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A DESCRIPTIVE ANALYSIS OF THE SAMPLE IRRIGATION SYSTEMS

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INTRODUCTION

This paper gives an overview of some of the physical and socio-economic characteristics of the sites in the final sample. The sample covers the range of irrigation management systems that exist in Zimbabwe as discussed in Chapter 2.

WATER RESOURCES

Rainfall during the study year was below average in most of Zimbabwe, and on all of the sample irrigation systems except Maboleni and Dufuya (Table 3.1). However, rainfall is only part of the total water available to plants on irrigation systems. The lower the rainfall, however, the more dependent crop production will be on irrigation.

Rainfall figures in Table 3.1 indicate that, on average, rainfall supplied 34 percent of available summer irrigation water and 13 percent of total annual water supply on community schemes. On Agritex schemes rainfall supplied 16 percent of available summer irrigation water and 7 percent of total. On *bani* schemes rainfall contributed slightly more to total available water at 22 percent[1]. The relatively small contribution of rainfall to water supply is a function of the fact that 1990/91 was a relatively dry year. However, even given this drought, on average, community schemes irrigated 64 percent of the command area in summer and slightly less than half in winter. This compares with 88 and 73 percent respectively for Agritex schemes and 106 and 67 percent respectively for *bani* schemes. The relatively high average proportion of the command area irrigated by Agritex schemes is a reflection of the more reliable water source and conveyance systems enjoyed by Agritex schemes, whereas that of the *bani* schemes can be explained by the fact that, in summer, most of the bani available water comes from sub-irrigation.

Rainfall supplied over half the total water available on Senkwazi and Mkoba in summer, but was negligible on all schemes in the winter season (Table 3.1). Total water availability, including rainfall and irrigation supplies, was over 1000 mm on Chakohwa, Mkoba, and Mwerahari[2] during both the summer of 1990/91 and the winter of 1991. Bangure had the lowest total water supply, with less than 150 mm in each season.

Water supplies on the *banis* are more difficult to estimate because much of the water available to crops comes from sub-irrigation, rather than from measurable surface flows. Water applied through hoses, channels, or lifting provided less than 20 percent of crop water requirement, but high water tables provided a considerable portion of crop needs through capillary action. The data on *bani* system water supplies in Table 3.1 represent the average amount of *bani* recharge available, after meeting the evapo-transpiration requirements of natural vegetation on the *bani*. With 1333 to 3111 mm available over the year, water supply on the *bani* systems is within the range supplied on community and Agritex systems. However, system averages mask a high degree of variability in water

availability within systems and even within garden plots, as some areas are waterlogged while nearby areas remain very dry.

Irrigation supplies per unit area for a scheme as a whole reflect both water resource availability and system planners' decisions on how much to concentrate the water on a limited area, versus spreading it more thinly over a larger area. This is determined to some extent in system design and construction, when average water availability and desired cropping patterns are used to decide how much irrigated land to develop. In addition, each year system managers decide how supplies should be allocated, how much of the potentially irrigable land should receive water, and which crops should be irrigated based upon estimates of total supply, water losses, and other local conditions. For example, in summer at least 95 percent of the developed command area was irrigated in Mwerahari and Chakohwa (which had the highest total water supplies in summer), Mkoba, and on all *bani* systems (Table 3.1). Senkwazi irrigated only 78 percent of the area, while Tawona, Mabodza, and Chibuwe irrigated at least 93 percent of the land with less total water available. The proportion irrigated in winter was lower on all schemes except Sachipiri, which increased from a low 37 percent in summer to 65 percent in winter. This was because in summer the canal was being repaired and no irrigation took place. As a result, only a portion of the scheme was cropped. The winter crop was irrigated and a larger portion of the command area was cultivated. At Mondi Mataga the irrigated portion of the command area increased from 98 percent in summer to 100 percent in winter due to one farmer who did not cultivate part of his land in summer.

