Economic viability of small-scale irrigation systems in the context of state withdrawal: the Arabie Scheme in the Northern Province of South Africa[1]

Abdul KAMARA [2], Barbara VAN KOPPEN and Litha MAGINGXA

International Water Management Institute (IWMI), 141 Cresswell Street, P. Bag X813, Silverton 0127, Pretoria, South Africa

[2] ab.kamara@cgiar.org

ABSTRACT

The reduction of state presence in irrigation and the transfer of management from government agencies to farmers or farming communities has become a widespread phenomenon, in response to the dual problem of low irrigation performance and constraints to public funding. The underlying principle is to encourage farmers and local communities to take responsibility for the management of local resources, and thereby limit external interventions to the provision information and institutional support services. As most of the schemes in question were not primarily designed for farmer management, experiences worldwide show a mixed picture of positive and negative results. The case of South Africa has recently received attention, as the few pilot schemes, especially in the Northern Province, do not seem to hold much promise of success. Current discussions on the subject raise a lot of issues and hypotheses about the subject of irrigation management transfer to farmers. The paper is an attempt to test some of these hypotheses in the African context, using the Arabie Scheme as a case study.

Key Words: *economic viability; small-scale irrigation; management transfer; South Africa*

1. BACKGROUND

Irrigation Management Transfer (IMT) has gained considerable attention in the last decades, with the broad objective of increasing irrigation performance and reducing constraints on public budget. The process is a strategy to improve economic conditions by reducing the role of the state or it's agents through privatization and empowerment of local communities. The underlying principle of this reorientation is to encourage farmers and local communities to take responsibility for the management of local resources, and thereby limit external interventions to the provision of information and institutional support services that enhance efficient resource allocation.

As evidence of successful IMT worldwide still remains limited especially in the smallholder context (Shah et. al, 2001), the issue has attracted a considerable attention for understanding the conditions of successful IMT (Svendsen, 1992; Vermillion, 1996; Svendsen and Nott, 1997; van Koppen and de Lange, 1999). The case of South Africa has recently received much attention, as most of the schemes in question were not primarily designed for farmer management. Small-scale irrigation schemes – constructed and managed by the state or parastatals – bear a considerable importance in South Africa's political and development history. The dualistic agricultural structure that prevailed during the apartheid era subjected black farmers to subsistence production in the homelands, most of them on government-supported smallholder irrigation schemes[2]. The schemes comprise an estimated 50,000

[1] This paper forms part of the findings of the DFID-funded Project on "Achieving Sustainable Local Management of Irrigation Water in Water Short Basins: South Africa Case Study". The authors extend their sincere gratitude to DFID for the financial sponsorship, and to all those who reviewed preliminary drafts and made various contributions.

[2] Van Zyl et al., (1996) estimate that 89% of arable land in South Africa is allocated to white commercial farmers while less than 13% is allocated to the black majority both for residential and agricultural purposes. A detailed analysis on land tenure in Arabie Olifants Irrigation Scheme is presented in Lahiff, E. (1999).

ha in 202 smallholder schemes with small sizes, many of them about 1 ha or less. Most of the schemes are located in the Northern Province, which is one of the poverty-stricken areas in the country. Initiated in the 1930s and 1950s, most of the schemes are believed to have been constructed without baseline socio-economic surveys or community consultation (Makhura and Mamabolo, 2000). Thus the increasing disenchantment with public support for small-scale irrigation and withdrawal of the operations of the Agricultural and Rural Development Cooperation (ARDC) has left most of the schemes almost dysfunctional[3], which hits hard at rural life in the province, especially in the former homelands.

Typical schemes that are affected by recent withdrawal of state support are the cluster of schemes along the Olifants River, which constitute the Arabie Olifants Irrigation Schemes. The schemes are located on the banks of the Olifants River, getting a large portion of their water supply from the Arabie dam, mostly from pumps or diversion canals from the river immediately downstream of the dam. The schemes consist of about 2,200 ha (in 14 schemes), of plot sizes that are around 1 to 2 ha, and operated by about 1,600 farmers in a mixture of flood, furrow, sprinkler and central pivot irrigation. Some plots are regarded as food plots (vegetable cultivation), but most plots in Arabie were for maize and wheat production, especially for market-oriented wheat production. Since the recent ARDC withdrawal, cultivated area instantaneously dropped by about 50% to 70% in 1997/98 and has continued to what now looks like abandonment by the farmers (van Koppen and De Lange, 1999; Shah et. al, 2001).

