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Technology Transfer for Development: Insights from the Introduction of Low Cost Water Well Drilling Technology to Uganda

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Abstract

Third World development theory and practice are changing so rapidly that it is important to critically examine the fashions of today before they become history. This thesis considers the development, transfer, early adoption and sustainable use of technology, coupled with private sector participation in rural water supply provision.

Improving water supplies for rural communities is one of the key challenges faced by development interventionists today. Lack of low cost, off the shelf technology for local enterprise which can provide affordable shallow wells for rural communities is one barrier to facilitating improvements.

This thesis is based on research undertaken in Uganda to develop and transfer low cost water drilling technology in the context of decentralisation and privatisation policies. An extensive range of literature has been drawn together into 16 principles which guide technology transfer and development intervention. These principles are re-examined in the light of analysis of first hand experiences of undertaking a technology transfer project and interviews with stakeholders regarding their attitudes and perceptions.

The research found that technology transfer is a cross-disciplinary and cross cultural process in which the linkages between the technology, context, individuals, organisations and beneficiaries need to be firmly established. Ugandan business and local Government culture plays a major role in facilitating successful technology uptake. Dealing with the risks associated with low cost groundwater technology is fundamental for its wider adoption. The *process* of technology transfer is important, particularly as high levels of stakeholder participation may compromise the delivery of outputs, at least in the short term.

In terms of future challenges, this thesis shows that, culture, governance and equity need to be closely examined in relation to private sector participation in rural infrastructure provision. Private sector participation can conflict with community participation. How to adequately support innovation in Sub-Saharan Africa while harmonising development interventions is a challenge to the development community.

Dedication

für Papa

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Firstly, I would like to express my thanks to Professor Richard Carter, for his unfaltering support, encouragement and guidance on this research journey. It has been an honour to be supervised by someone with such dedication.

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The Pounder Rig in Operation

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1 Introduction

1.1 PREAMBLE

Since the birth of the concept of Third World[1] development in the 1950s politicians, economists, engineers and social scientists have endeavoured to bring about social change and human progress in these countries. However, upon examination of the array of development goals and approaches which have been tried, and in many cases abandoned, one is left with the impression that the purpose of development was not always in the interests of local people, and was sometimes not even clear to the decision makers and practitioners.

Although there have been changes in the focus of development, as well as different approaches, there has been a tendency to search for a silver bullet which will solve *"the problem"*. However, the silver bullet seem to be as elusive as the pot of gold at the end of the rainbow, or, if found at all, considerably case specific. Technology transfer was and is one of these elusive silver bullets, while participative approaches and private sector involvement may prove to be others. However, given the fact that all of these can provide some success stories, they surely must contain something from which we can learn.

This thesis sets out to provide insights into development through the analysis of a project concerned with low cost groundwater technology development for Uganda. The project combined technology transfer with stakeholder participation and involved the private sector. The insights provided are used as a basis to reflect upon development intervention. The thesis draws upon an extensive range of literature and first hand experience of implementing a research and development project in a Third World country. The project provided an action research environment for the work presented. Thus, mainstream development thinking is illuminated through reflection upon the

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[1] The term "Third World" has connotations of inferiority, and groups together a vast diversity of peoples and environments (de Haan, 2000) while some consider the term redundant given the collapse of communism. In this thesis the term is used as it was intended within "Les Trois Mondes" which grouped countries into capitalist (First World), communist (Second World) and ex-colonial, newly-independent, non-aligned countries (Third World) (Worsley, 1984).

practical experience of a project, and the findings from the project are given wider significance within current development thinking.

The background to the project is that improved access to safe water is now considered a crucial aspect of development intervention. Global targets to halve the number of people without access to clean drinking water by 2015 have been signed up to by the United Nations and numerous national Governments (United Nations, 2000a; United Nations, 2002). An estimated 1.2 billion people living in the Third World do not have access to clean water (United Nations, 2001). This, coupled with an estimated population growth in Africa of 2.41 % (UNPD, 2002:163) illustrates the need for considerable input if the millennium targets are to be met in Africa. However, funding for improved water supplies is limited and heavily dependent on foreign aid or debt relief and competes with other sectors such as education and primary health care.

Groundwater is considered to have great potential to provide safe water in sub-Saharan Africa, particularly for sparsely populated rural areas (Carter, 1988). However, the cost of providing contractor-drilled boreholes in sub-Saharan Africa is very high due to the high equipment and labour costs, lack of competition and a small market. Alternative, low-cost drilling methods could increase the viability of providing groundwater sources in the region but they are limited by a number of factors. Hydrogeological factors call for careful technology design and the use of high quality materials; economic factors call for affordable technologies; social and institutional factors call for appropriate support mechanisms. Not only do the above inter-relate, but there may be additional factors which require consideration. Improving access to safe water supplies through low-cost appropriate drilling technology thus requires consideration of a wide scope of issues.

July 1998 saw the start of the three year participatory action research project entitled *"Private Sector Participation in Low Cost Water Well Drilling in Africa"*. Funded by the Department for International Development (DFID), under their Knowledge and Research (KaR) scheme, and later joined by other funding bodies, the project was led by Cranfield University at Silsoe. The project set out to *design* a new, low-cost water well drilling rig, bring about its *manufacture* in Africa, and its *uptake* by small, local contractors. The project was undertaken in the UK and Uganda, with the centre of gravity shifting from the UK to Uganda in the second year. The Government

of Uganda (GoU), at both local and central levels, several small Ugandan commercial enterprises and non-Governmental organisations (NGOs) as well a UK commercial enterprise participated in the project. I worked full time on the project, including one short visit to Ghana and Kenya and two to Uganda in the first year, followed by living and working in Uganda as the team leader for the remainder of the project.

The project provided the vehicle from which to undertake the research presented in this thesis. Through first hand experience of the project, I developed an intimate knowledge of the issues analysed in this work. The current mainstream development concepts of sustainability, participation, empowerment, ownership, public-private partnership, poverty alleviation, appropriate technology and the link between national policy and grass roots implementation formed key aspects of the project. They were tackled by the project team, and are reflected upon in this thesis. This thesis thus contains insights for future developmental interventions, although these insights are not intended to be blueprints.

1.2 THIRD WORLD DEVELOPMENT

1.2.1 Background

It was after the end of World War II, when many colonies gained independence, that modern development theory was born. Since then a myriad of organisations, Governments and academics have all played their part in shaping developmental thinking and action throughout the world. This has influenced the way that Third World countries are perceived by others as well as by themselves.

The conceptualisation of development has generally been influenced by trends set by the ideologies and cultural values of those with power and influence. Early development theories such as *modernisation* and *classical Marx inspired theories* of the 1950s and 1960s tended to generalise in their approaches (Hulme and Turner, 1990). These theories concentrated on structural changes in the economy, state and social system (Pieterse, 2001). Latterly, diversity has been highlighted resulting in a greater variety of localised approaches, and questions regarding the type of development are being asked, resulting in a re-evaluation of development goals.

However *"at a time when there is widespread admission that several development decades have brought many failures, while the development industry*

continues unabated, there is a continuous and heightened self-correction and a persistent pattern of co-option of whatever attractive or fashionable alternatives present themselves" (Pieterse, 2001:79).

The concept of development is dynamic; ever changing with ideas new and old being taken up, while others are dropped suddenly or fade away quietly. Yet all the while, there is a tendency for development practitioners to be sure that their goals and approaches, while in progress, are the correct solutions to the correct problems.

1.2.2 Development Theory

The theory of development has been dominated by two main schools of thought, **modernisation** theory, which rose to prominence in the 1950s and 1960s, and **underdevelopmen**t theories, in particular *dependency* theory, which entered the development arena in the 1960s. Development thinking has continued to change both beyond and within these theories, with the rise of alternative development in the 1960s (Pieterse, 2001). Since the 1950s, *"development thinking has been ... state led (classical political economy, modernisation, dependency), market-led (neoliberalism) and society-led (alternative development) ..."* (Pieterse, 2001).

Modernisation theory, influenced by Durkheim (1893) and Weber (1905, 1919, 1920), is primarily based upon a distinction between traditional (rural, backward and agricultural) and modern (urban, advanced, industrial) societies (Webster, 1990). This, combined with an extension of Darwinian theory to social evolution has equated economic growth with development. Modernisation theory considers that industrialisation as well as the diffusion of ideas and values from the West, in particular the entrepreneurial ethic, innovation, rationality and achievement orientation provide the blueprint route to development (Webster, 1990). It was believed that these were the key to the development of capitalism in the West. This theory, exemplified by Rostow's (1960) *Stages of Growth*, with mass consumption as the ultimate in human progress, provides the basis for the conceptualisation of non-industrial societies as underdeveloped. This conceptualisation has rendered ancient centres of civilisation to be considered as being poor in a cash sense as well as in the values and ideas required for modernity. Cultural attributes such as the intimacy of family and community life and traditional artistic achievements are seen as primitive and backward. Lack of

modernity is considered to be primarily a result of barriers caused by internal socio-economic systems rather than external forces (Webster, 1990).

Underdevelopment theories consider class conflict and the inequalities of power as key components in influencing social change and development. These theories take into account the economic distortion of the Third World due to the historical processes of merchant capitalism, colonialism and neo-colonialism which have enriched the capitalist societies of the West at the expense of the Third World. There are several linked, but different perspectives under the umbrella of *underdevelopment.* One version is Frank's dependency theory which holds that these countries remain in a continual state of poverty because riches are siphoned off from the poor countries to the rich. *"It is capitalism, world and national, which produced underdevelopment in the past and still generates underdevelopment in the present"* (Frank, 1971:1). This background has provided a route out of exploitation, inequality and underdevelopment which involves the removal of the bourgeoisie and establishment of a self-reliant socialist state (Webster, 1990).