IRRIGATION TECHNOLOGY

The technology used to convey water from the source to the fields varies considerably. Middle Sabi has large-scale pumps and sprinkler application systems. Most community and Agritex systems have open lined canals with siphons delivering water into furrows. Both ARDA systems and four of the Agritex systems (Mondi Mataga, Senkwazi, Chibuwe, and Tawona) have pumps, while the remaining community and Agritex systems are gravity-fed. *Bani* irrigation systems are the most diverse. Their sources include gravity flow from "sponges" through small channels as well as manual lifting from small wells or cisterns. Farmers apply water by sub-irrigation and gravity flow in unlined channels, as well as direct application from hoses, buckets, and watering cans (Table A1).

LAND AND SIZE OF FARMS

Settler farmers on ARDA systems have the largest irrigated holdings among the sample farmers. Average irrigated holdings on Chisumbanje are 3.58 ha, while on Middle Sabi all farmers have 10 ha (Table 3.2).

On average irrigated land holding on Agritex schemes was 0.99 ha, followed by community schemes with average irrigated land holdings of 0.36 ha. The smallest holdings were on *bani* schemes, which averaged 0.24 ha. Dryland holdings are largest at Chisumbanje (the only sample ARDA scheme with dryland) at 7 ha, followed by dryland sites with an average of 5.1 ha. Dryland holdings averaged 4 ha on *bani* sites, and 2 ha on Agritex and community systems.

In addition to irrigated land and dryland, many farmers also have gardens. On average, garden area was highest on Agritex and dryland sites at 0.52 ha, and lowest on the bani sites (due primarily to the small plots on Mbiru and Dufuya).

Among the Agritex schemes, Mabodza is a classic "comma hectare" scheme, with irrigated holdings averaging 0.13 ha. The three community schemes in the Midlands Province (Bangure, Charandura, and Mkoba) are "comma hectare" systems, with average irrigated holding sizes ranging between 0.14 and 0.3 ha (Table 3.2). Irrigated holdings on Mutambara, the community system in Manicaland, average 0.55 ha. Mondi Mataga and Senkwazi have irrigated holdings of approximately 0.5 ha, and the remaining Agritex systems have irrigated holdings ranging from 0.8 to 1.5 ha. However, the size of irrigated holdings varies significantly within the individual schemes.

Farmers on the community and *bani* irrigation systems have the smallest irrigated holdings, which supplement their dryland holdings. The two *bani* systems in the Midlands, Dufuya and Mbiru, have average plot sizes of under 0.2 ha, but total irrigated *bani* land on Maboleni averages nearly 0.5 ha. Mushimbo, the *bani* system which is most highly commercialized, has a mix of holding sizes that average nearly 1 ha. In addition to irrigated land, 97 percent of *bani* system plotholders also had dryland, averaging 4 ha (Table 3.2). On community schemes, 89 percent of farmers had dryland holdings, averaging 2 ha. More than half of Agritex plotholders also have dryland holdings (average 2 ha). The prevalence of dryland holdings appears to vary across the ARDA schemes. For example, Chisumbanje farmers are quite heavily involved in dryland cultivation because 92 percent reported having dryland, averaging 7 ha. On the other hand, Middle Sabi is the only sample scheme on which no farmers reported having any dryland. Average holding sizes in the two sample dryland areas were 6.4 ha in Charandura, and 3.1 ha in Chakohwa.

Half of the plotholders on the ARDA irrigation systems, and nearly 60 percent of community irrigation system plotholders also have garden land, while nearly a quarter of Agritex farmers have gardens. Gardens are more common in areas of the Midlands where *bani* landforms are more prevalent, and on ARDA schemes, where gardens are often included in the home site. Mondi Mataga is the only sample scheme where there were no farmers with gardens. Among those farmers with gardens, average garden size was 0.47 ha. The largest gardens were at Agritex and dryland systems. However, there is high variability in sizes among the Agritex systems ranging from 0.1 to 0.9 ha. Average garden land for community systems was 0.4ha, for ARDA systems 0.3 ha, and for the *bani* systems it was 0.24 ha. (Table 3.2). In the following analysis, garden plots for farmers on the sample garden irrigation systems are included as "irrigated holdings", analogous to the irrigated plots on community, Agritex and ARDA, systems. The survey includes basic information about garden plots held by farmers on formal irrigation systems, but does not include detailed garden level production and system performance data for those gardens.

