieties, and production of sunflower as a cash crop supplemented with improved sorghum varieties. Therefore it was postulated that farmers in this marginal area could derive more stable income by adopting sunflower as cash crop compared to the traditional practice of growing maize and sorghum, and sorghum yield could be improved by adopting improved varieties instead of growing local landraces. Appropriate cultivars were identified by the researchers and were procured from either breeders or commercial sources. Particular attention was paid to find

varieties that are suitable for the agro-ecological region and that were expected to stabilise household food and income security in semi-arid areas.

*Conduct of the farmer-managed trials*

Thirty sunflower producers (10 from each ward) were randomly selected and each farmer was given 10 kg seed of maize (R201), sorghum (ZWSH-1) and sunflower (Mopani). All selected test varieties are certified early maturing hybrids which are commercially available and suited to the environment in Matibi II. Thirty sorghum producers (10 from each ward) were randomly selected and each farmer was given 10 kg of sorghum varieties ZWSH-1 and SV-2 (early maturing open pollinated variety), and were asked to provide one local sorghum variety which the farmer considered best for comparison with improved varieties. All farmers provided Chitichi — an open pollinated white sorghum landrace. The amount of seed was given with a provision for resowing if it turned out that the farmer obtained poor stand establishment. These were tested with farmers in farmer managed but researcher monitored participatory research trials. The farmers planted these in blocks adjacent to each other following own husbandry practices. Excess seed, if any was recommended for use elsewhere on the farm. Sixteen farmers (eight from sunflower, sorghum and maize trial and eight from sorghum varietal trial) were selected at random from the sixty farmers for detailed monitoring. Farmers recorded all operation details and researchers made bi-weekly visits to each farm throughout the growing season during which data on operation details was collected together with visual assessment of standing crop and plant population measurement by quadrat sampling. Researchers monitored amount of inputs, method of land preparation, planting dates, seed rates, spacing, plant population before and after thinning and at harvest, thinning and weeding management, pests and diseases, days to maturity and yield.

*Evaluation of the trials by the farmers*

Three field days were organised and held before harvesting but at crop maturity. Farmers selected sites for the field days and were responsible for all organisation and host farmers assisted by researchers and extension workers explained trial objectives and performance to other farmers. Invited farmers made visual assessment of standing crops. Discussions on performance of crops were held by researchers, extension officials and farmers. Problems raised during the conduct of these field days were debated by the farmers, researchers and extension staff and some solutions were suggested.

*Evaluation of the trials by the researchers*

Grain yield data was obtained by harvesting three $10m^2$ quadrats randomly selected in each crop block at harvest. Yield was expressed $ha^{-1}$ and reported at 12.5 percent grain moisture. Local prices and floor prices offered by Grain Marketing Board, a parastal responsible for purchasing grains, were used to calculate gross income. Net income was determined. Total variable costs (TVCs) were derived

from the monitoring exercise. Net incomes were subjected to analysis of variance. Efficiency indicators were determined using labour hours derived from literature (Chiduza, 1994) and TVC.

## Results

*Participatory rural appraisals*

Sorghum was the most preferred crop in terms of production reliability in this semi-aria area (Table 1). Majority of the respondents indicated that sorghum was drought tolerant with excellent recovery properties after episodes of drought followed by sunflower whilst maize was the least. Sunflower was the most profitable crop on a per tonne basis according to farmers (Table 1). This profitability ranking agreed with the prices offered by the GMB. Maize and sunflower production constraints identified by farmers were: poor stand establishment, low yields, shortage of household income, seed, draught power and labour, poor and unreliable rainfall, and poor infrastructure and market facilities. In sorghum, major constraints cited were lack of seed (by 60 percent of the farmers), weeds (52 percent), lack of draught power (29 percent), shortage of labour (29) and poor rainfall (100 percent).