Lipton (1977), contributed to *underdevelopment* theory with his thesis regarding the 'urban bias', which holds that development occurs from and for the people in cities who are corrupt and parasitical towards the "internal colonies" of the rural areas, and that local capitalist classes serve global, rather than national interest. In providing evidence for this, he includes the vast difference between the access to the fruits of development by the prosperous in the cities, in contrast to the poor in the rural areas. Lipton's work provides a direct challenge to modernisation theory by advocating the development of efficient, low cost and self-reliant rural agriculture rather than industrialisation (Webster, 1990).

Booth (1995) perceived an ‘impasse’ in development theory in the 1980s as dependency theory failed to deliver an alternative to modernisation theory. This became a landmark in development teaching (Munck, 1999). Many texts have been written in recent years which call for rethinking of ‘development’ and a move beyond the ‘impasse’ (Munck, 1999).

The late 1980s saw ‘post-development’ approaches flourish, which cluster around alternative- and anti-development. "***Alternative*** *development has been concerned with introducing alternative practices and redefining the goals of*

development" (Pieterse, 2001:74, my emphasis) . It has been associated with a variety of movements including anti-capitalism, environmental protection, feminism, Buddhist economics and appropriate technology. Alternative development tends to be practice oriented, rather than theoretically inclined (Pieterse, 2001), and a coherent definition is not possible. The diversity of ideas and concepts within alternative development, coupled with its practical foundations, account for this approach not to be considered as a theory. Pieterse (2001) considers alternative development to hold pertinent positions on the development agency (a preference for community led development); the development methods (a preference for participatory, endogenous and self-reliant methods); and development objectives (such as basic needs and conservation). There is less of a clear perspective on the macro-micro interface, or alternatives to macro policy than in mainstream development theories. Although alternative development can be considered as a challenge to mainstream development, many aspects of alternative development are now well entrenched into the mainstream, such as basic needs, participation and sustainability. This is illustrated by Rogers' (1995:127) definition: *"Today **development** is defined as a widely participatory process of social change in a society intended to bring about both social and material advancement (including greater equality, freedom and other valued qualities) for the majority of people through their gaining greater control over their environment".*

Anti-development thinkers are very sceptical about the whole development process and in some cases abandon the idea. Take Wolfgang Sachs (1995:10) as an example: *"[t]he word [development] always implies a favourable change, a step from the simple to the complex, from the inferior to the superior, from worse to better ... but for two thirds of the worlds population it is a reminder of **what they are not**. It is a reminder of an undesirable, undignified condition. To escape from it, they need to be enslaved to others' experiences and dreams".* Sachs (1995) argues that "development" was invented to cover the US domination of the Third World. Anti-development is not without its critics. For example Munch (1999:203), who argues that the *"self-righteous tone of much of this [anti-development] literature says more about the authors than about the problems of underdevelopment (however defined) which cannot be simply wished away".*

The conceptualisation of development as change which should come from within the Third World, rather than be applied to it from the First World is shared to a certain extent by alternative and anti-development thinkers.

1.2.3 Development Policies and Agencies

Introduction

National Governments of the Third World have focused on their own *development* (including economic growth, industrialisation and infrastructure improvements), Governments of Euro-America have disbursed aid both to support and influence the process, diverse non-governmental organisations (NGOs) are involved in development efforts and international finance institutions such as the World Bank and intergovernmental organisations such as the United Nations are involved in the process. The latter three comprise many organisations established explicitly for the purpose of development. This section takes a closer look at the changing policies and the agencies involved in development since its conceptualisation in the 1950s.

Development policies and the agencies involved have been influenced by social development theories. For example, Nyerere's policies in Tanzania towards self reliance were a form of socialism, while socialist development practices have been followed in Cuba and Guinea-Conakry (Rist, 1997) and Ethiopia. However, Hulme and Turner (1990) consider economics to have taken (and retained) *"the dominant position in relation to its influence on the practice of development"*. This view is echoed by Chambers (1997): *"among disciplines and professions concerned with poverty, deprivation and development, economics is the most influential"*. Bauer (1983, 1984), Balassa, (1971, 1981), Little (1984), Little et al (1974) and Lal, (1993, 2000) are examples of economists who have influenced development practice.

1950s

The first *Report on the World Social Situation*, published by the UN in 1952 described the existing social conditions in the Third World and provided inspiration to proponents of programmes to deal with the immediate concerns of poverty and provide relief through basic social services and the caring professions (Sachs, 1995:12).

However, these concerns were overshadowed by the mainstream development policy dogma of that time, the modernisation theory of the 1950s and 1960s.

Modernisation asserted that following the path to change set out by the industrialised nations in conjunction with political and economic nationalism would lead to development of the Third World (Gore, 2000). The dominant paradigm of development at that time comprised the following four main elements:

(i) *economic growth* through industrialisation and accompanying urbanisation, approximately mimicking the Euro-American Industrial Revolution;

(ii) capital-intensive, labour saving *technology*, mainly transferred from industrialised nations, with the capital provided by national Governments, local entrepreneurs, international loans and through multinationals;

(iii) *centralised planning*, mainly by Government economists and bankers in order to speed up the process of development;

(iv) *the causes of underdevelopment*, believed to lie mainly within the developing nation rather than in their trade or external relationships with industrialised countries (Rogers, 1995 & 1976).

When the required social structures did not materialise to support the externally introduced material technologies, the blame was placed upon "traditional" ways of thinking, beliefs and social values. There was a firm adherence to individual-blame as well as on inadequate internal social-structures (Rogers, 1976).

While modernisation theory was considered to be the panacea for development, national Governments, with intergovernmental financial backing, were the dominant players in the field of development. Development came in the form of large scale technology transfer. In fields from water supply to agriculture, top down, Government service provision was the order of the day, albeit for the benefit of predominantly urban minorities and the rural elite.

1960s

The *Proposals for Actions* of the first UN development decade (1960 - 1970) established that development was not just a problem of quantitative growth but also of social, cultural and qualitative change (Sachs, 1995:13). Social development was seen as a precondition for economic growth, rather than an end in itself. The technology-dominated development model was not providing the desired effect by the late 1960s.

For example, the impressive increase in crop yields during the Green Revolution was accompanied by an increased socio-economic gap between large and smaller farmers. In water and sanitation, low-income groups were being excluded and marginalised from the applied models of service delivery and expansion (Black, 1998).

Disenchantment with the growth and structural change development model, coupled with disillusion with corrupt, bureaucratic Governments, and a desire for self-help spawned the birth of many civil society and non-government organisations, which have continued to increase in number from the 1960s to today. These have tended to operate at grass roots level, trying to provide local basic services such as primary health care, access to potable water and appropriate technology for local people. Broadly speaking, these organisations fall under the umbrella of alternative development. The mainstreaming of participatory approaches and pro-poor objectives has been partly fuelled by organisations operating at grass roots trying to address the issues overlooked by Governments and international finance institutions as they focused on economic growth and industrialisation.

1970s

Influenced by underdevelopment theory as well as the evidence from failed development, environmental concerns and the oil crisis, the 1970s provided a challenge to the focus on economic growth with structural change for development (Rogers, 1976). The mid 1970s included talk of a change in the main model of development to include equity, quality of life, integration of the modern and traditional, appropriate technology, self reliance, participation and the consideration of external as well as internal causes of underdevelopment (Rogers, 1976). *The Basic Needs Approach*, introduced through the International Labour Organisation in 1976 advocated the achievement of a certain minimum living standard before the end of the twentieth century and proposed to deal directly with absolute poverty rather than expecting it to be solved by the development process (Esteva, 1995:15). In the Second Development Decade of 1970 to 1980, McNamara, the head of the World Bank from 1968 to 1981, insisted that there should be more than gross measures of economic growth to measure development (Sachs, 1995:13). In practice little changed at macro policy level. However this was the precursor for the International Development Targets (IDTs) and the Human Development Indicators of today.

The dominant approach to development from the early 1980s which was propagated by the World Bank and International Monetary Fund (IMF) is referred to as the *Washington Consensus* and has shifted policies from being state-led to market-oriented. The recommendations of this approach are "*that Governments should reform their policies and in particular:*

(a) pursue macroeconomic stability by controlling inflation and reducing fiscal deficits;

(b) *open their economies to the rest of the world through trade and capital account liberalisation;*

(c) *liberalise domestic product and factor markets through privatisation and deregulation*" (Gore, 2000).

This approach to development focuses on the promotion of Gross Domestic Product (GDP) growth, with top-down implementation led by outside experts. As within modernisation theory, economic growth is considered to be the goal of development, albeit within a liberal economy.

1980s

The 1980s saw *structural adjustment* at the forefront of development. *"There must be adjustment it was said, and later there can be development..."* (Rist, 1997:171). The budgetary cuts which formed part of the adjustment process often resulted in drastic cuts in subsidies and health and education benefits while alternative development was undertaken through humanitarian initiatives of UNICEF and many NGOs (Rist, 1997).

1990s

The *Washington Consensus* started to be challenged in the late 1980s, on a number of fronts. Firstly, the concept of sustainable development challenged the pursuit of economic growth. Questions were initially strongly raised by the Club of Rome, who had published the *"Limits to Growth*" in 1972 (Meadows et al, 1972). This argued that if exponential growth continued for ever, it would terminate in some kind of catastrophe. The accompanying message was that growth should be replaced with no growth. This heralded a new concept in development (Mitcham, 1995) formed against a background of environmentalists advocating no, or limited growth, and economists advocating development and more growth. The link between environmental protection

and economic growth and development was established in mainstream development (Mitcham, 1995), and the solution proposed was that of *"sustainable development"* which promotes growth, but with limits.