2. OBJECTIVES AND ANALYTICAL FRAMEWORK

2.1. Objectives and Hypotheses

The above observations clearly raise a number of questions about the future of the schemes. More importantly, it is of interest to understand the issues that have culminated into this seeming abandonment of the schemes, and to assess whether there is any potential for the farmers to operate the schemes on their own, perhaps with minimal initial support in terms of capacity building, organization and facilitation. There is a need to substantiate whether or not the people are truly interested (and believe in) irrigation farming as a reliable source of income and livelihood. If so, then it is important to assess the role of irrigation in their livelihood strategies. That is, to assess whether or not irrigation farming forms a significant proportion of their incomes to create strong reliance on it as a source of livelihood, or whether it is merely a supplement to other important income sources. While one expects a decline in production to have accompanied the ARDC withdrawal, a complete abandonment is only imaginable if other more remunerate income opportunities or sources are readily available. These assertions are, however, only hypothetical as many other issues such as land tenure security, access to markets and credit, etc., are equally posited as being crucial for the viability of the scheme. Based on IWMI's international experience (Vermillion, 1996; Svendsen and Nott, 1997; Brewer et al.,1999; Shah et al., 2001), we hypothesize that the success of IMT will depend on three broad categories of issues:

- the process of management transfer and how it is accomplished;
- the internal conditions of the irrigation system being transferred (technical conditions, land holdings, reliance on irrigation, heterogeneity, etc.); and
- the presence of institutional support service systems that facilitate integration into the national economic system.

The study is intended to test some of the above hypotheses, highlight factors that affect the viability of the schemes and assess their relative importance. A general framework is developed for analyzing viability but its full application is at this stage constrained by data limitations. Therefore the current study will be limited only to highlighting the current production trends, cost functions and crop budgets, and an estimation of a regression model for a sample of selected schemes. This will form a basis for the design of an in-depth, more data-intensive study that will facilitate a full application of the framework on the entire scheme, which is currently beyond the scope of this paper.

[3] The ARDC is the state supported parastatal that operated all small-scale irrigation schemes in the country. After the change of government in 1994, funding of ARDC activities, which fell in the hands of the provincial governments, posed a big constraint which accelerated the IMT process in the country.

2.2. Conceptual Framework

The concept of viability can be defined at different levels and in various contexts. In a general context, it includes the ability of the scheme to generate sufficient income to satisfy the household income expectations of the irrigators, and to cover basic operational and maintenance (O+M) costs of the irrigation infrastructure, while not mining the natural resources (soil and water). Though income expectations may differ widely across cultures and among individuals, it is much related to the relative role irrigation plays in the income functions of individual irrigators (Shah et al., 2001). Further considerations include the ability of the scheme to maintain cash flows and consistency of income generation over time, and management of risks and shocks associated with small-scale farming. This conceptualization requires a holistic approach, which is depicted in the framework below. The framework is largely developed from IWMI's global studies on the subject (Svendsen, 1992; 1994; Vermillion, 1996; Svendsen and Nott, 1997; Brewer et al.,1999). While most these studies stress on "getting the process right" along with favorable technical, legal and institutional conditions as being crucial for viability, Shah et al. (2001) emphasize that viability after IMT will further depend on the