*Formal surveys*

Sunflower was grown by high proportion of farmers (73 percent). About 15 percent of the farmers grew improved hybrid Mopani and 52 percent grew Panner 7369, both hybrids. However, some farmers used retained seed. Most of the seed planted was that of Peredovik, retained by farmers for decades. Only 2 percent of the farmers purchased their own hybrid seed with the majority securing seed from government relief packages and NGOs. However, 83 percent of the farmers were willing to purchase their own seed, if available. At least 20 percent of the area was under sunflower. The level of production was low both in terms of acreage and tonnage. Land under sunflower ranged from as low as 0.3ha up to as high 16ha with an average of 2 ha / household. Only two farmers had eight and 16 ha of sunflower, indicating that sunflower is the main crop enterprise on some smallholder farms in the marginal areas.

All farmers grew short season hybrid maize varieties, grown by 92 percent of the farmers. The most common maize variety was R201 obtained from free government packs under the drought recovery programme. On the contrary, sorghum production was largely based on home grown seed of local landraces (Chitichi, Chihumani, Chichayeni, Chibova and Gangara and others). Eighty-three percent of the farmers grew sorghum on 39 percent of the land. Chitichi was the most common white sorghum landrace favoured. There was also an appreciation of improved sorghum varieties, with a noticeable 25 percent of the farmers growing SV-2, Red Swazi and DC 75, with Red Swazi occupying the largest proportion of improved varieties. The increase in availability of improved sorghum varieties was attributed to the free packs received from government and NGOs. Other crops grown by farmers in the area were groundnuts, pearl millet and cotton, grown by 60, 43 and 17 percent of the farmers, respectively, and occupied five, eight and three percent of the land.

**Table 2: Average seeding rates (kg/ha) of three sorghum varieties used at ten farms in Mukuwini, Chichingwe and Dzinzela wards of Matibi II communal area.**

| Farm | ZWSH-1 | SV-2 | Chitichi (local) |
|---|---|---|---|
| 1 | 25 | 25 | 35 |
| 2 | 25 | 25 | 30 |
| 3 | 20 | 20 | 25 |
| 4 | 18 | 18 | 20 |
| 5 | 10 | 10 | 30 |
| 6 | 25 | 25 | 35 |
| 7 | 25 | 25 | 30 |
| 8 | 10 | 10 | 25 |
| 9 | 20 | 20 | 25 |
| 10 | 25 | 25 | 30 |
| Mean | 20.3 | 20.3 | 28.5 |

Poor stand establishment was due to inadequate moisture, poor seed quality and pest damage. Farmers broadcast their sorghum resulting in uneven planting depths and consequently, germination and emergence is poor. Solutions implemented by farmers to improve stand establishment included gap-filling, transplanting sorghum, and increased seed rates.

Farmers with some formal education, adequate family labour and draught power obtained high yields than those without. These farmers devoted more land to sunflower. Only 60 percent of the farmers had draught power in form of cattle and 14 percent had donkeys. Purchasing of improved sorghum and sunflower seed was inhibited by shortage of income and unavailability of seed in the area.

*Farmer management of the crops*

Most farmers used high seed rates in all three species, sorghum, sunflower and maize (Table 2). Eighty percent of the participating sorghum farmers used seed rate of 20 $kgha^{-1}$ which is higher than the recommended seed rate. In sunflower, seed rates of up to 15 $kgha^{-1}$ were used. Seed rates between 4 and 8 $kgha^{-1}$ are recommnded in sorghum and between 5 and 7 $kgha^{-1}$ in sunflower in semi-arid areas like Matibi II communal area. A range of spacing was used depending on the farmers' circumstances and this resulted generally in high plant population, for example, sorghum plant population ranged from 70 000 to 300 000 plants per hectare which was thinned to between 50 000 and 90 000 plants/ha. Sunflower plant population ranged from 22 000 to 100 000 plants/ha, thinned to 22 000 and 57 000 plants/ha. Maize population ranged from 22 000 to 37 000 plants/ha.

*On-farm grain yield*

Grain yields of sunflower, sorghum and maize are shown in Table 3. Maize had the highest variation in grain yield of the three species. The relative performance of species in terms of seed yield varied with site. Barren percent was highest in maize (51 percent) than sunflower (11 percent) and sorghum (33 percent).