The second challenge to the *Washington Consensus* was the increased focus on poverty and the poor. The lack of impact of the long awaited trickle down effect of macro-policies to the poor was no longer tolerated. Several international NGOs and pressure groups have become very active in advocating for change in the policy of the international financial institutions. The introduction of the *Basic Needs* approach in the 1970s followed by the work of Amartya Sen (eg Sen, 1985) on capabilities and entitlements in the mid 1980s had contributed to a redefinition of the understanding of development to that of entitlements. This has led to Human Development which considers the enlargement of people's choices, human capacitation and the importance of basic needs, health, literacy, education and housing (Pieterse, 2001).

It was the first World Summit for Social Development in Copenhagen in 1995 which officially recognised the harmful effects of the International Monetary Fund Structural Adjustment Policies (SAPs) and committed itself to *"...ensur[e] that when structural adjustment programmes are agreed to they include social development goals, in particular eradicating poverty..."* (United Nations, 1995: Commitment 8). This call for poverty reduction, rather than blind economic growth to be placed at the centre of International Monetary Fund policies resulted in the replacement of SAPs by the Poverty Reduction Strategy Papers (PRSPs). Although these recognise poverty, they have been heavily criticised for making the receipt of debt relief through the Highly Indebted Poor Country (HIPC) Initiative conditional on the liberalisation of the economy and privatisation (Abugre, 2000). Further criticisms include the focus on economic growth without addressing redistribution to the poor (Kjell, 2001).

End of the 20th Century

There appears to be a contradiction in the response emerging from the World Bank and others in mainstream development to the challenges faced by the *Washington Consensus*. There is the *Washington Consensus* on one hand which continues to advocate accelerated economic growth through structural reform. Meanwhile the other hand encourages human development goals and alternative development methods, in particular programmes with a direct intervention in the health and education of the poor.

Although the true development motives of organisations such as the World Bank and donors may be questionable, human development goals and alternative methods now tend to be argued on ethical grounds, rather than within the Cold War rhetoric used prior to the fall of the Berlin wall. Powerful contrasts such as while men travel to the moon, and the human genome is decoded, an estimated 2.2 million people, most of them children, die annually from disease associated with inadequate safe drinking water, inadequate sanitation and poor hygiene (WHO/UNICEF, 2000) are common place. This is reflected in Clare Short's (Secretary of State for International Development, UK) foreword to the UK White Paper *Eliminating Poverty* (1997): *"It is our duty to care about other people, in particular those less well off than ourselves. We have a moral duty to reach out to the poor and needy"*.

2000

At the UN Social Summit +5, in Geneva in 2000, UN member countries made a new commitment to eradicate poverty, address unemployment and promote social integration. The eradication of poverty was placed at the centre stage of national and international policy agendas (United Nations, 2000b). Poverty means different things to different people. In Farsi, more than 30 words are used to name people who are poor for one reason or another (Rahnema, 1995b) but most of the development work associated with poverty has been based on consumption, or income. Recently, the concept has broadened and the World Bank now includes hunger, lack of shelter, being sick and not being able to see a doctor, not being able to go to school, illiteracy, unemployment, fear of the future, powerlessness, lack of representation and lack of freedom within its definition of poverty (World Bank, 2000). The Human Development Index (HDI) has become an influential standard within mainstream development.

The International Development Targets (IDTs) of halving the proportion of people living in extreme poverty by 2015; reducing infant and maternal mortality by 2/3 and 3/4 respectively; ensuring that there is universal primary education for boys and girls and to halving the number of people unable to access safe drinking water (OECD, 1996 & United Nations, 2000a) have the explicit purpose of freeing men, women and children from poverty. The Organisation for Economic Co-operation and Development (OECD) targets of *environmental sustainability and regeneration* by implementation of sustainable development strategies by 2005 to reverse loss of environmental resources

by 2015 (OECD, 1996) place environmental protection centrally. The IDTs have been widely accepted with poverty eradication, equity, vulnerability of livelihoods and sustainability as the purpose of development intervention. (Farrington and Lomax, 2001).

The IDTs have influenced Government policies of at least the UK (1997), Denmark (2000) and Canada (2000). Following their incorporation into the UK Government's White Paper on International Development, (UK, 1997), there has been a significant pro-poor bias in many of the UK Department for International Development (DFID) funded projects and it is firmly embedded in the Livelihoods Approach.

Mainstream development policy continues to widen in scope from its former focus on economic growth. Further issues on the agenda are those of democratisation, good governance, empowerment, gender, globalisation and sustainable development.

Conceptually and politically at least, the development of the 1990s has taken on the form of *sustainable development* "for our common future" and comprises approaches which are considerably less top down than before. *"[Sustainable development] is an ideal which now guides much of contemporary thinking about, and public policy with regard to, science and technology...[and, along with ideals such as] love or patriotism, points towards something necessary and even noble*" (Mitcham, 1995). "*We are finally waking up to the fact that our global resources are limited. The concept of sustainability is drawn from the environmental movement and increasingly used in economics and management. It reflects a concern to husband resources wisely and to manage production and organisation in a self-perpetuating fashion"* (Osborne, 2002).

The concept of sustainability is interpreted in a variety of ways, both at macro and micro levels and criticisms of its usefulness are abundant. Mitcham (1995) criticises the inflation of the term 'sustainability' as leading to a 'plastic word', ie a word which can mean almost anything to anybody. He argues that interpretations of 'sustainable development' depend on the political agenda of the interpreters and concludes that sustainable development has become a synonym for what we in the west do not want to give up and thus calls for its philosophical criticism. This is echoed by Esteva (1995), who maintains that the mainstream interpretation of sustainable development is actually a strategy for sustaining *development*, rather than a way of

supporting the *"flourishing and enduring of an infinitely diverse nature and social life"*. Esteva (1995) considers the interpretation of sustainability as a minor adjustment of the goals of development to include placing more emphasis on the desired outcome of longer term impact.

The UNDP's sustainable human development approach *"...argues that the ultimate test of development practice is that it should improve the nature of people's lives, and advocates that it should be founded on participation and a more equal partnership between developing countries and donors"* (Gore, 2000:759). DFID (1998) links sustainability with effectiveness, equity, efficiency and replicablity and points to the need for transparency when stakeholders undertake the political process of finding a resolution between these conflicting objectives.

NGO involvement has remained very high since their rise in the 1970s and 1980s. NGOs form an extremely heterogeneous group, with a range of objectives and practices. Although they tend to function outside Government control, they are still answerable to their funders, and are thus subject to their agendas, be they religious evangelical movements or participatory self-help biased. The amount of NGO assistance in the developing world is considerable. NGOs in Bangladesh, for example manage far larger budgets than local Governments (Sogge, 2002).

Coupled with calls for accountability, transparency and streamlining, there is a shift in emphasis back to supporting Governments once again, at least in those countries where Governments are considered worthy of such support. In many countries, bilateral donors such as DANIDA, SIDA and DFID are now co-operating with Governments to provide basic services, which tend to be highly subsidised for the financially poor. Furthermore, Governments of Third World countries are required to demonstrate commitment to poverty reduction if they are to qualify for debt relief under the Highly Indebted Poor Countries (HIPC) initiative. Thus the pressure to industrialise has been replaced by a focus on poverty alleviation through basic service provision. Economic liberalisation is also still high on the agenda and Governments are under pressure to privatise parastatals and contract out work including service provision**.**

The Sector-Wide Approach to planning (SWAp) is becoming increasingly important. SWAps are designed so that all public support (Donor and Government) to a sector is informed by a common vision and strategy, and implemented though a

common framework (Gilling et al, 2001). Donors and Governments collaborate by directing all donor funding within a sector to the national Government. The funds are subsequently used for programmes, rather than individual and dissipated donor-funded projects (MoFPED, 2000). Aid agencies are thus being drawn to supporting Government budgets which were previously by-passed in favour of grass roots organisations, NGOs, or were funded under very strict guidelines. In addition, the concept of participation is increasingly being applied to all levels. International agencies are being called on to change their role from project support to that of co-players with Government in the broader, political processes. Relationships between the two are expected to change, so that there is more ownership by partner countries, organisations and citizens (Chambers et al, 2001).

Despite the renewed interest amongst bilateral donors in the role of Governments, the macro policy, including the International Monetary Fund's Structural Adjustment Policies (SAPs) and the recently introduced policies of the Poverty Reduction Strategy Papers (PRSPs), of public sector streamlining is still being promoted strongly. In conjunction with this, there may be more emphasis on the role of Government, but it is expected to take the role of regulation. Service delivery is increasingly expected to be undertaken by the private sector in the form of various public-private partnerships.

1.2.4 Development Managers

Development managers are the individuals who work for development institutions such as local and central Government or NGOs. They run the development projects and programmes funded by their national Government or donors, and are thus part of the development process. Although the literature is not abundant with comprehensive analysis of how informed, enabled or constrained development managers are in their work, some insightful discussions and case studies have been published. The interpretation of strategies, professional norms, bureaucracy and resource constraints are issues that impact on the effectiveness of development managers, and thus on the development process. These issues, outlined below, are not exclusive but are presented to highlight the importance of considering the doers as well as the theories, policies and agencies when reflecting on Third World development.