WORKING CAPITAL

Equipment Ownership

Very few farmers on the sample schemes own modern equipment such as motor vehicles, tractors, planters, or ridgers. However, the majority own basic equipment such as ploughs and harrows for land preparation, and ox-drawn carts, wheelbarrows, and bicycles for transportation (Table A1). The most widely owned implement on all schemes is the plough, owned by more than 80 percent of farmers on

community, Agritex, *bani* and dryland sites. This is a reflection of the relative importance of this implement to the production process particularly where the timing of planting is concerned. Ownership of a plough is lowest on ARDA schemes, where farmers can hire tractors from the ARDA estate. The next most widely owned implement on average appears to be the harrow, followed by the cultivator. Variability in ownership of these implements is shown by the fact that whereas at Tawona 74 percent own a harrow and 47 percent a cultivator, ownership of these two implements is 46 percent and 92 percent, respectively, at Mondi Mataga.

The relative prosperity of farmers on Middle Sabi is evident in the proportion of farmers owning motor vehicles (47 percent), compared to 10 to 20 percent on Mabodza, Mondi Mataga, Chakohwa, Charandura and Mkoba, and less than 10 percent of plotholders on all other schemes. However, Middle Sabi farmers do not own land preparation equipment because land preparation is done under contract with the estate and commercial firms.

Vehicles and scotch carts (farm carts pulled by oxen or donkeys) are particularly important for obtaining inputs and getting produce to markets. Those who own their own transport or land preparation equipment are less dependent on borrowing or renting from others, and can therefore do cultivation or marketing activities in a more timely manner. Tiffen (1990) also points out that farmers who do not own equipment are at a disadvantage because the costs of rental reduce the availability of funds for fertilizer and other input expenditures.

Siphons are the primary irrigation equipment for water application on community and Agritex schemes. Some schemes provide a common pool of siphons which are available to all farmers, but on Chisumbanje, Mabodza, Senkwazi, Chakohwa, Bangure, and Mkoba, at least 90 percent of the farmers own their own siphons. Only 8 percent of farmers on sample *bani* systems own siphons, because siphoning from open channels is a less common form of water application in *bani* systems and stream sizes are often very small. Instead, farmers use buckets, drums, and watering cans. Farmers on *bani* systems have also invested in irrigation structures such as wells, supply and drainage channels, and other infrastructure like fencing (Andreini 1993).

Livestock Ownership

Ownership of livestock provides draft power, manure, and alternative income sources for irrigated as well as for dryland farmers. The ownership of draft power is particularly important as it determines the timelines of planting and sometimes weeding, where farmers use cultivators. On average, about 80 percent of the farmers on community, Agritex, and dryland schemes own draft cattle (Table 3.3). At most schemes more than 50 percent own draft power, except at Middle Sabi where no farmers own draft animals. On average, draft numbers averaged more than 2 animals at all schemes. Donkeys are also used for draft purposes. However, except at Mabodza, Mondi Mataga, Mwerahari/Sachipiri and Maboleni, on the rest of the schemes less than 50 percent of farmers own donkeys. Of those who own donkeys, the average number is above three. It appears therefore that donkeys are a less important draft power source but they are an important source for some farmers.

In assessing the adequancy of draft power, farmers were asked whether the animals they had were sufficient for their draft power needs. At most schemes more than 50 percent of farmers reported that they had enough for their needs, except at Bangure and Mutambara where only 35 and 46 percent, respectively, reported

having sufficient draft power. Mondi Mataga is the scheme with the highest draft power adequacy where 100 per cent of farmers reported having adequate draft power.