**Table 3: Mean yield of sunflower, sorghum and maize at eight sites in Matibi II during 1994/95 cropping season.**

| Site | Crop | | |
|---|---|---|---|
| | Sorghum | Maize | Sunflower |
| | Mean seed yield (kg/ha) | | |
| 1 | 2 310 | 1 280 | 410 |
| 2 | 490 | 660 | 610 |
| 3 | 1 180 | 0 | 420 |
| 4 | 2 640 | 2 550 | 1 010 |
| 5 | 3 700 | 1 290 | 1 470 |
| 6 | 2 220 | 2 570 | 1 400 |
| 7 | 2 090 | 2 140 | 560 |
| 8 | 2 200 | 420 | 930 |
| Average | 2 104 | 1 364 | 851 |
| SE (mean) | 337 | 346 | 149 |
| CV (percent) | 45 | 72 | 49 |

**On-farm economic benefits from sunflower, maize and sorghum**

*Local prices*

There was significant interaction ($P<0.05$) between crop species and sites. Sorghum had highest returns at four of the eight sites, maize at three and sunflower at only one site (Figure 1). Sunflower gave significantly ($P<0.05$) higher net income than sorghum at only one of the eight sites and was as good as sorghum at only one site ($P>0.05$). Sunflower was significantly ($P<0.05$) better than maize at only three sites. Maize realised significantly ($P<0.05$) higher net income compared to sunflower at the other four sites and was as good as sunflower ($P>0.05$) at only one site (Figure 1). Sorghum had the highest gross margin/ha and sunflower the lowest (Table 4). However, maize had the highest gross margin/labour hour, which was almost four times as better as that of sunflower.

*GMB prices*

There was significant interaction ($P<0.05$) between crop species and sites. Sorghum had the highest net income at only two sites, maize at three and sunflower at three sites (Figure 2). Sorghum was significantly ($P<0.05$) better than sunflower at only two sites. There was no significant ($P>0.05$) difference in net income between sorghum and sunflower at four sites. Sunflower was significantly ($P<0.05$) better than sorghum at two sites. Sunflower had significantly ($p<0.05$) better net income than maize at four sites and performed worse than maize at three sites only. Sunflower had the highest gross margin/ha and sorghum the lowest. However, maize still gave the best return to labour (Table 4). Gross margin per dollar invested for sunflower was almost double that of maize and four times that of sorghum.

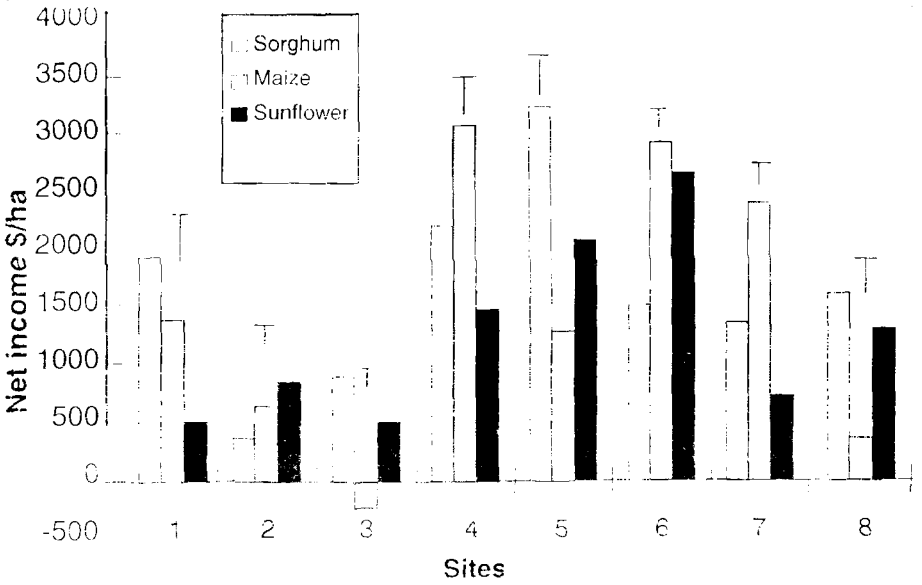


Figure 1: Net income of sorghum (ZWSH-1), maize (R201) and sunflower (Mopani) using local prices over eight sites in Matibi II communal area.