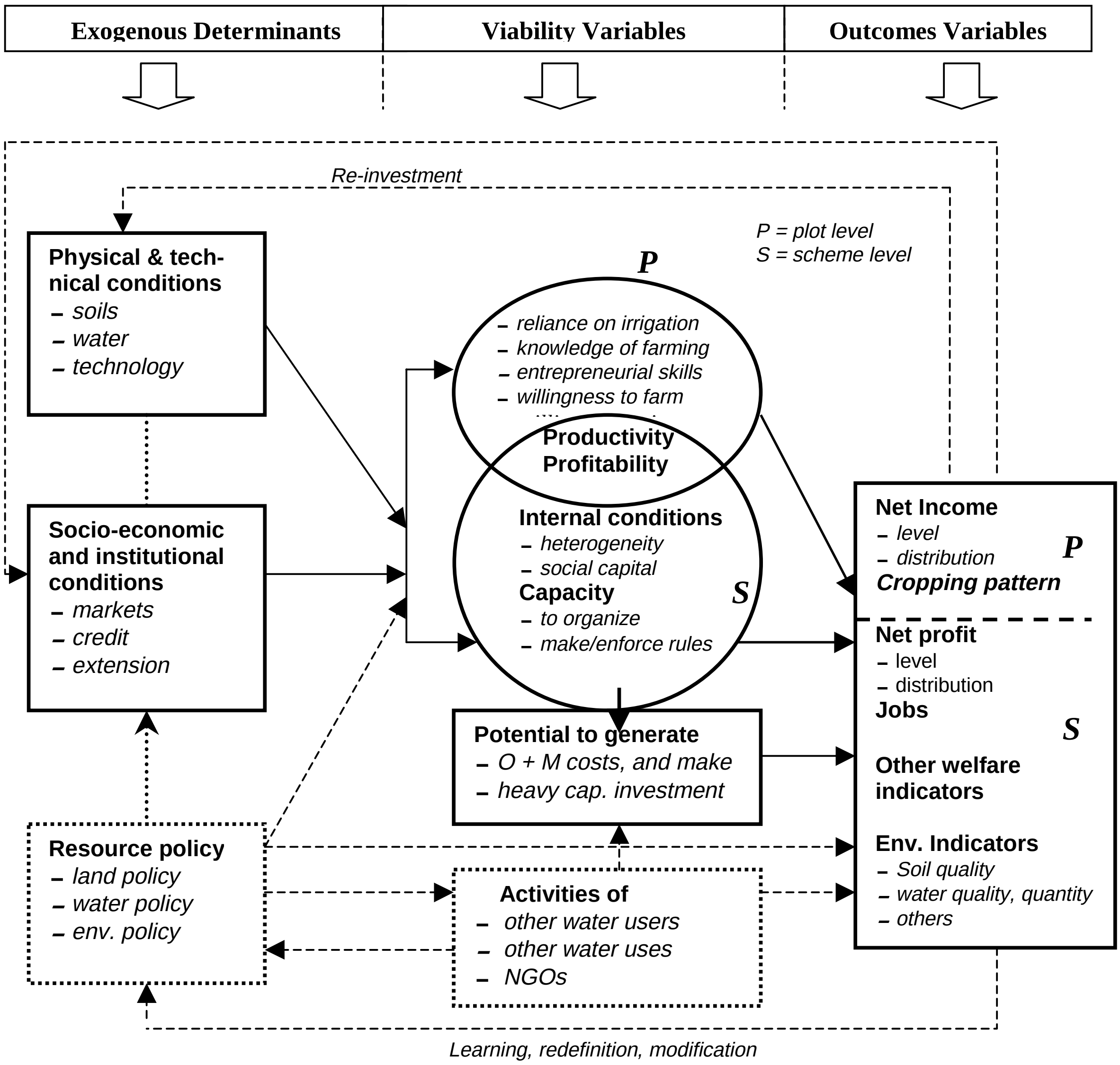

Figure 1: A Framework for Analyzing the Viability of Small-Scale Communal Schemes

costs of sustainable self-management and reliance of the farmers on irrigation. In particular, the authors assert that for the process of IMT to succeed, it must satisfy the following conditions:

- hold out a promise of significant improvement in the life-situations of a significant proportion of the farmers involved in the process;
- irrigation must be central to creating such improvement, i.e. a large proportion of the income of the farmers must come from irrigation;
- the cost of sustainable self-management must be acceptably a small proportion of the improved income; and that
- transaction costs of the proposed organization must be relatively low.

As depicted in the conceptual diagram above (Figure 1), the physical and socio-economic conditions of the scheme must be in harmony with the prevailing water management technology and irrigation system in the context of farmer management. These will influence key viability variables such as productivity and profitability at both the plot and scheme levels. At the plot level, productivity will largely depend on reliance on irrigation as income source, knowledge in farming and entrepreneurial capacity, investment initiatives and other household level variables. The driving hypothesis is that the role of these variables in influencing plot level productivity becomes more significant when the scheme is transferred to farmer management.

At the scheme level, viability will largely depend on the capacity to organize into water use associations, manage the organization, make and force resource use rules and regulations, and resolve emerging conflicts. This capacity is hypothesized to be affected by heterogeneity within the scheme in terms of plot sizes, income sources and social capital variables that enhance meetings and forums for discussing issues related to self-management. These variables will further affect the ability of the scheme to generate management and operational costs, and long-term potential to make heavy investments during periods of shocks. In addition, the activities of other water users such as mines, large scale farmers and NGOs will affect scheme viability, either directly through their production activities, which may affect water quantity and quality, or indirectly through lobbying and social net-working to shift policy variables in their favor. The effect of policy variables such as land policy, water and environmental policy is felt directly or indirectly at all levels of activity, while outcome indicators may lead to policy redefinition through learning and modification. The level and distribution of net income and net profits may result in investments in new technology, and improvements in resource conditions, as well as the provision of institutional and support services (markets, credits, training) that further enhance viability and sustainability of the scheme.