Participative Rural Appraisal (PRA) is a developmental approach that is often demanded by donors and has consequently been introduced to NGO and Government projects and programmes. Despite the potential benefits of PRA to enable the needs of the rural poor to be heard, Chambers (1997:115) finds that the *"sudden popularity of PRA has generated huge problems and widespread bad practice"*. In particular, the institutional, behavioural and professional implications of PRA have not been understood, or, if understood, not internalised (Chambers, 1997:211). This provides an example of the gulf that can exist between development rhetoric and field realities.

Chambers' (1997) discussion on the normal (successful) career path of professionals questions the ability of development managers to relate to field realities as they progress. *"[P]romotion moves them upwards in hierarchies …[and] draws them inwards to larger urban centres with better schools and other facilities. The more successful a person is, the faster he moves from the rural periphery"* (Chambers, 1997:63). This suggests that development theory and policies cannot be considered without examining the professional and personal norms of development managers. In addition, policy decisions usually take place far from the field.

Not all development managers make the transition upwards in terms of their career and thus remain in the rural periphery. These individuals and those at the earlier stages of their careers face other challenges. For example, despite decentralisation, district health managers in Tanzania felt powerless to address the weaknesses in health care performance (Gilson et al, 1994). Due to overlapping authority, accountability was very confusing and district health managers could not manage resources effectively. They also suffered from weak resource allocation and financial management procedures, conflicts over control and limited institutional capacity. Development managers can be extremely constrained from practising the development policies in place.

1.2.5 Development of Rural Water Supplies

It was the World Water Conference in Mar del Plata in 1977 which initiated the era of international co-operation for improved water supplies and sanitation in the Third World (Black, 1998). Although the International Drinking Water Supply and Sanitation Decade (IDWSSD) from 1981 to 1990, which followed, failed to meet the target of safe water and sanitation for all, an estimated 31% of the population in the less-developed

countries were lacking safe water supply facilities after the decade, compared to 56% before (Carter et al, 1993). Progress was hampered by financial and technical resource constraints, and the fact that completed schemes were broken down and abandoned, or functioning below capacity (Arlosoroff et at, 1987). However, during the IDWSSD, community participation was identified as one of the prerequisites for improved performance in the sector (see Korten, 1986; Parwoto 1986).

The lessons of the IDWSSD were drawn into the Global Consultation Safe Water 2000 in New Delhi in September 1990 (UNDP, 1990). The resulting Delhi Statement promoted the principle of "*Some for all rather than more for some*", which set out the guiding principles as the basis of future sector work. Safewater 2000 followed on from IDWSSD while the Earth Summit in Rio de Janeiro in June 1992 saw world leaders commit themselves to *"provide the poor with access to fresh water and sanitation"* in Agenda 21 (United Nations, 1992). Vision 21 (WSSCC, 2000), led by the Water Supply and Sanitation Collaborative Council (WSSCC) is one of the major current international initiatives to put an end the global crisis of an estimated 1.2 billion of the earth's citizens still lacking safe drinking water and 2.4 billion lacking adequate sanitation.

The organisations involved in the provision of water and sanitation facilities range from bodies such as the UNDP and World Bank to national Governments, to both international and local NGOs. Access to clean drinking water supplies is now considered to be a key contributor towards improved health, which is considered to be a key factor in human development. The inclusion of drinking water in the international targets of the UN Millennium summit which pledges: *"To halve, by the year 2015, the proportion of the world's people whose income is less than one dollar a day and the proportion of people who suffer from hunger and, by the same date, to halve the proportion of people who are unable to reach or to afford safe drinking water"* (United Nations, 2000a) will further increase the profile of safe water provision as a key development priority.

Groundwater sources utilising handpumps became considered to be the most promising low-cost option for community water supplies due to the generally unpolluted nature of the source and the almost ubiquitous nature of groundwater (Arlosoroff et al, 1987). In addition, the use of suitable drilling techniques can render

capital cost low (Carter, 1988) and the source can often be developed close to the community, reducing the burden of walking long distances. The concept of *'village level operation and maintenance'* (VLOM) pumps emerged from the UN Drinking Water Decade, and there was a recognition of the importance of community involvement, analysis of the aquifer, well design and construction, the maintenance system and finance (Arlosoroff et al, 1987).

In terms of approaches, the community water supplies sector has been both influential on and influenced by the wider trends in development practices as discussed above and below. Community participation in planning and construction has become accepted practice and sustained impact has become a measure of success (Carter et al, 1999) and private sector involvement is being actively encouraged (DFID, 2001).

1.3 TECHNOLOGY AND TECHNOLOGY TRANSFER

Science and technology have been considered fundamental to Third World development since the end of World War II and US president Truman's stated commitment to *'aid the efforts of economically underdeveloped areas to develop their resources and improve their living conditions'* (Pronk, 2001). *"Despite occasional relapses and insecurities, the religion of progress has installed itself so firmly in most people's minds that, even today, a critique of it is more likely to be regarded as incorrigible heresy than as a voice warning of a false path"* (Ulrich, 1995). As components of progress, technology and its diffusion are of particular interest to individuals and organisations concerned with the development of the Third World. This section provides a brief historical overview of trends in innovation diffusion and appropriate technology.

1.3.1 Diffusion of Innovations

On a daily basis, citizens around the world are bombarded with the application of diffusion research by commercial companies in the form of advertising and other promotional activities. Coca Cola, for example, is the world's most well known brand, having successfully managed to reach even the remotest corners of this planet. Advertising, however, is only one component of several diffusion research traditions, in which Rogers (1995) classifies anthropology, 19th century sociology, rural sociology,

education, public health and medical sociology, communications, marketing and management, geography, general sociology, general economics and others.

Rogers' (1995) "Diffusion of Innovations", now in its fourth edition, reviews the 20th century diffusion process taking into consideration both the planned and spontaneous spread of new ideas, practices and objects from almost four thousand research publications. *"**Diffusion** is the process by which an innovation is communicated through certain channels over time among the members of a social system"* (Rogers, 1995:35).

Research on the diffusion of innovation has moved on and expanded considerably from the observations of trends in society by the French sociologist Gabriel Tarde (1903) at the turn of the last century, and the subsequent work of the European anthropological diffusionists who explained social change in one society as the result of the introduction of an innovation from another. The basic diffusion paradigm originated in the 1940s hybrid corn study by Ryan and Gross (1943) in Iowa. The heart of this paradigm involves consideration of: (1) the innovation decision process for an individual, (2) the role of communication, (3) the s-shaped rate of adoption and (4) the personal, economic and social characteristics of adopters and the classification of individuals according to when they adopt the innovation (Rogers, 1995).

This basic diffusion paradigm, and the research approach employed has had a significant impact on subsequent diffusion research. *"If the 1940s marked [its] original formulation..., the 1950s were a time of proliferation...of studies in the US [and] the 1960s involved the expansion of research in developing nations..."* (Rogers, 1995:99). Technology was considered to be at the epicentre of Third World development in the 1960s and the basic diffusion paradigm developed in the US and Europe was exported to the developing world along with this premise.

It was not until the 1970s that introspective criticisms of the universality of the diffusion research paradigm to different cultures started to be voiced. This occurred within the context of a change in the conceptualisation of development, as discussed in sections 1.2.2 and 1.2.3 .

Criticisms of the basic diffusion paradigm include its *pro-innovation bias*, (Rogers, 1995 & Bordenave, 1976) which implies that innovations ought to be diffused

and adopted. This component of the diffusion paradigm still pervades as we enter the 21st century. A description such as "failed" with respect to technology uptake, is highly representative of this bias, which is pro-technology, rather than "pro-something else" such as equity, social cohesion, preservation of cultural heritage or linguistic advancement. Recognition of this bias can help researchers to investigate legitimate causes for the rejection of innovations, providing considerable insights into the needs of a society, thus enabling more appropriate intervention to be undertaken, or none at all. This thesis addresses the pro-innovation diffusion bias to a certain extent by examining the early stages of innovation generation and diffusion rather than just examining a "successful" diffusion after the event and by investigating the broad context of diffusion.

Further criticisms of diffusion research include the *individual-blame bias* (Rogers, 1995) which considers an individual responsible for their innovativeness and ignores the system in which (s)he has to operate; and the *issue of equity:* the lack of consideration of the widening of socio-economic gaps which often come hand in hand with the adoption of an innovation.

1.3.2 Intermediate Technology

Consideration of the type of innovation suited to the Third World became increasingly important from the 1970s. Economist E.F. Schumacher launched an attack on high technology in his book *Small is Beautiful*, published in 1973, and his ideas caught on in several countries by early 1976 (Rogers, 1976). He defined the level of technology in terms of the equipment cost per worker and advocated for intermediate technologies to be utilised for Third World development. Intermediate technology was intended to fill the enormous gap between the indigenous technologies of a Third World country and the technologies of the industrialised world. It was the intention that intermediate technology would be more productive than the indigenous technologies while remaining immensely cheaper than the technologies of the industrialised countries. When Schumacher's Intermediate Technology Development Group (ITDG), started, *"...there were likely to be four characteristics of [technology 'appropriateness']: it would be small scale so that it could fit into small market situations. It would be simple so that sophisticated manufacturing skills, organisation and finance would be*

unnecessary. It would not be capital-intensive. And it would be non-violent" (Smillie, 2000).

1.3.3 Appropriate Technology

Certain schools of thought distinguish between the terms 'intermediate' and 'appropriate' technology while others tend to use them synonymously. Smillie (2000) points out that some technologies are appropriate without being intermediate, ie penicillin for health world-wide and satellite warning systems of cyclones for villagers in Bangladesh. He adds that intermediate technology needs to be appropriate if it is going to result in practical development. This thesis refers to appropriate technology, subsuming intermediate technology.