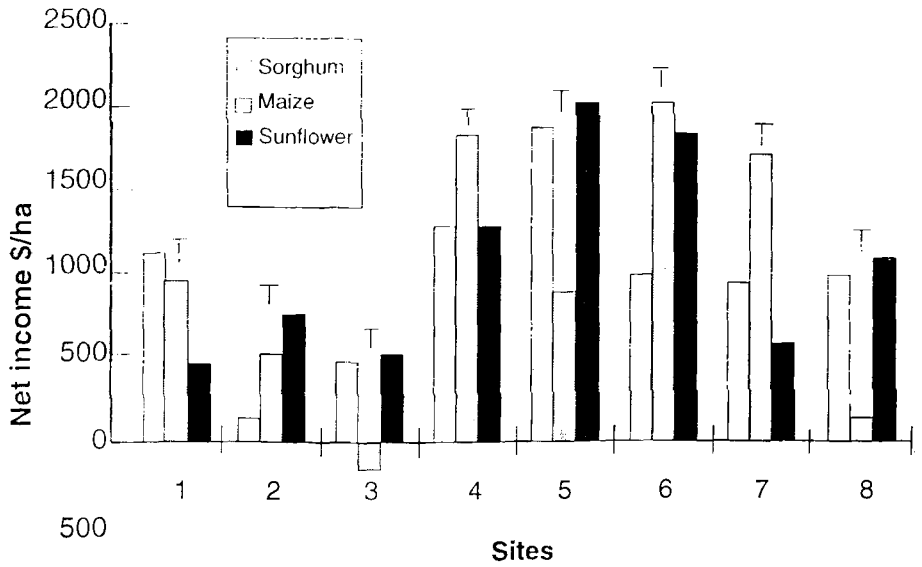


**Figure 2: Net income of sorghum (ZWSH-1), maize (R201) and sunflower (Mopani) using GMB prices over eight sites in Matibi II communal area.**

**Table 4: Gross margin and efficiency indicators for sunflower, sorghum and maize using local and GMB prices**

| Parameter | Crop | | |
|---|---|---|---|
| | Sunflower | Sorghum | Maize |
| **Local price** | | | |
| Mean seed yield (kg/ha) | 851 | 2 104 | 1 364 |
| Gross income (Z$/ha) | 1 317 | 1 894 | 1 705 |
| Total variable costs (Z$/ha) | 132 | 180 | 197 |
| Labour[a] (hrs/ha) | 585 | 892 | 196 |
| **Efficiency indicators** | | | |
| Gross margin $ha^{-1}$ | 1 185 | 1 714 | 1 508 |
| Gross margin $hr^{-1}$ | 2.03 | 1.92 | 7.69 |
| Gross margin $TVC^{-1}$ | 8.98 | 9.52 | 7.69 |
| **GMB price** | | | |
| Gross income (Z$/ha) | 1 278 | 1 370 | 1 278 |
| Total variable costs (Z$/ha) | 210 | 387 | 326 |
| **Efficiency indicators** | | | |
| Gross margin $ha^{-1}$ | 1 068 | 983 | 958 |
| Gross margin $hr^{-1}$ | 1.82 | 1.10 | 4.89 |
| Gross margin $TVC^{-1}$ | 5.08 | 1.43 | 2.94 |

[a]Chiduza (1994)

*On-farm benefits of improved sorghum varieties compared to the popular unimproved variety*
There was significant interaction ($p<0.05$) between variety and site. ZWSH-1 performed as good as SV-2 at six of the eight site ($p>0.05$) (Figure 3). SV-2 yielded significantly ($p<0.05$) better than Chitichi at five of the eight sites. ZWSH-1 yielded significantly ($p<0.05$) better than Chitichi at seven of the eight sites. In overall ZWSH-1 had highest yield than SV-2 and Chitichi ($p<0.05$). Improved sorghum varieties performed consistently higher than local unimproved variety. The results in Figure 3 were achieved with approximately 300 mm rainfall. The results show clearly yield superiority of hybrid ZWSH-1. Yield of ZWSH-1 was twice that of Chitich at the majority of the sites.