2.3. Data Sources and Analytical Methods

Secondary data were obtained from the ARDC for most of the schemes in Arabie. Due to the inconsistent and incomplete nature of the data, only six schemes[4] were considered in the preliminary analysis of the ARDC data – aggregate crop budgets and estimation of cost functions, net income and gross margins. As the ARDC data did not have any socio-economic component, primary data was collected in two of the six schemes, and intensive surveys further conducted in two of the only three schemes that are currently operational The final analysis was thus conducted with a sample of 64 farmers, selected from four schemes, two of which are completely out of operation since the ARDC withdrawal while two are still operational. Testing the hypotheses developed in the theoretical framework requires various levels of analysis, including regression estimations and production function analysis, benefit-cost analysis, scheme budgeting and linear programming at the whole scheme level. However, the above data only permits the first part of these analyses.

---

[4] The six schemes on which the ARDC data was used include: Veeplaats, Gataan (North), De Paarl, Vlakplaats, Vogelstruiskopje and Wonderboom. Intensive primary data was collected on Strydkraal and Krokodilheuvel. Other schemes in Arabie include, Mooiplaats, Haakdoringdraai, Goedverwacht, Nooitgezien, Coetzeesdraai and Hindustan.

3. DATA DEVELOPMENT, RESULTS AND DISCUSSION

The first part of the results presents an overview of production activities and distribution of gross margin across the selected schemes. This is followed by the socio-economic profile of the sample schemes, and the output from the regression analysis.

3.1. Overview of Production Activities in the Arabie Scheme

Table 1 summarizes recent production activities in the selected schemes. During the last few years of ARDC support, only maize and wheat were alternately produced on the schemes in summer and winter respectively[5], which was very much imposed. Production in the last years was rather spontaneous, with a very sharp reduction in area cultivated as well as number of farmers cultivating following the ARDC withdrawal. Aggregate mean yield across the sample schemes are very marginal, with the highest of 5,830 kg/ha for wheat is observed in Vogelstruiskopje (1997), and 4,072 kg/ha for maize observed in Veeplaats (1995/96). While wheat cultivation was virtually abandoned after ARDC withdrawal, maize yields have dropped significantly to about 1,440 kg/ha and 1,804 kg/kg for two of the three schemes that are still active. These results are quite similar to those recently obtained in Hindustan and Coetzeesdraai (Tren and Schur, 2000). Many of the schemes produced at a loss (negative gross margin) even while the ARDC was still in operation especially after the mid-1990s.

Table 1: Recent Crop Production Trends in the Schemes

		Overview of Production Activities Across Selected Schemes (1995 – 2000)							
Scheme	Year *Crop*[b]	*Cultivated Area (ha)*	*No. of Farmers (N)*	*Yield Kg/ha*	*Total harvest (kg)*	*Gross income (R)*	*Total Prod. costs(R)*	*Net income (R)*	*Gross Margin R/ha*
Veeplaats[a]	1995/w	55 [430]	22 (172)	3,552	195,360	152,907	89,688	63,219	1,149
	95/96/m	275 [430]	106(172)	4,072	1,121,520	795,998	316,069	419,929	1,525
	1996/w	278 [430]	107(172)	3,617	1,006,570	902,691	477,883	424,808	1,525
Gataan (North)	1996/w	42 [75]	35 (180)	4,902	211,760	165,014	43,452	121,562	2,814
	96/97/m	62 [75]	50 (180)	1,850	115,051	75,495	59,043	16,451	265
	1997/w	53 [75]	43 (180)	3,987	209,760	57,320	77,689	79,631	1,514
De Paarl	1996/w	59 [63]	46 (151)	3,054	176,951	37,889	117,489	20,399	352
	96/97/m	55 [63]	45 (151)	897	49,506	32,488	41,679	-9,186	-166
Vlakplaals	1997/w	34 [74]	28 (66)	3,985	135,200	101,400	82,538	18,862	556
Vogelstr.	1997/w	68 [119]	55 (96)	5,830	397,680	298,260	302,108	-3,848	-56
Wonderb.	1997/w	109 [115]	86 (92)	4,439	483,760	362,820	254,654	161,879	1,485
Strydkraal	99/00/m	21* [403]	16[c] (277)	1,806	36,960	46,200	55,152	-8,952	-437
krokodilh.	99/00/m	13* [242]	12[c] (--)	1,440	18,800	18,800	18,797	2.11	0.16

[a] on going peanut, wheat and potato production since early in 2001 by a certain large, white commercial farmer.
[b] wheat is usually grown in winter (May – October) and maize in summer (August – February)
*based on a sample of 16 and 12 farmers respectively; [c] sample only.
( ) = total number of farmers on scheme; [ ] = scheme area; US $ 1.00 = approximately R8.30
[b] *w* and *m* stand for wheat and maize cultivation respectively; N = number of farmers cultivating.