The concepts of 'intermediate' and 'appropriate' technology of the mid 60s triggered hundreds of organisations with an appropriate technology bias. These organisations were situated throughout the First and Third World (Eckaus, 1987), and experiments with technologies including small biogas plants, windmills, and simple pumps proliferated.

Smillie (2000) states that the appropriate technology (AT) movement comprised two groups: one which concerned itself with the economic and social development of the Third World; and the other which grew out of the counter-culture of the late 1960s and early 1970s and focused on 'alternative' technologies for people disenchanted with mainstream industrial and technological development in the First World. In some cases, these two groups have tried to merge, as is the case of the Northern based environmental movement.

"The spread of the AT philosophy can be partly attributed to the evidence of failed large-scale, capital-intensive projects to either work properly or produce the expected benefits [in the third world]" (Segal, 1992). Early AT of the late 60s and early 70s involved criticism of such projects and sought to develop alternatives which ranged from adaptations of existing Third World technologies such as brick making, to the promotion of existing, but unknown small scale technologies such as maize grinders, to the simplification of modern technology such as hydro-electric power (Smillie, 2000). The 1980s was a period in which AT was dominated by technology and hardware and little attention was paid to dissemination, which was assumed would follow a good technology, or was considered the responsibility of other organisations (Smillie, 2000).

Although the AT concept has had a striking impact on global technology development for the Third World (Segal, 1992), the progress of AT on a significant scale is acknowledged to have been disappointing. "*Nothing has emerged from the AT movement that is even close to the significance of the high yielding seed varieties of the Green Revolution"* (Eckaus, 1987). This has been attributed to macroeconomic policy obstacles (Stewart, 1987) as well as a the lack of emphasis on its diffusion (Segal, 1992; Smillie, 2000). The disappointing results have also provided arguments for the proponents of a return to mainstream economics and the continued export of high cost, Northern manufactured goods (Smillie, 2000).

By the mid 1980s there was a desire in the AT movement to uncover the causes of limited uptake. Lack of perceived benefits in the case of food processing equipment, organisational problems in the case of health promotion, lack of technical expertise in the case of improved water and sanitation facilities, lack of improvisation in the case of transport, and lack of capital to invest in energy technologies are some of the numerous factors cited as inhibiting technology uptake (Segal, 1992).

The 1990s saw AT undergo another shift in emphasis. Appropriate Technology International (ATI) in the US moved towards small business development, in which the technology was less prominent in its own right, but rather viewed as a component of business development. Meanwhile, *"in ITDG, process, participation and sustainability took on more prominence, meaning that in the 1990s, as much emphasis was placed on the users as on the technology itself"* (Smillie, 2000). The AT movement has become more user-, business- and environmentally-focused than it was in the past.

Eckaus (1987) criticises AT for lacking in economic and social analysis, and placing too much emphasis on technology. As there have been no comprehensive evaluations of AT in Africa, identifying diffused, operational technologies is based on *"...fragmented, anecdotal, impressionistic, and partial sources"* (Segal, 1992). Proponents of AT explain that its full potential has not been reached due to lack of donor support, opposition from political elites, lack of suporting macro-policies, lack of emphasis on indigenous applied research and lack of demonstration, diffusion and dissemination (Segal, 1992). Segal (1992) cites the positive experiences of AT in Ghana which *"demonstrate the importance of profits, careful selection of entrepreneurs, market research and follow-up support. Simply launching a product is not enough*" and

concludes that *"AT is the best, in some cases perhaps the only, technological alternative that could satisfy the dual requirements of efficiency and equity."*

1.4 INTEGRATION - INTERDISCIPLINARITY AND HOLISM

Calls for integration, consideration of the importance of input from different disciplines and holistic approaches are found in development and technology transfer literature.

The term "integration" in development is used to refer to processes including the fusion of international economies and societies in globalisation (Collier and Dollar, 2001), unified development (UNRSID, 1980) and the consideration of more than one aspect of development simultaneously. Annis (1987) considers the micro-macro links in development to be very important: *"Grass roots development does not occur in a vacuum. There is no either/or choice 'bottom up' and 'top down'. Rather, it is necessary to create healthy linkages between the micro and the macro..."*. He illustrates this by pointing to the disparity between the introduction of new technologies and skills training if not accompanied by opportunities for work. Foster et al (2001) state that better focused agricultural services require fundamental policy questions to be resolved.

Shove (1998) points out that barriers, either technical or economic in nature often impede the market penetration of well established or successful technologies. Häusler (1993) states that the *"...inherently political problems of environmental degradation cannot be solved by compartmentalised technical means....the natural, historical, economic and political factors that have led to environmental degradation need to be analysed. A full account of specific international, national and local situations, constraints and needs is also imperative"*. Grindle and Hilderbrandt (1995) have found that development interventions which most constructively address poor Government performance require an assessment of a relatively broad set of variables including economic, political and social factors which are interrelated within countries and vary considerably between them. However, Pieterse (2001:129) states that *"...the partial nature of development theories...reflect[s] disciplinary territories - and policy interventions...in addition, reflect political and institutional interests - the development field is carved up in many ways"*.

Integrative approaches to development have been tried in the past. The Second Development Decade (1970 - 1980) tried to merge social and economic development and called for *"a global strategy, based on joint and concentrated action in all spheres of economic and social life"* (Esteva, 1995:14). Almost simultaneously the UN launched *"The Quest for a Unified Approach to Development"* (UNSRID, 1980) while the 1970s saw Integrated Rural Development.

A powerful integrative approach of the 1990s is Livelihoods, which has been embraced by donors such as the UNDP, DFID and the World Bank (de Haan, 2000). It has grown out of the work of Chambers and others (Chambers et al, 1992) and uses participatory methods to explore a wide range of factors pertinent to poverty reduction, while targeting a few core areas (DFID, 1999). The Livelihoods framework is a conceptual model to improve the understanding of the poor and help stakeholders with different perspectives to enter dialogue. The livelihoods approach recognises *"...that the poor rely on a complex range of assets, and that differential access to and returns from these assets have a major impact on livelihoods"* (Gilling et al 2001) and sets out to be integrative by recognising the importance and linkages between five livelihood assets (human, natural, financial, physical and social capital) as well as the structures, processes and vulnerability context which impinge on those assets. Livelihoods recognises structural bottlenecks, or barriers, as well as the indigenous, or micro-level issues which affect development (de Haan, 2000) so indicating a broader understanding than previous micro or macro level approaches.

Pieterse (2001) states that many new concepts in development imply a combination of disciplines and that new theories are interdisciplinary. One sided disciplinary perspectives in development studies *"are gradually in retreat and being relegated to partial knowledge. A development economist can no longer afford to ignore sociology, gender, ecology [or] culture...most problems now faced in development require a combined approach, such as structural adjustment...corruption... [and] poverty"* (Pieterse, 2001:142). Rahani and Geyer (2001) see development increasingly being treated as a long-term process that involves a wide variety of inputs and outputs.

Chambers (1997) draws attention to the diverse livelihoods of most poor people whereas external agents tend to have a sector specific understanding. Gore (2000) states

that sustainable human development approaches argue for a return to the notion of a development strategy which is based on a long term perspective, with a more holistic approach, centred on the transformation of societies, and that development should cease to be the monopoly of economists. However, despite the rhetoric, Pieterse (2001) finds that *"interdisciplinary research is more widely applauded than it is practised"*. Ellis and Biggs (2001) state that few Third World Governments or donors currently take a sufficiently cross- or multi-sectoral view of the possibilities of rural poverty reduction.

Pieterse (2001) advocates critical holism for development, which in practice involves a *"case-by-case, contextual assessment"* of whether linear (predictable by cause and effect) or non-linear (behaviour governed by local interactions of numerous internal elements) dynamics prevail and whether robust or gentle action is appropriate. *"[Development should] include macroeconomic management, global democratisation and planetary ethics...it may be summed up as a collective learning process of human self-management according to the most comprehensive standards conceivable and practicable"* (Pieterse, 2001).

Requesting integration is a call for consideration of development as crossing the traditional disciplines and an understanding of their linkages. Although integration and holistic approaches are considered important, there is no unified theoretical framework which integrates the development ideas which have emerged (Rihani & Geyer, 2001). The elusive nature of integration renders it difficult to implement and a practitioner is left with a sense that integration means that there is always something missing, something which needs to be added to make such the intervention work, ie a gap in the "whole" picture which still needs to be filled.

Although Annis (1987) calls for micro-macro linkages to be made, he questions how the World Bank can creatively make these linkages. If one subscribes to the case by case assessment required for successful development interventions, offered by Pieterse (2001) and acknowledges that change agents do not know the problems from the outset (see Bond & Hulme, 1999), a flexible approach to development, involving a learning process is called for. However, criticisms of the livelihoods approach have included the fact that a huge agenda can be raised, which cannot feasibly be dealt with (Ashley & Carney, 1999). This problem is inherent in all integrative, flexible approaches.

Despite the recognition that integration is difficult and somewhat elusive, the literature suggests that its importance must be acknowledged and considered when undertaking development interventions. Change agencies and agents ought to be prepared for wide range opportunities and challenges from the outset of their work.

1.5 THE NEED FOR REFLECTION

The above sections provide a brief historical account of mainstream thinking in Third World development and technology transfer. Thinking has changed in the last 50 years, but throughout, there has been a tendency for theorists and practitioners alike to promote *the solutions* for *the problems* which need to be addressed (Pieterse, 2001). Since these have continued to change, either by bringing new ideas on board, or by returning to former ways of thinking, there is no reason to suppose that the current fashions are *the solutions* to *the problems* either. Adelman & Morris (1997) state that the application of universal and simple theories to very different contexts has contributed to the limited development success of the last 50 years.