Middle Sabi is the only scheme on which farmers have no livestock except poultry. Livestock is most important for Mondi Mataga farmers who have an average of 19 cattle and 37 animals total, including donkeys, sheep, goats, and pigs (Table 3.3 and Table A2). Other schemes with relatively high herd sizes include: Chisumbanje, Mabodza, Mwerahari/ Sachipiri, Charandura, and Dufuya, which represent different scheme types. A large proportion of farmers on the sample schemes own goats. Relatively few farmers own pigs and sheep (Table A2). Most livestock, except donkeys, provide manure. Farmers were asked whether they had enough livestock for manure. Except at the *bani* sites where only 40 per cent reported that they had enough livestock for manure more than 50 percent of farmers in the other sites reported that they had enough livestock for manure. The highest was at Mondi Mataga (100 percent) and the lowest at Senkwazi (30 percent). Among those farmers who did not have enough animals for draft or manure needs, over half (53 percent) said that they could not afford more animals, and a third (36 percent) said they had been forced to sell animals. Prohibitions against having animals on the scheme were not reported as a constraint, but approximately 10 percent reported that insufficient grazing land was a problem, most notably on Chisumbanje, Mabodza, Nyahoni, Charandura, and Mbiru.

There appears to be little buying and selling of livestock in the sample schemes. At all schemes less than 50 percent of farmers sold oxen and other cattle (Table 3.4). Very few sold pigs and sheep. This may be a function of ownership. Goats were sold by more farmers at community, Agritex and dryland sites than at ARDA sites. At ARDA sites no farmers sold smallstock.

More farmers bought oxen than sold oxen (Tables 3.4 and 3.5). This shows that farmers are interested in building their draft power source. Again, very few farmers bought sheep and pigs but many farmers bought goats, except at ARDA and *bani* sites (Table 3.5).

Credit Use

Use of credit for inputs varies considerably among scheme types. Over 95 percent of ARDA settler farmers use credit, compared to 36 percent for Agritex, and 33 percent for community system farmers. *Bani* irrigation system and dryland farmers are significantly less likely to use credit than farmers on formal irrigation systems. While less than 10 percent of farmers in the Midlands *bani* systems use credit, 25 percent of those in the highly commercialized *bani* system at Mushimbo do use credit for inputs. Only 5 percent of dryland farmers reported use of credit.

The significantly lower use of credit on *bani* systems than on other types of irrigated land is not surprising. Much formal sector credit was contingent on the production of regulated crops[3], for which repayment could be collected from the Grain Marketing Board. Vegetable crops grown on *bani* systems are generally deemed too risky for government administered credit because of their perishability, price fluctuations, and the difficulties of collecting loan repayments. Furthermore, the nebulous legal status of irrigation on *bani* landforms may make obtaining credit more difficult. Given the relatively high investment and input costs of garden production, lack of credit is a potential constraint for the agro-economic performance of *bani* irrigation.

Human Capital

ARDA and Agritex have attempted to allocate irrigated land to good farmers, to ensure that the irrigation facilities are used as productively as possible. Thus the human capital resources of different farm households and irrigation schemes, including education and farm management skills, are likely to have a bearing on farm productivity. The literacy rate on the sample ARDA schemes is 95 percent, and 63 percent on Agritex schemes (Table 3.6). The sample community systems have a very high literacy rate (90 percent), in part because they were founded by missions, which also established schools nearby. Even the *bani* irrigation systems have a literacy rate of 80 percent among sample farmers. Dryland farmers at Charandura (near a mission) had a literacy rate of 80 percent, but those near Chakohwa had a 50 percent literacy rate. Average years of formal schooling shows a slightly different pattern: it is highest on community and ARDA systems (6.1 and 5.6 years respectively), followed by Agritex (4.1 years), dryland (4.0 years) and *bani* systems (3.4 years). However, the variability between households within schemes is very high (Table 3.6).

Farm management skills are more difficult to measure, but participation in Zimbabwe's Master Farmer training programme provides one indicator. Table 3.6 indicates that 61 percent of sample ARDA farmers are Master Farmers, compared to 49 percent on Agritex and community schemes respectively, 40 percent on *bani* systems, and 38 percent on dryland sites. The relatively low proportion of Master Farmers on dryland and *bani* systems may reflect the higher extension worker to farmer ratio on irrigation schemes as opposed to other systems. Because of this higher ratio more farmers get training. The proportion of Master Farmers is highest on Mwerahari/Sachipiri (95 percent), Mondi Mataga (85 percent), and Mkoba (83 percent).