While some of this is attributed to natural disasters such as floods on some schemes (especially in 1996), current gross margins in Strydkraal and Krokodilheuvel seem to be even worse than the ARDC period

[5] Cotton production was introduced in some of the schemes (Veeplaats and Goedverwacht) under contract by LONRHO in 1998/1999 but the program has been long abandoned. In Veeplaats, the entire scheme is currently operated by a certain white commercial farmer under arrangement with the local chief (Kgoshi) but with compensation to some farmers who hold the PTO (permission to occupy) on the land. However, some claim that the process is not legitimate and that they are not receiving anything. Employment of PTO owners as laborers on the farms was also promised. Many are currently working as laborers while others claim to have been dismissed in favor of more productive laborer from elsewhere.

(Table 1). Although local extension agents attribute this to a general under-use of inputs since the ARDC departure, it may also refer to a general lack of interest or care in performing other yield enhancing farm operations, and partly due to high cost of mechanized farm operations such as land preparation which is now in the hands of individuals since the ARDC departed. Although one could expect a reduction in costs during this post-ARDC period due to the disappearance of ARDC's storage, marketing and insurance levies, high ESKOM electricity bills after ARDC departure could also have contributed to a collapse in some schemes. Currently, regulation of water services (distribution, fee collection, etc.) is largely in the hands of the Department of Agriculture through the local extension agents. Fees are only collected for electricity for pumping water on a plots basis – no volumetric charges. Of the three schemes currently in operation, only Strydkraal (sprinklers) and Krokodilheuvel (partly dependent upon pumps) pay water charges. Coetzeesdraai uses flood irrigation and therefore does not pay electricity charges.

3.2. Distribution of Gross Margins Across Schemes

Although most the schemes were generally producing at a loss during the last ARDC days and some are still doing so, the distribution of gross margins across schemes indicates a great diversity among farmers within schemes – some were doing fairly well while other were performing poorly. The same trend is also observed on the schemes that are currently in operation. These trends are highlighted in Table 2.

The level of heterogeneity (in net farm income) is quite high and varies from one scheme to another, and among farmers within a scheme. Nearly all the schemes exhibit coefficients of variation higher than 0.3, which indicate that the distribution of gross margin is highly skewed within each of the schemes. In at least four of the schemes (two of them currently producing), nearly 50% of the farmers produced at a loss (negative gross margins) while others got, on average, R 2,000/ha on the same schemes. This high degree of heterogeneity has serious implications for the formation the proposed water user association (WUAs) or legal entities that will take over the management of the schemes.

Table 2: Distribution of Gross Margins (R/ha) Across Schemes (1995 – 2000)

Scheme	*Year*[b]	*N*	*Min.*	*Max.*	*Mean*	*St. Dev.*	*CV*[a]
Veeplaats	1995/w	22	557	1604	1149	368	0.3207
	95/96/m	106	37	3543	1525	937	0.6144
	1996/w	107	428	2058	1525	489	0.3206
Gataan (North)	1996/w	35	1,146	4345	2814	816	0.2899
	96/97/m	50	-1,026 (22)	3049	265	1139	> 1
	1997/w	43	-1,464 (1)	2479	1514	663	0.4379
De Paarl	1996/w	46	-1,936 (16)	2460	352	1449	> 1
	96/97/m	45	-814 (27)	1859	-166	745	> 1
Vlakplaats	1997/w	28	-2,272 (6)	1950	556	1071	> 1
Vogelstruiskopje	1997/w	55	-3320 (27)	2650	-56	958	> 1
Wonderboom	1997/w	86	-1827 (12)	3445	1485	1211	0.8154
Strydkraal	99/2000/m	16*	-3670 (8)	2784	-437	1828	> 1
Crocodilheuvel	99/2000/m	12*	-1349 (7)	1786	0.162	800	> 1

[a] Coefficient of variation of gross margin among farmers within the scheme; US $ 1.00 = approximately R8.30
[b] w and m stand for wheat and maize cultivation respectively; N = number of farmers cultivating;
( ) = number of farmers with a negative gross margin. * = sample only.

The high heterogeneity (wealth, income levels) gives rise to different incentive structures for investment and preferences for institutions. This may lead to the emergence of interest groups that may influence the formation of the WUAs in their own interest, make the process less transparent, raise the level of transaction costs and increase the chances of failures. This could partly explain why the process of forming legitimate entities to take over the running of the schemes has been complex and is still showing little sign of success in the entire scheme. At the same time, it is relevant to inquire into alternative sources of livelihood for those entirely withdrawing from irrigation, and seek a rational explanation for those who continue to produce at a loss.