In light of this, there is the need for detailed and critical examination of ongoing development goals and approaches. After all, why should the fashions of today be any better than the fashions which we have already abandoned? One of the main challenges facing Third World development today is to seek ways in which to challenge and overcome the "impasse", in development theory perceived by Booth (1995). For the immense human suffering to which most of the World's population are subjected can surely no longer be tolerated within a World of such excess.

The impasse needs to be challenged not by rhetoric, but with possibilities which are grounded in practical experience. Given the immense heterogeneity within the Third World and the fact that development, or change in one area both affects and is affected by the state of another, the context in which development intervention takes place must be considered in detail. This includes making links between different micro-components as well as between micro and macro issues.

This thesis sets out to consider the extent to which technology development and its diffusion in practice may help to meet the current development objectives of poverty elimination. Through the critical analysis of one action research project which involved the development and transfer of "appropriate" technology to local private enterprise this thesis provides insights into Third World development. Given the centrality of

technological advancement and privatisation to our current conceptualisation of development approaches, the analysis of this project provides the basis for reflection on the practical application of fashionable development approaches of today.

Adequate water supply is considered to be fundamental for poverty elimination. However, ensuring the sustainability of improved water sources continues to be a challenge for development. The technology examined by this thesis is that of water well provision and thus central to the purpose of current mainstream development.

2 Research Aim, Objectives and Methodology

2.1 AIM

The aim of the research is to gain an improved understanding of Third World development through technology transfer, by an analysis of technology transfer in practice.

2.2 OBJECTIVES

There is extensive documentation which provides description, analysis and synthesis of a wide range of current developmental aims and approaches as well as principles for technologies and technology transfer practice. Drawing out a generalised framework from the literature would provide a starting point for the analysis of a specific development intervention. Therefore **the first objective of this work is to assemble a working framework from the literature which synthesises diverse views on accepted practice of technology transfer in a developmental context.**

This thesis is tied to one particular technology transfer project entitled "Private Sector Participation in Low Cost Water Well Drilling", which is subsequently referred to as the Low Cost Drilling Project (LCDP). The first three-year phase of the LCDP was completed in June 2001. The purpose of the LCDP was to design low cost drilling equipment and bring about its local manufacture and uptake by private enterprise in Uganda. The LCDP was not merely observed or read about, but provided the vehicle for the research which I undertook alongside my role as in-country team leader. Consequently **the second objective is an analysis of the early adoption and implications for sustainable uptake of the technology from the experience of the LCDP.**

The notion of a comprehensive conceptual framework linking all the various aspects of technology transfer and development theory and practice, is explicitly rejected as a goal for this work. Since the work is based on detailed knowledge of one project, it is however the aim to draw out experience-based insights into the technology transfer process. Consequently **the third objective of the research is to develop**

insights based on action research and analysis of stakeholder viewpoints which can assist others who apply principles of technology transfer to Third World development.

2.3 METHODOLOGY

2.3.1 Background

An inductive approach was taken to this research, with the LCDP defining the research context. The methodology comprised a number of steps as illustrated in Figure 2.1 and outlined below.

General inferences were drawn out of the field work of the LCDP and were utilised to define the research objectives. Subsequently, a literature review was undertaken to extract and develop literature-based principles. The field data collected were analysed both in the field and at the end of the LCDP in order to draw out findings, comprising key issues and linkages. This was followed by a reflective process in which the literature-based principles were used to critique the findings of the field work, and the findings of the field work were used to critique the principles. This reflection has enabled the findings to be examined in depth with self-criticism and the literature to be related to field realities. In this way the thesis relates the findings from the LCDP to current development theory and practice.

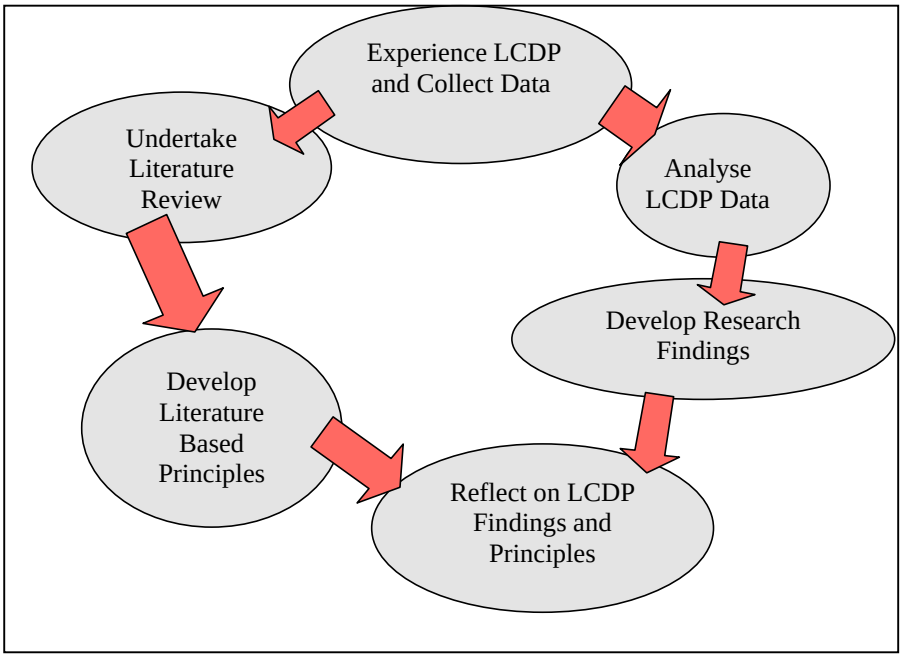

Figure 2.1: Schematic Diagram of Thesis Research Steps

2.3.2 Research Methodology

The LCDP provided a vehicle for the research. The LCDP comprised action and learning ie *"The process of developing the technology and introducing it to the private sector, and the concurrent investigation and learning process, were intertwined in such a way that the project informed the research and the research informed the project*" (Carter, 2001). Figure 2.2 depicts the methodology of the LCDP. The overall question for the LCDP was: "*what enabling conditions and external actions are necessary to stimulate and strengthen effective rural water supply service delivery by the private sector?"* (Carter, 2001).

The LCDP involved collaboration between the project team and national partners. Through the communication and action involved in trying to change aspects of the existing system (by introducing a new technology for uptake), these two sets of stakeholders[2] were able to reflect on and learn about the technology and the context. The methodology of the LCDP can be described as action research, explored below.

[2] 'Stakeholder' has been used to refer to all individuals and organisations who, directly or indirectly stand to gain or lose from the LCDP. Primary stakeholders are those directly affected, ie the communities and private enterprises. Key stakeholders are the agents of change, ie Government and the LCDP team. 'Partner' refers to stakeholders who joined hands with the LCDP team to work towards agreed objectives.

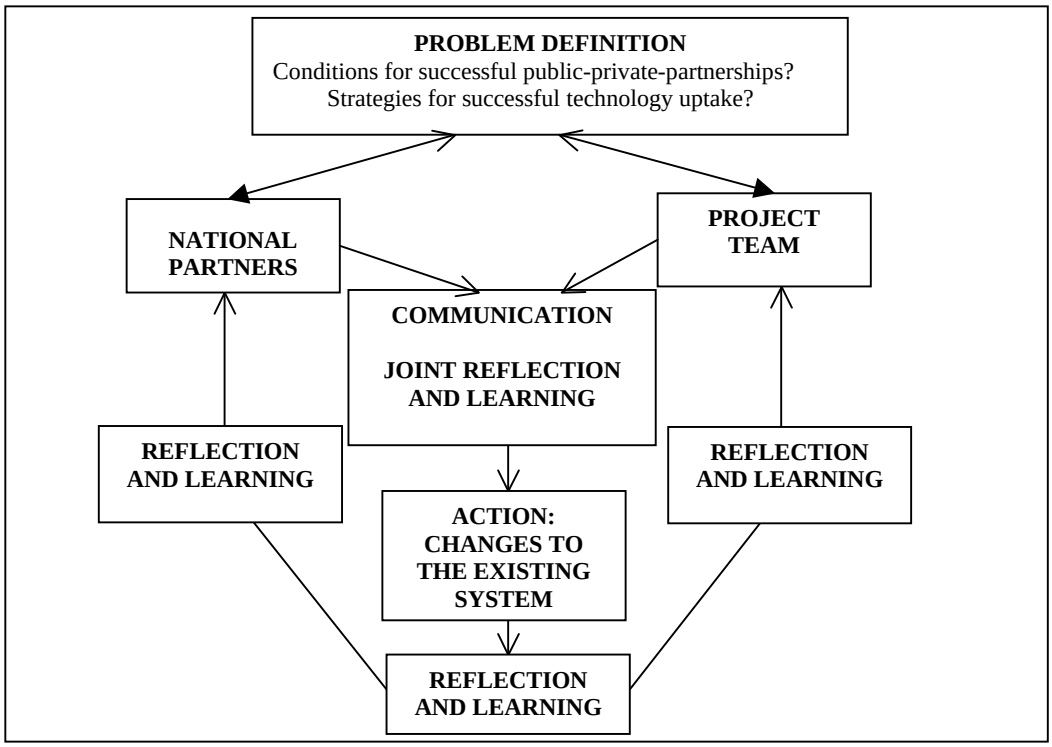

Figure 2.2: Research Project Methodology (Adapted from Greenwood and Levin, 1998)

2.3.3 Action Research

The term *"Action Research"* is used to refer to a range of social research and action oriented approaches. Action Research and other terms, such as Participative Research and Participative Action Research overlap for some writers and schools and are completely incompatible for others (Greenwood and Levin, 1998). The recent resurgence of Action Research in the North has caused many Southern activists to worry about co-option of their perspectives (Greenwood and Levin, 1998).