*Lessons learnt in this on-farm participatory approach*
Farmers were isolated and conservative. Farmer participation was not easily forthcoming until their initial suspicion was overcome. Low level of literacy often made it difficult to elicit cooperation from farmers in gathering data (for example, rainfall, yields). During focus group discussions a few articulate and aggressive group members dominated the meetings and this tended to bias responses. Attendance at group meetings were sometimes poor at critical periods. When the researchers indicated that participating farmers were going to be supplied with seed, a lot of farmers showed some interest but after getting the seed, they failed to

implement the trial as required. When working through defined protocols, farmers tend to ignore meetings called by the farmers whom they dislike. In spite of these limitations, farmers can actively participate in evaluating improved cropping technologies once their suspicion is overcome. Almost all of the farmers who participated in three wards said they would grow improved sorghum and hybrid sunflower next season.

*Impact of on-farm participation approach on adoption of new technologies*

Surveys conducted after 1995/96 season by Doreen Vhevha and Kizito Mazvimavi (unpublished data) focusing on indigenous knowledge of sorghum in Matibi II showed that adoption of improved sorghum varieties ZWSH1 and SV2 was very good. In this study, farmers identified 16 sorghum varieties grown in Matibi II. Out of these 16 varieties, 40 percent of them were improved varieties comprising SV1, SV2, DC75 and ZWSH1. This showed a high adoption rate given a single season exposure to SV2 and ZWSH1. This is true because in our pre-trial survey only 25 percent of the farmers grew improved sorghum varieties. This follow up study showed that improved varieties like SV2, SV1 and ZWSH1 were ranked second, third and fourth best among the 16 varieties grown, respectively, by female farmers (Table 5). A pairwise ranking confirms these results identifying SV1, SV2, ZWSH1 being among the most preferred varieties (Tables 5 and 6). Overall, Chihumani was the most preferred sorghum variety in Matibi II. However, Chihumani is believed to be a version of the improved SV2, though not in a pure form.

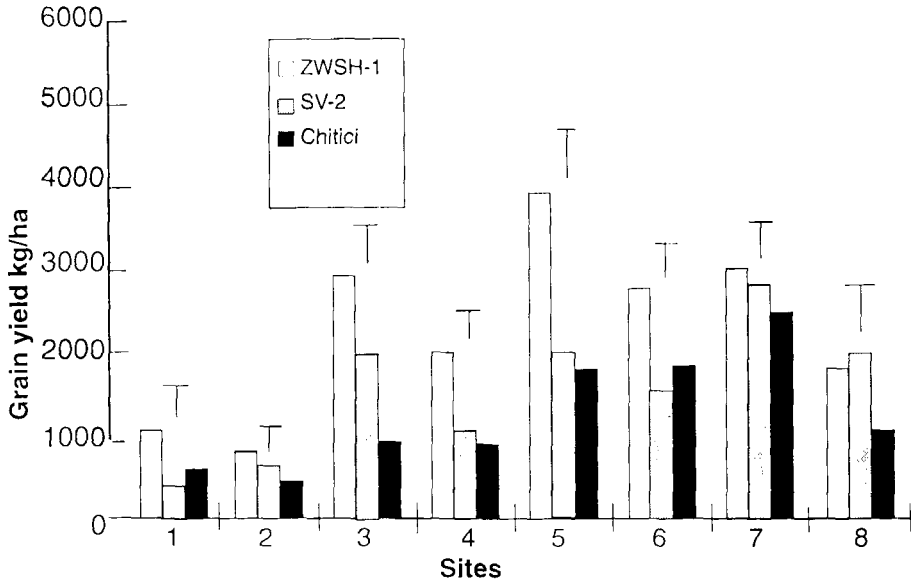


**Figure 3: On-farm benefits of improved sorghum varieties compared to unimproved variety under farmer management at eight sites in Matibi II, 1994/95 season. Vertical bars represent S.E.**