3.3. Socio-economic Characteristics of the Sample Farmers

The descriptive statistics indicate a low level of education among the farmers, a majority of whom are old people, with ages of between 53 and 61 (scheme averages), and maximum ages of around 90 years and above. About 56% to over 80% of these farmers (scheme averages)[6] are females with a strong reliance on non-farm income, most of them on pension schemes. Job opportunities in the mines (and perhaps cities) are more suited to men, which could partly be a reason this observation. This high proportion of female farmers may suggest that the future of the scheme is largely in the hands of women, while the dominance of old aged farmers raises critical questions about the future of irrigation farming in the area. For nearly all the households of the sample farmers, non-farm income (pensions, off-farm labor, etc.) by far exceeds farm income. Most of them claim not to be getting any credit, neither do many get support from their migrant husbands and relatives.

In nearly all the schemes surveyed, a considerable percentage of farmers possess livestock (cattle and/or goats), which is particularly important in Krokodilheuvel, Strydkraal and Wonderboom. These observations further support the hypothesis that "on-scheme" irrigation farming may in fact not be playing a very significant role in the income function of many of the farmers. In nearly all the schemes,

Table 3: Descriptive Statistics of Socio-economic Characteristics

Scheme	*Variable*	*Min.*	*Max.*	*Mean*	*Std Dev*
Strydkraal (n = 16)	Age (years)	37	97	61.4	16.6
	HH size	4	16	8,42	3.19
	Education of farmer (yrs)	0	8	2.3	3.03
	Farm income (R)	-4,697	1,960	-1,137	1,931
	Non-farm income (R)	0	7,800	4,010	3,294
Krokodil-heuvel (n = 12)	Age (years)	39	77	61.25	12.0
	HH size	3	15	7.42	3.32
	Education of farmer (yrs)	0	8	2.52	3.32
	Farm income (R)	-843	2,429	0.25	925
	Non-farm income (R)	0	12,960	6,577	4,177
Wonder-boom (n = 25)	Age (years)	23	96	56.48	19
	HH size	3	11	6	2
	Education of farmer (yrs)	0	12	4.2	4.52
	Farm income (R)	749	3,355	2,275	738
	Non-farm income (R)	0	1500	540	666
Veeplaats (n = 11)	Age (years)	37	73	53	15.25
	HH size	2	8	4.18	3.12
	Education of farmer (yrs)	0	10	4.18	1.83
	Farm income (R)	1,255	7,755	4,226	2,130
	Non-farm income (R)	2,400	9,000	6,360	2,166

US $ 1.00 = approximately R8.30

there is some form of spontaneous vegetable gardening along the canals, which they describe as "illegal gardening", which seem to be highly productive. Because every outsider fears that it is illegal, it is difficult to elicit reliable information on this through interviews, even though it was alleged that a majority of the farmers are actually involved in it. To many therefore, this spontaneous vegetable gardening (and home gardening in some schemes) combined with livestock keeping, and currently farm labor for commercial farmers (as in Veeplaats) may have become more attractive than investing in cultivation on the schemes after the withdrawal of ARDC support.

[6] Proportion of female farmers in sample: Strydkraal: 56 %; Wonderboon: 72%; Veeplaats: 73% and Krokodilheu.: 83%.

The issue is also complicated by the land tenure arrangements, which indicate that over 50% of the sample farmers that are currently producing (mostly women) do not have the PTOs (permission to occupy) registered in their name (current sample). The figure is much higher for the entire scheme (van Koppen and de Lange, 1999). Except for widowed females (and exceptional cases), PTOs are mostly registered in the names of males who quite often do not farm but pass the plot to the wife or some third party. Inheritance of PTO, which is possible under the communal property administration, also largely favors males. This situation of women being the actual farmers but titles being mostly in the names of men may also be creating disincentives to farming. Moreover, the situation of the farmers will get more complicated if, for instance, husbands threaten to claim parts of the harvest to which they have contributed nothing but the possession of a mere PTO, or if other PTO owners request for rents for plots in their name but farmed by others.