Reason & Bradbury's (2000) working definition of action research is useful: *"action research is a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes.... It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities".* This definition bridges the different ideologies behind different Action Research approaches. These differences are due to the range of political, economic, institutional and social contexts which form their history, as well as cross-fertilisation and co-option of other approaches.

Greenwood and Levin (1998) conceptualise action research as a balance of the three elements of research, participation and action. They trace the origins of action research back to the social experiments of Kurt Lewin in the 1940s through the socio-technical experiments, started at the Tavistock institute. Kurt Lewin is believed to have coined the term "Action Research" and is credited with the phrase *"The best way to understand something is to change it"* (Greenwood and Levin, 1998). Action research can also be traced back to:

- Marxist roots in the educational work of Freire (1970), who argued that teaching and research should not be dominated by experts but rather based on dialogue with a community of oppressed people (Cancian and Armstead, 2000). This spawned the participatory research practice of those working for the liberation of the oppressed and underprivileged such as Fals Borda (2000);
- practices such as participatory rural appraisal (Chambers, 1997);
- Maguire (2000), who points out that the feminist practice of consciousness raising is a form of experiential action and enquiry;
- Bell (2000) who shows how the roots of action research were firmly grounded within progressive research on race and
- William T. Whyte (1989), working with management and workers in organisations to deal with problems such as reducing costs referred to his work "participatory action research" (Cancian and Armstead, 2000)

The subject matter of action research is wide ranging and different practitioners and approaches consider empowerment and the extent of participation differently. Action research approaches differ in how they conceptualise the *democratisation process* referred to in the quote by Reason and Bradbury (2000) above. For some, action research is used in order to create liberation through greater self-realisation, while others focus on more political meanings (Greenwood and Levin, 1998). There is considerable variation regarding how strong a political liberation agenda is advocated. Some practitioners link action research to revolution and others consider themselves as democratic reformers (Greenwood and Levin, 1998).

The LCDP methodology drew primarily on the *pragmatic action research* approach developed by Greenwood and Levin (1998), as outlined below.

With respect to empowerment, the LCDP team operated as reformers rather than revolutionaries, reflecting pragmatic action research rather than more radical action research approaches.

Greenwood and Levin (1998) equate democracy with the "*creation of arenas for lively debate and for decision making that respects and enhances the diversity of the groups"*. In the LCDP, arenas for debate and decision making were created through the process of introducing a new technology to existing socio-economic and political structures, and existing development implementation strategies.

Cogenerative research is one of the characteristics of *pragmatic action research* undertaken by the LCDP. Cogenerative research means that *"the research process emerges out of joint experiences and from mutual reflections about these research experiences shared between participants and researchers* (Greenwood and Levin, 1998). The LCDP adjusted and enlarged its scope in light of joint reflection by researchers and participants. The dependency of the researchers on Ugandan participants for finance and a forum for the technology operation encouraged democratic processes.

The LCDP used multiple research methods to collect data, reflect and undertake action. This is a characteristic of *pragmatic action research* (Greenwood and Levin, 1998), which does not adhere to a specific methodology. The LCDP worked with participants individually and in groups, in a range of settings from semi-structured interviews to observation in training sessions to informal discussion during field visits. Both qualitative and quantitative data was gathered.

The plans, methods and learning processes which took place in the LCDP depended on the judgements made in the concrete research situation by all the participants in the research.

Box 2.1: The Relationship between the LCDP Methodology and Pragmatic Action Research

The LCDP differed from *pragmatic action research* in that it did not take place in the industrial settings of Europe and North America, but primarily in Uganda. However, the majority of the key Ugandan and European stakeholders had completed secondary, if not higher education and were thus of a similar educational background. It should also be noted that the technology transfer was initiated from outside Uganda. However, initial consultation revealed that the innovation was highly relevant and welcome in Uganda by central and district Government officials and Ugandan commercial enterprises.

I became familiar with the subject matter through observing and participating in the LCDP by working as in-country team leader. I was responsible for the co-ordination of the Ugandan team as well as the direct implementation of several project activities, in particular liaising with local partners. I thus have first hand experience of the LCDP, which has provided me with a depth of understanding which could not have been obtained through reviewing the project after its completion or as an external observer.

I undertook both overt and covert research within the LCDP. The overt research concerned topics which could be discussed openly. I was also repeatedly requested to put my pen down when confidential topics were discussed. The covert research involved noting down such information later, *but not revealing details to third parties including research and project supervisors.* This enabled trust to be maintained between myself and the other stakeholders. This trust is vital both on ethical grounds and in order to continue to obtain sensitive yet important information regarding key issues with respect to the technology deployment. Knowledge of such issues has contributed to the in-depth understanding of the context in which the technology was transferred as well as to steer certain aspects of the LCDP. To avoid breaching the confidence of the informants any sensitive information is presented here either in general terms or anonymously. Anonymous sources of information are referenced as (Comment Chapter Number.Consecutive Number) ie (Comment 5.1), followed by (Comment 5.2). Thus, the reader cannot cross reference anonymous informants.

Action Research (planning, producing and evaluating change while changing) is advocated by Bordenev (1976) as a way of studying global strategies for technology transfer. The action undertaken enabled issues and constraints to be experienced from within and the flexible project approach enabled locally raised concerns to be considered. This provided the opportunity to understand a broader set of issues than had the approach been more rigid. These issues and the links between them provide novel insights into the technology transfer and uptake.

In supporting research into real life, it is worth mentioning Bourdieu, who warned all sociologists that: *"observation of reality puts us on our guard against the temptation to construct over-simple models*" (Guardian Weekly, 2002) and Susman and Evered (1978), who have pointed out that by viewing life from the outside and under strictly controlled conditions, the utility of the knowledge so produced can be seriously limited.

As I was making subjective decisions and formed relationships with other stakeholders throughout the LCDP, the issue of objective research must be considered. The literature provides both criticisms and defence of the action oriented, participatory research methods employed. Feminist research approaches reject objective, detached research, and embrace the interaction and collaboration with the people they study,

while postmodernists object to the presentation of results in a detached and neutral way and advocate that the author of a report should never be hidden when someone reads it (Neuman, 2000).

This thesis is concerned with depth of understanding through experience coupled with some outsider knowledge gathered from documentation and interviews. My work contained ethnographic components. I participated in the day to day working life and decision making of Ugandan partners in order to make sense of their situations through experience. In this way, both I and the other stakeholders benefited by understanding the requirements for technology adoption and the foundation for long term uptake at first hand.

Although the LCDP aimed to *understand* the enabling conditions and external actions for technology transfer, the team had an interest in seeing the technology taken up. The successful (or not) uptake of the technology contributes to the team members perception (or not) of a successful project. There was thus a certain degree of pro-innovation bias to the research. However, given that action research aims to understand *something* by *changing* it, this bias is a necessary contribution to the learning process. I have endeavoured to overcome this bias in the analysis by examining different stakeholder perspectives on the technology and its uptake.

As the in-country team leader of the LCDP, I formed the main link between the change agency (Cranfield University) and the client system (local actors and context). My responsibilities included trying to influence the local actors' innovation decisions in a direction considered to be desirable by the change agency, ie uptake of the technology. Rogers (1995) defines my role as that of the *change agent*, who faces two main problems:

- (s)he is socially marginal as (s)he is positioned between the change agency and the client, who will tend to pull in different directions, and
- information overload, in which excessive communication inputs cannot be processed and used, leading to breakdown.

Although these problems render the job of a change agent a difficult one, the experiences have the potential to enable the change agent to understand both the change agency and client system at considerable depth. My own experiences echo Rogers' (1995) observations. Despite the "pro-innovation" bias within the LCDP team I

developed considerable empathy with the range of views and concern of the Ugandan stakeholders. These were not always "pro-innovation". While trying to facilitate uptake, I was often pulled in different directions and thus grew able to understand different stakeholders' perspectives. Although I often understood where different sides were coming from, I was not always able to help them to understand each other. My inner conflict demonstrates less of a bias in either direction than there could have been had I been a less empathetic change agent.

In order to further minimise any bias I undertook a series of in-depth, recorded interviews with key LCDP stakeholders at the end of the research duration. These interviews were designed to draw out the opinions and ideas in an empathetic way. The fact that each stakeholder voiced a mix of positive and negative views regarding the LCDP and the technology indicates that the stakeholders did not only tell me what they thought I would find pleasant. The transcripts of these interviews have contributed considerably to the analysis. Further reflection for this thesis has been undertaken in consideration of the literature. This has added additional new angles from which to consider the LCDP data, the interviews and my own experiences.

The fact that I was able to empathise with different stakeholders, and feel the conflicts between them means that I have a well grounded and multi-directional view of barriers to the technology uptake which are at the interface between different stakeholders.

2.3.4 Research Data Collection

The data for this thesis have been collected both directly by the author as well as indirectly from other members of the LCDP team. The amount of research undertaken during the LCDP meant that all of the data could not be collected directly by the author. However, all the data collection was supervised by the author. The data collection is summarised below.