**Table 5: Female farmers' perceptions and pairwise ranking of improved and local varieties two seasons later after the introduction of SV-2 and ZWSH1 in a participatory approach in Matibi II communal area.**

| | Chivelana | Chibedyani | Mukadzi Usaenda | DC75 | SV1 | ZWSH1 | SV2 | Sagalini | Chihumani | Gangarai khaki | Gangara red | Chitichi | Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chitichi | Chitichi | Chitichi | Mukadzi Usaenda | Chitichi | SV1 | ZWSH1 | SV2 | Sagalini | Chihumani | Chitichi | Gangara Red | * | 4 | 8 |
| Gangara Red | Gangara | Gangara Red | Gangara Red | Gangara Red | SV1 | ZWSH1 | SV2 | Gangara Red | Chihumani | Gangara Red | * | | 7 | 5 |
| Gangara Khaki | Chivelana | Chibedyani | Mukadzi Usaenda | Gangara Khaki | SV1 | ZWSH1 | SV2 | Sagalini | Chihumani | * | | | 1 | 11 |
| Chihumani | Chihumani | Chihumani | Chihumani | Chihumani | Chihumani | Chihumani | Chihumani | Chihumani | * | | | | 11 | 1 |
| Sagalini | Sagalini | Sagalini | Mukadzi Usaenda | Sagalini | SV1 | ZWSH1 | SV2 | * | | | | | 5 | 7 |
| SV2 | SV2 | SV2 | SV2 | SV2 | SV2 | SV2 | * | | | | | | 10 | 2 |
| ZWSH1 | ZWSH1 | ZWSH1 | ZWSH1 | ZWSH1 | SV1 | * | | | | | | | 8 | 4 |
| SV1 | SV1 | SV1 | SV1 | SV1 | * | | | | | | | | 9 | 3 |
| DC75 | Chivelana | Chibedyana | Mukadzi Usaenda | * | | | | | | | | | 0 | 12 |
| Mukadzi Usaenda | Mukadzi Usaenda | Mukadzi Usaenda | * | | | | | | | | | | 6 | 6 |
| Chibedyani | Chivelana | * | | | | | | | | | | | 2 | 10 |
| Chivelana | * | | | | | | | | | | | | 3 | 9 |

*Source: Doreen Vhevha and Kizito Mazvimavi, 1997 (unpublished data)*

**Table 6: Male farmers' perceptions and pairwise ranking of improved and local varieties two seasons later after the introduction of SV-2 and ZWSH1 in a participatory approach in Matibi II communal area.**

| | Chimashiya | SV2 | ZWSH1 | DC75 | Chitichi | Chihumani | Gangara | Chivelani | Sagalani | Chichayeni | Mukadzi Usaenda | Chiredhi | Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chiredhi | Chimashiya | SV2 | ZWSH1 | Chiredhi | Chitichi | Chihumani | Gangara | Chivelana | Sagalini | Chichayeni | Mukadzi Usaenda | * | 1 | 11 |
| Mukadzi Usaenda | Chimashiya | SV2 | ZWSH1 | Mukadzi Usaenda | Chitichi | Chihumani | Gangara | Mukadzi Usaenda | Mukadzi Usaenda | Mukadzi Usaenda | * | | 5 | 7 |
| Chichayeni | Chimashiya | SV2 | ZWSH1 | Chichayeni | Chitichi | Chihumani | Gangara | Chivelana | Sagalini | * | | | 2 | 10 |
| Sagalani | Chimashiya | SV2 | ZWSH1 | Sagalani | Chitichi | Chihumani | Gangara | Chivelana | * | | | | 3 | 9 |
| Chivelana | Chimashiya | SV2 | ZWSH1 | Chivelana | Chitichi | Chihumani | Gangara | * | | | | | 4 | 8 |
| Gangara | Gangara | SV2 | Gangara | Gangara | Gangara | Gangara | * | | | | | | 10 | 2 |
| Chihumani | Chimashiya | SV2 | Chihumani | Chihumani | Chihumani | * | | | | | | | 8 | 4 |
| Chitichi | Chimashiya | SV2 | Chitichi | Chitichi | * | | | | | | | | 7 | 5 |
| DC75 | Chimashiya | SV2 | ZWSH1 | * | | | | | | | | | 0 | 12 |
| ZWSH1 | Chimashiya | SV2 | * | | | | | | | | | | 6 | 6 |
| SV2 | Chimashiya | * | | | | | | | | | | | 11 | 1 |
| Chimashiya | * | | | | | | | | | | | | 9 | 3 |