3.4. Output from the Regression Analysis

To assess the relative importance of the factors discussed so far, an ordinary least square regression model is developed and estimated, with net income per ha being the dependent variable. The model was estimated separately for the two sets of communities covered in the socio-economic surveys,

TABLE 4: Summary of Ordinary Least Square Regression Output[7]

Explanatory Variables	**Dependent Variable : Net Income per ha**					
	Strydkraal and Krokodilheuvel		*Wonderboom and Veeplaats*		*Pooled Estimates*	
	Coeff.	*t-value*	*Coeff.*	*t-value*	*Coeff.*	*t-value*
Age of farmer (yrs)	-14.527 (15.489)	-0.938	-10.376 (8.226)	-1.261	-4.104 (9.812)	-0.418
Sex (dummy)	78.265 (483.61)	0.162	74.518 (290.24)	0.257	620.756 (332.10)	1.869*
Land Title (dummy)	1124.92 (621.92)	1.809*	-95.924 (258.69)	-0.371	624.72 (346.95)	1.801*
Education of farmer (years)	148.034 (79.780)	1.856*	-74.203 (37.272)	-1.991*	53.230 (46.241)	1.151
Family size	-193.931 (78.279)	-2.477**	39.446 (53.869)	0.732	-150.600 (48.268)	-3.120***
Plot size	603.421 (850.95)	0.709	512.595 (192.59)	2.662**	401.756 (309.63)	1.297
farm income as a % of total income	1.620 (3.430	0.472	22.651 (6.813)	3.324***	9.861 (2.905)	3.394***
% of harvest un-marketed	19.386 (15.843)	1.224	--		--	
Livestock (dummy)	87.796 (501.64)	0.175	-231.908 (255.38)	-0.908	-111.370 (342.64)	-0.325
Observations (N)	28		36		64	
R^2-Adjusted	0.41		0.89		0.56	

*; **; *** significant at 10%, 5% and 1% probability levels respectively.
( ) in parentheses are standard errors; -- variable excluded in equation;

[7] Dummy variables: Sex (1= female, 0 = male); Land title (1 = PTO in farmer's name, 0 = otherwise); Livestock (1 = possessing some livestock, 0 = no livestock).

representing different phases of development of the scheme. These include wheat production in Wonderboom and Veeplaats during the ARDC period, and maize in Strydkraal and Krokodilheuvel in 1999/2000 (post-ARDC). Only maize was produced in the second set of communities in the last years so an assessment of the hypothesized determinants of net income for the same crop (across schemes) was not possible. Also, given that the relative importance of these factors across schemes will vary from year to year, a pooled estimation of the entire data was further conducted in a single analysis. A summary of the estimates is presented in Table 4.

Overall, the results conform largely to the main hypotheses included in the conceptual framework. Most of the explanatory variables carry the expected signs. The important determinants of net income in all the estimations are possession of PTO in farmers name, education, reliance on farm income (farm income as a % of total income of the farmers), and to a lesser extent gender of the farmer. Proportion of farm income positively affects plot level performance. The coefficient is highly significant in two of the estimations while the third estimate also bears the expected sign but remains insignificant. This indicates that those who derive a higher proportion of their income from irrigation put more effort into it to maximize farm income. This is also confirmed by the dummy coefficient for the possession of livestock, which indicates that those with livestock are performing relatively poorly in terms of net income per ha from irrigation. The possession of PTOs in farmer's name is also positively related to net income per ha derived from irrigation. This relation is significant at the 10% probability level in the post-ARDC equation as well as in the pooled estimation, but remains negative and insignificant in the second equation (ARDC period). This may indicate that the possession of PTOs for women farmers has recently gained more significance in terms of incentives for farming than it was during the ARDC period.

In all the estimations, the dummy coefficient for gender, indicate that female farmers do better than males. This conform largely to the proposition (also in previous studies)[8] that women are more genuinely committed to irrigation farming in the Arabie schemes than men, and that the future of the schemes after IMT will largely be with the women. The few male farmers are either retired pensioners or males who lost their jobs in the cities (or could not find one) due to the increasing unemployment in the country. Most of these men are more reliant on their pensions, livestock or other means of subsistence than farming activities on the schemes. As hypothesized, the level of education, which may be related to knowledge in farming has a positive effect on plot level performance. However, the sign of the coefficient is inconsistent and needs further examination. Also, the significantly negative effect of household size on net income per ha requires further attention. One possible explanation is that of high dependency ratios, with most of the households having only one or two adult work force, with many children and old people to care for. It is likely that the migrant young generation (to the mines and cities) leave their children behind with the grand parents. This analysis, however, does not entail exhaustive data on household dynamics to quantify this assertion.