Years of experience with irrigated farming provides another potential indicator of management skill. Farmers in the Mbiru *bani* scheme held their plots for the shortest average period (4 years). Overall, the average length of time sample farmers held their irrigated plots was 13 years, and this does not vary much between different types of schemes. This average is higher than for Agritex systems in general, because one of the selection criteria for sample schemes was that they had been in operation for at least 5 years. Thus, many of the new irrigation systems, on which farmers have held irrigation plots for less time, have been excluded.

Farmers' ages across systems does not vary greatly. On average plotholders are above 40 years of age.

One of the major characteristics of agricultural production in Zimbabwe is that sometimes the husband is formally employed but still makes decisions while the wife executes the plan and makes the day to day decisions with consultation with the husband wherever possible (Makombe, 1991). Farmers were asked whether husbands were resident or away. ARDA schemes had the highest proportion of resident husbands (84 percent) with 100 percent of the Middle Sabi husbands being resident. Agritex systems had 63 percent resident husbands, followed by community (58), *bani* systems (52) and dryland systems (49) percent (Table 3.6). The effect of the absence of the husband on production is difficult to tell. Sometimes when they are away, the decision making process is slowed down leading to poor performance. On the other hand, where the absent husbands are formally employed they may provide inputs (fertilizer for example) leading to improved performance.

Farmer performance can also be enhanced by keeping records of inputs and outputs. The greatest number of farmers who kept records were at Middle Sabi (100 percent), Mwerahari/Sachipiri (84 percent), Mkoba (91 percent), Mabodza (61 percent), and Chisumbanje (54 percent). At the rest of the schemes less than 50 percent of farmers kept records (Table 3.6).

Farmers were asked about membership in voluntary organizations as an indicator of local involvement. Participation in organizations such as marketing cooperatives, savings clubs, or labour groups was quite high on the 3 community schemes in Midlands, (Bangure, Charandura, and Mkoba) and for the Charandura dryland area (Table 3.7). On these schemes, 70 percent or more of sample plotholders belonged to at least one of these organizations. This exceeds participation rates for Chakohwa, Chibuwe, and Chisumbanje (less than 15 percent), and the average for all irrigation schemes (42 percent). Overall, sample farmers in Midlands are twice as likely to be active in cooperatives, savings clubs, and labour groups than sample farmers in Manicaland (52 versus 24 percent).

Sources of Income

Farmers were asked whether they were involved in off-farm income generating activities. Farmers reported shops, business, handicrafts and remittances as some of the off-farm income sources. More farmers received remittances than were involved with shops or handicrafts (Table 3.8). More community scheme farmers (50 percent) received remittances than those on any other schemes. Less than 40 percent of the farmers had handicrafts as a source of income and less than 10 percent reported shops as a source of income.

Table A3 summarises the major sources of income for households at sample irrigation schemes. For community, Agritex and ARDA schemes, the major source of income for most farmers is irrigated land. At these scheme types, on average, 57, 82 and 98 percent of farmers respectively, reported irrigated land as their major source of income. On community, Agritex and ARDA schemes both formal and informal employment do not play major roles as income sources.

Sources of income are more diverse for *bani* schemes. At Maboleni and Dufuya a comparable number of farmers reported that their major source of income is gardens and dryland. At Mbiru most farmers derive their income from dryland whereas at Mushimbo the garden irrigated land provides income for most farmers. At *bani* schemes, more farmers derive income from cattle sales, business and pension.

Sources of Food

On community schemes nearly equal proportions of farmers get their primary source of food from dryland and irrigated land. Very few farmers at these schemes rely primarily on gardens for food (Table 3.9).

There, however, is great variability among sources of food within the community schemes. For instance at Charandura 85 percent of the farmers reported that they get their food from dryland whereas at Mutambara 97 percent reported they get their food from irrigated land. This is a function of agrocological circumstances and land holding. Mutambara is in Natural Region V where dryland is not very productive, so farmers have to concentrate on irrigated land. In Charandura, Natural Region III, dryland is productive and farmers have very small irrigated plots (Table 3.2), so that most farmers get their food from dryland.