*Source: Doreen Vhevha and Kizito Mazvimavi, 1997 (unpublished data)*

## Discussion

PRAs revealed that improved cultivars are not readily available on the market, and as such this inhibits their adoption. Seed houses seem to fail to meet farmers' demands in the marginal areas. This is supported by a higher percentage of farmers willing to buy improved seeds if they become available on the market. The PRAs conducted in Matibi II proved to be quick and effective methods of identifying and characterising farmers' crops, production constraints, identifying crops perceived to be profitable and building rapport with farmers to facilitate farmers' participation. From the results of the subsequent trials, PRA was clearly an essential first step which enabled us to choose varieties to be tested by the farmers. A somewhat similar approach was reported by Joshi and Witcombe (1996). The advantage of PRA is that farmers' requirements can first be identified in order to give them more appropriate material to test (Joshi and Witcombe, 1996). Nevertheless, PRAs are limited because they cannot reveal best performing variety unless a field comparison is conducted.

A reasonable proportion of farmers grew sunflower in the area, often, improved varieties reflecting the importance the crop is gaining in semi-arid areas. However, the area under the crop varied with the majority of farmers having below 2 ha. Sunflower lagged behind other crops such as sorghum and maize in this area, generally agreeing with the findings of Shumba *et al.*, (1989). This lag can be attributed to the fact that sunflower is often considered last on the farmers' cropping calendars. The crop is often considered when: other crops have failed due to inadequate rains, the rains start late for planting other crops, and if there is extra land remaining after planting other crops (Hikwa and Malusalila, 1992). Other reasons attributed to the decline of sunflower production by smallholders include poor yields due to low use of fertiliser. However, the average sunflower yields of 851 kg $ha^{-1}$ achieved by farmers in this study are far in excess of communal area average of 0.5 t $ha^{-1}$ (Hikwa and Whingwiri, 1986) and average yields in farmers' fields reported by Jones, Nyamudeza and Nyati (1987) of 350 kg $ha^{-1}$ in Chiredzi District in 1983/84, a season with less than 300 mm of rainfall.

The preponderance of local sorghum landraces, which are desired for other reasons, is responsible for low yields, consequently leading to food insecurity. Some of the desirable traits inherent in these landraces such as resistance to bird attack and stalk borer damage, and good keeping quality may be lacking in improved varieties. Therefore, efforts to develop and disseminate improved technologies for smallholder farmers should be guided by an understanding of the farmers' requirements. For example, such varieties as SV-2, an improved short cycle bred for food has proved to be one of the most preferred variety in other semi-arid sorghum growing areas of Zimbabwe (Chiduza 1995; Heinrich and Mangombe, 1995).

High seed rates used by farmers reflect farmers' experiences in obtaining poor stand establishment. These high seed rates impact negatively on the adoption of improved cultivars, as such adoption would imply a high cash outlay for seed

purchases. Therefore, research work focusing on working out strategies to obtain good stand establishment without using high seed rates would help improve crop production in semi-arid areas. These high seed rates resulted in higher plant population densities than recommended for the area by Nyamudeza (1993). Plant population achieved by the farmers were higher than recommended, a tendency that could increase risks of crop failure due to competition for moisture, given the low rainfall in the area. Recommended plant population in this semi-arid area for sorghum is between 33 000 and 66 000, and 22 000 for maize (Nyamudeza, 1993; 1996). Fields with high plant population had low yields as a result of high proportions of barren plants.

Highest income and gross margin per hectare achieved with sorghum using local price clearly show the increased demand for sorghum for subsistence and this is in agreement with farmers' objective to meet household subsistence requirements by devoting large area (39 percent) to sorghum - perhaps a reflection of farmers' experience and pragmatism in a harsh environment. The fall in official prices for sorghum is clear evidence of limited demand for commercial purposes. There is little demand for sorghum from the commercial sector. The largest demand is for improved red sorghum (high in tannins) bred for malting quality for the brewing industry. Yet smallholders grow mostly pearly white, not desirable for brewing, but, desirable for consumption. Hence the recommendation for sunflower as a cash crop to supplement cereal production.