Plot size correlates positively with net income per ha in all the equations but as sizes do not vary much in the current sample (0.84 to 2.5ha), the findings need to be better substantiated in surveys that will entail a wider range of farm sizes. The market access hypothesis could only be tested in the first equation (ARDC marketed for farmers in its days). Market distance could not be used as a proxy as this is fairly uniform for farmers on the same scheme. Appraisal was made of un-marketed maize (which could not be sold) and inserted into the equation but no explicable relationship could be established. This issue also needs to be re-examined.

[8] See e.g. van Koppen and De Lange, 1999; Shah and van Koppen, 1999; Makhura and Mamabolo, 2000; Schreiner and van Koppen, 2000.

4. CONCLUSIONS AND POLICY IMPLICATION

The descriptive statistics reveal a high degree of heterogeneity among the farmers. This is true in terms of many variables especially net income derived from irrigation and non-farm income. This heterogeneity has important implications for the formation of WUAs, common property associations or other legal entities that are expected to take over the management of the schemes. Secondly, the analysis shows that there is a significant relation between having PTOs in farmer's name and plot level performance. The issue of PTOs being in the names of men while the actual farmers are women, which did not seem to be very relevant in the ARDC days (ARDC was the effective entrepreneur), is becoming increasingly important. It is extremely important to assess the number and types of people genuinely interested in irrigation farming on the schemes, and to distinguish these from those who are just "passing the time" or mere pretenders who have other more reliable income sources, but perhaps wanting to capture rents from development assistance by being part of the IMT process. The genuinely interested should be involved in processes of organization, and be vested with membership. Land reallocation at the start of the establishment of the new Water Users Association may be considered.

As noted by other studies (also emphasized in the draft revitalization policy), the issue of market access needs attention as large quantities of maize produced by farmers (especially in Strydkraal) rots away un-marketed, neither do the farmers have the processing technology that makes it readily available for consumption. One female farmer in Strydkraal emphasized that "we would rather leave the product unharvested, than use more labor to harvest and thresh only for it to rot away unsold". Finally, the spontaneous vegetable gardens along the canals, the so called "illegal gardens" need to be assessed for their potential of generating income and improving immediate food security. If vegetable production on the schemes is what the farmers prefer to the traditional maize/wheat rotation, especially on these very small plots, then let is be prioritized.

REFERENCES

Brewer, J. et al. (1999), Irrigation Management Transfer in India: Policies, Processes and Performance. Indian Institute of Managements, Ahmedabad, India, and the IWMI, Colombo, Sri Lanka. Oxfod and IBH Publishing Co. Pvt. Ltd.

Lahiff, E. P. (1999), Land Tenure on the Arabie Olifants Schemes. South African Working Paper No. 5. IWMI, Colombo, Sri Lanka.

Makhura, M. and Mamabolo, M. (2000), Socio-economic Issues in Small-Scale Irrigated Agriculture: A Literature Survey of the Olifants Basin, RSA, and SADC. Report to IWMI, Sri Lanka.

Schreiner, B. and van Koppen, B. (2000), From Bucket to Basin: Poverty, Gender and Integrated Water Management in South Africa. Workshop on Integrated Water Management in Water Stressed Basins: Strategies for Poverty Alleviation and Economic Growth. October, 2000.

Shah, T. and van Koppen, B. (1999): Water Management Research Issues in Northern Province, South Africa: Field Notes from Arabie Irrigation Scheme in Olifants Basin. Trip Report. IWMI. Colombo, Sri Lanka.

Shah, T., et al. (2001), Institutional Alternatives in African Smallholder Irrigation: Lessons from International Experience in Irrigation Management Transfer. IWMI Draft Working Paper.

Svendsen, M. (1992), Assessing Effects of Policy Change in Philippine's Irrigation Performance, Working Paper on Irrigantion Performance 2, IFPRI, Washington, D. C., USA.

Swendsen, M. and Nott, G. (1997), Irrigation Management Transfer in Turkey: Early Experience with a

National Program Under Rapid Implementation. IWMI, Colombo, Sri Lanka.
Tren, R. and Schur, M. (2000): Olifants River Irrigation Schemes. Reports 1 & 2. Working Paper 3. South Africa Working Paper No. 5. IWMI. Colombo, Sri Lanka.
Van Koppen, B. and De Lange, M. (1999), Irrigation Management Transfer in the Arabie/Olifants Scheme, Summary findings of an Appraisal. *. IWMI, Colombo, Sri Lanka*. Van Zyl, J., Kirsten, J. and Binswanger (eds) (1996), Agricultural Land Reform in South Africa: Markets, Policies and Mechanisms. Cape Town. Oxford University Press.
Vermillion, D. (ed) (1996): The Privatization and Self-Management of Irrigation: Final Report. IWMI, Colombo. Sri Lanka.