Most farmers, (on average 80 percent) on Agritex schemes reported that their major source

of food is irrigated land. None reported that they get their food primarily from gardens (Table 3.9) even though many have gardens (Table 3.2). At Mabodza and Mondi Mataga nearly equal proportions reported that their major source of food is dryland and irrigated land, whereas at schemes like Tawona and Chakohwa all farmers reported that they get their food from irrigated land. These are cases where dryland production is almost not possible because of lack of rainfall.

Of the ARDA schemes, all farmers at Middle Sabi reported that they get food from irrigated land and at Chisumbanje 52 percent get their food from irrigated land, 44 percent from dryland and 4 percent form gardens (Table 3.9).

Surprisingly, most farmers from *bani* sites get their food from dryland except at Mushimbo where 58 percent of farmers reported that they get their food from gardens.

As an indicator of food security, farmers were asked whether they ran out of food at some time during the year. Almost all schemes except Mwerahari had some farmers who ran out of food during the year. On average 43 percent of the dryland site farmers ran out of food followed by 34 percent on *bani* sites. The greatest food deficits appear to occur at Chakohwa dryland where 65 percent of farmers ran out of food during the year. This is essentially a result of the fact that Chakohwa is in Natural Region V where rainfall is low, thus making dryland production risky. Of the irrigated systems, Mutambara, at 49 percent, has the greatest number of farmers who run out of food during the year followed by Mushimbo (42 percent) and Maboleni (39 percent).

The analysis on sources of food and shortage of food appears to make a strong case for the development of smallholder irrigation schemes from a food security point of view, particularly for the dry areas.

Plot Allocation

On community schemes 35 percent of farmers, on average, reported that they were allocated their plots by Agritex and 26 percent reported that they inherited their plots, while 20 percent bought their plots. Fifteen percent were given their plots (Table A4). On Agritex schemes 53 percent reported that plots were allocated by Agritex, 20 percent were allocated by tenants' committee, while 17 percent inherited plots. On ARDA schemes most farmers reported renting plots.[4] On *bani* schemes plots were allocated by Agritex (18 percent) or inherited (18 percent). Even though on *bani* schemes all the possible means of garden acquisition were not covered, it is surprising that some gardens were allocated by Agritex. One would have associated allocation of gardens more with local authorities like headman than with Agritex.

Health Aspect Related to Irrigation

Farmers on irrigation schemes face the risk of contracting water borne diseases while they are irrigating. This danger increases if farmers are using the water for domestic purposes like drinking and washing.

Table 3.10 shows that 96 percent of farmers at Chisumbanje use irrigation water for drinking. The highest percentage of farmers using water for washing clothes was also at Chisumbanje (73 percent). On average, few farmers on community and Agritex schemes use water for washing and drinking except at Chakohwa, where 80 percent reported that they use water for washing. Surprisingly at this scheme none of the farmers reported using water for drinking. More farmers on *bani* schemes, on average, used water for drinking and washing clothes than on community and Agritex schemes.

The incidence of diseases like bilharzia and malaria is also not high on most schemes. However on all schemes there are people reported to have suffered from the diseases. Whether the incidence of these diseases is a function of using irrigation water for domestic or agricultural purposes needs investigation. However, at schemes where more farmers use irrigation water for domestic purposes, the incidence of these diseases is also high, for instance at Chakohwa and Chisumbanje, suggesting there might be an association. An interesting result is that farmers on dryland sites reported suffering from bilharzia and malaria. The proportion of people who reported suffering from bilharzia and malaria in the dryland sample are comparable to those on Agritex and community schemes suggesting that participation in an irrigation system does not significantly increase incidence of these water-related diseases.

CONCLUSION

This paper highlights the similarities and differences between the sample sites in terms of both physical and socio-economic circumstances. The interpretation of the results for the comparison of the perfomance of the system types should take cognisance of these similarities and differences. While differences between types of systems receives greatest attention, the differences between schemes in each category should also be recognized.

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ENDNOTES

1. On *bani* sites only total annual water availability figures were available.

2. Although the irrigated areas of Mwerahari and Sachipiri are adjacent, they receive water from different sources: Mwerahari from a weir, and Sachipiri from a dam.

3. Most crops have been deregulated under the structural adjustment programme.

4. However the range of alternative means of acquiring plots did not cover all the possible means of plot acquisition for ARDA schemes.