In recent years, the majority of the smallholder farmers have tended to sell their produce through official channels. Based on official prices offered by grain marketing board and local prices, the hypothesis that farmers are better off producing sunflower compared to sorghum and maize appears to hold. Nevertheless, maize still gives farmers the best returns per labour hour as compared to sunflower and sorghum. Labour continues to be the most limiting factor on smallholder farms, particularly those in semi-arid area where farmers crop extensively to spread risk, in part explaining the increased adoption of maize by farmers. The lower labour requirement of maize is in disagreement with farmers' perception of sunflower as being the least labour requirement enterprise (Table 1). Sunflower requires more labour because of the need to thresh, winnow and clean in order to meet buyers' minimum requirements. Also labour is required to protect sunflower fields against predation by mainly birds throughout the period of grain development and maturation. Also, the hypothesis that sorghum would provide higher and more stable grain yield is borne out of the results of the on-farm work reported in Table 3. Sorghum averaged 2.1 t/ha compared to 1.4 t/ha for maize, an advantage in yield of 50 percent and had a lower coefficient of variation of grain yield 45 percent across farms compared to 49 percent for sunflower and 72 percent for maize. The results agree with farmer perception of sorghum as the most reliable crop for subsistence.

Maize yield and income variation in this study reflects the variation in rainfall in space and time. Rainfall at sites 1 to 3 was less than 320 mm and the yield of maize within these sites also reflects poor rainfall distribution within sites, particularly site 3. However, in addition to low rainfall the farmers at low yielding sites weeded

the crop relatively late, largely due to labour shortage. Coupled with low rainfall there was poor thinning at sites 1 and 2 in sunflower and sorghum, respectively, resulting in poor yield performance and low income. This emphasises the importance of timeous weeding and thinning in the management of both sorghum and sunflower. There is little data that highlights the effect of weeds on crop production in dry areas of Zimbabwe.

Maize will continue to be a chief cereal staple regardless of the productive gain which might be achieved for sorghum and millets. This is because maize has become the preferred staple due to palatability, is not favoured by birds, and processing industries and market linkages are well established. Further to this, although maize may have highest variation in grain yield of all the three crops, farmers often realise best returns per labour hour invested - possibly reflecting that maize may be agroecologically unfit but returns to scarce resources may be attractive. Nonetheless, ample scope remains, however, for exploiting farmers' desirable sorghum traits and incorporate these in the breeding programme to produce farmer acceptable varieties with fairly high demand for commercial use.

*The importance of farmer participation*

A few farmers had grown improved sorghum varieties in the previous seasons in Matibi II. Indeed, farmers are recommended by extension personnel to adopt improved sorghum varieties in this area. However, there was no noticeable increase in the number of farmers adopting these recommended improved varieties despite several years of extension recommendation. This indicates a failure by traditional extension method of recommending farmers to adopt improved technologies without involving these farmers in testing and adapting these varieties. This lack of adoption of improved varieties is surprising given that improved varieties yield better than local unimproved varieties. We concluded that farmers cannot appreciate the benefits from improved varieties unless they are given an opportunity to experiment for themselves, to do their research and evaluation. The participatory approach used in this study has been highly effective in empowering farmers to test, adapt and adopt improved sorghum varieties and to appreciate their benefits. Therefore, the importance of group and community participation in evaluating potentially useful technology should never be undermined.

Placing the farmers at the centre of the research process offered two significant opportunities in this study. Firstly, farmers were in a far better situation than the researchers to assess their local situation and to determine whether a given innovation was relevant. Secondly, farmers retained the responsibility for further experimentation with the innovation under local conditions, and for adapting the innovation to local conditions (Beebe, 1994). Although farmers can be conservative during the initiation of the research process, they can actively participate in technology evaluation once their initial suspicion is overcome. The study has shown that smallholder farmers can significantly improve sorghum yield by adopting improved sorghum varieties compared to local landraces. Nevertheless, improved varieties should be viewed as additions to available local varieties and

this will provide a basket of choices to farmers. The problem of shortage of income to purchase improved seed for example, can be alleviated by growing cash crops like sunflower.

Interaction with farmers during field days offered further benefits of identifying areas that need further research, for example, the problem of poor stand establishment needs to be investigated further by developing strategies that will ensure good stand establishment without using high seed rates. This would improve crop production in semi-arid areas and may save farmers' income in terms of seed purchases.

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