1. semi-structured interviews, informal discussions and group discussions between the author and LCDP team, key stakeholders and informants as broken down in Table 2.1);

Table 2.1: Meetings Attended by Low Cost Drilling Project Team Leader

	NO. OF	APPROXIMATE TOTAL

TYPE OF ORGANISATION	MEETINGS	NO. OF HOURS
Ugandan Based NGOs	29	69
Directorate of Water Development (DWD)	38	64
Private Enterprises	33	79
Ugandan Support Organisations	3	3
Research Institutions	6	14
Donor Organisations	29	40
Consultants to the LCDP	19	43
District Government	68	232
LCDP team members	81	218
Ugandan Manufacturers and Suppliers	19	37
Other Key Informants	14	30
Multi-Stakeholder National Workshops	2	16
Total	**341**	**845**

2. semi-structured interviews, informal discussions and group discussions between the LCDP team members and key stakeholders, informants and communities;
3. informal discussions between author and communities;
4. author observation of stakeholder behaviour and attitudes during the LCDP;
5. author observation of the operation and use of the technology;
6. experiences of author in Uganda and the UK during the LCDP;
7. author observation and questioning of participants in business training courses conducted by LCDP;
8. project documentation from LCDP as given in Table 2.2;

Table 2.2: Summary of Low Cost Drilling Project (LCDP) Documentation

LCDP DOCUMENTATION	AUTHOR (YEAR)
Hand Sludging: a Report from North West Bengal.	Ball, P and Danert, K(1999)
Field Trials of the Prototype Pounder Rig, Uganda, 20th August - 13th November, 1999.	Ball, P and Danert, K (1999)
Design review of the Pounder Rig, Following Field Trials of the Prototype.	Ball, P (1999)
Project Progress Reports to DFID, dated (1) September 1998, (2) March 1999, (3) September 1999, (4) March 2000, (5) September 2000, (6) March 2001.	Carter, R C, (1998, 1999a, 1999b, 2000a, 2000b, 2001)
Private Sector Participation in Low Cost Water Well Drilling. DFID Infrastructure and Urban Development Division KAR PROJECT R7126 Final Report.	Carter, R C (2001)
Study of Taxation, Registration, Legal and Regulatory Issues Affecting Small Businesses in Uganda.	Kakooza, S M, Ball, P, and Danert, K (2000)
Pounder rig contractor business: projected cashflow.	Kakooza and Danert, K (2001)
Artisan business training programme, Luwero diocese water project.	Rwamwanja, R (1999)
Water quality data for 5 Pounder wells and 5 hand-augered wells in Katabi subcounty, Mpigi district, Uganda.	Rwamwanja, R, Danert K, and Carter, R C (2001)
Information on potential sources of credit.	Ssebalu, J, Rwamwanja, R, Snell, M,

	and Danert, K (1999)
Contractor drilling with Pounder II, Uganda, December 2000 - June 2001.	Danert, K and Carter, R C (2001)
Histories of Pounder wells and hand-augered wells in Mpigi and Jinja districts.	Rwamwanja, R and Carter, R C (2001)
Compilation of work on small business identification, analysis, training and evaluation.	Ssebalu, J and Carter, R C (2001)
Compilation of work on siting methodology and hydrogeological potential of the Pounder rig.	Tindimugaya, C, Luutu, A, Danert, K and Carter, R C (2001).

9. documentation of other water supply projects operating in Uganda and
10. media coverage of relevant issues.

Discussions with the actors generally revolved around the LCDP implementation. However, time and situation permitting, other interests of the stakeholders would also be discussed. In the last six weeks of phase I, the author held semi-structured interviews with 18 key actors to identify and expand key findings of the research.

2.4 ANALYSIS

2.4.1 Literature Based Working Framework

Although reviews of the literature were carried out periodically during the three year project, the bulk of the literature review was undertaken at the end of the LCDP. Consequently the background of project experience enabled me to focus on relevant material and draw more meaning from the literature than would have been possible prior to the project. Analysis of the literature was grounded in a rich base of experience.

The LCDP emphasised practical technology development and transfer, initiated by first world external agents, into a low income country, with the technology intended for use by local private businesses to provide a service to communities. Such projects today need to consider mainstream development thinking if they are to be eligible for donor funding. Thus, I have primarily focused on literature which considers the mainstream development areas.

A set of principles has been developed through a process of comparing and reflecting on a range of texts. In order to maintain a balance of viewpoints I reviewed literature which considers development and technology transfer from different philosophical standpoints. The principles thus comprise my own attempt to represent current mainstream thinking in the area of focus. There has been no wider testing of the criteria by development practitioners or development theorists in order to form a consensus. In fact, one has to question whether a consensus would be possible, given the political debate going on between different factions.

As the principles are used as the starting point for the subsequent analysis, the fact that they are selective, and may be considered incomplete, is not an issue. The purpose of the principles is to provide a bridge between the literature and the analysis of practical experience, and thus provide insights which are pertinent to technology transfer in the name of development.

2.4.2 Analysis of LCDP

The analysis of the LCDP reflects four aspects of grounded theory methodology as developed by Glaser and Strauss (1967):

1. it is grounded in the data of the LCDP;

2. the data collection and analysis have been going on simultaneously and throughout the LCDP;
3. the data have been *coded* to aid the development of concepts and their linkages;
4. *memos* have been written during project implementation and thesis preparation to record ideas triggered by my own reflections, observations, field notes, literature and suggestions from other individuals.

The qualitative data analysis software, NVivo[3] has been utilised to aid the coding process. Key components of the LCDP data have been coded in order to draw out key themes. Initially open coding was undertaken, ie the generation of many codes from the data. Subsequently, similar codes were merged and organised into tree structures. The tree structures built up are compatible with the thesis chapters, but not all the codes fitted into this structure. These were left as free nodes, or organised into other trees. Codes were linked in order to keep their interdependency alive in the data. Mapping of the codes was also undertaken periodically to help visualise the linkages. Due to the complexity of the linkages, the maps are not included in the thesis as they only tend to confuse. NVivo forces the user to organise in tree structures, and the way in which linkages between trees are recorded and displayed is not ideal for this type of analysis.

Grounded theory emphasises the importance of *theoretical saturation.* This relates to two phases within grounded theory. These are points where no further: (i) data collection or (ii) review, would further illuminate the concepts or linkages (Bryman, 2001:391). It is of note that the research was limited as the LCDP was time bound. Consequently, it cannot be maintained that theoretical saturation was reached in the field. However, the data collected were analysed extensively in order to reach theoretical saturation in the review phase.

The analysis is no doubt biased to the extent that it is influenced by my subjective experiences. However, as the LCDP progressed, the trust between the other stakeholders and myself grew and they often expressed direct criticisms of the LCDP to me. These have been considered in the analysis. In addition, the data from the semi-structured interviews at the end of the LCDP, in which key actors were requested to

[3] QSR International's NVivo is a software designed to integrate qualitative memo writing, coding, linking, and modeling

directly express their opinions and criticism have contributed to reducing the researcher bias.

2.4.3 Reflection on the Framework in Light of the LCDP Findings

The short time frame of five years from conception to completion of the first phase of the project has witnessed changes in development thinking. For example, the Livelihoods approach, which is discussed in chapter 3 had not been introduced into mainstream development practice in 1996. Thus, when the LCDP started it could not set out to fulfil all the fashionable development concepts of today. This is true of many projects, given the pace of the generation of new ideas within development theory and practice. In this thesis, the principles which are being analysed are up to date, while the LCDP under analysis was undertaken with the 'current' practices of five years ago, along with the experience and judgement of the implementers. The analysis involves reflection on the principles and the project findings in order to criticise mainstream development thinking and the LCDP.

2.5 THESIS STRUCTURE

Chapter 3 lays the foundation for the subsequent reflection by reviewing the literature and developing a working framework with which to reflect on the project; chapter 4 presents the Ugandan context and an outline of the LCDP story. Thus the reader is equipped with the background for the analysis in the remaining chapters.

When attempting to consider wholes, both integration and detail are important, with detail vital in forming a depth of understanding while integration is necessary to highlight links. This work is concerned with technology transfer as a whole, rather than as a series of parts, but the linear structure of written material, and the practical limit as to the number of ideas which the mind can cope with simultaneously, demands a linear presentation. In order to consider the detail, the material under study is broken up into manageable components.

The analysis of the LCDP is divided into five chapters, the technology, the private sector, the public sector, the communities and the process. Each chapter is limited, as it is only able to consider a select amount of information, rather like eyes which can see, but do not hear, smell, touch or taste. However, within each chapter, there is a tremendous scope for detail and understanding. When preparing a meal it is

sight which tells us if the raw onion is bruised and should be included. However, our ears will tell us if the spices are starting to fry or not, and our nose will alert us if chilli has started to burn. We use touch to determine if the tomatoes are too firm or too soft and we use taste to determine if we need to add more salt. Thus the different senses give us different detailed insights, but it is their combined use which enables one to prepare an exquisite dish, which our guests can smell, see, touch and taste, and hopefully enjoy.

The discussions within these chapters are not the whole story. The compartmentalisation of the material creates an incomplete caricature of the whole picture. If the incompleteness of each chapter somewhat frustrates the reader, then the author will have communicated the problem of fragmentation in development.

The relevant principles are reflected upon at the end of each chapter. Although each principle may be relevant to the LCDP findings of more than one chapters, they are only reflected upon once in order to provide clarity for the reader. Where the reflection of a principle benefits from the analysis in more than one chapter, the principle is considered in the later rather than earlier in order to draw together the analysis.

3 Development & Technology Transfer Framework

3.1 INTRODUCTION

Sections 1.2.2 to 1.2.5 outline the development thinking of the last 50 years, and show some of the changes in emphasis which have taken place. The goal of current mainstream development emphasises poverty alleviation and sustainable development (DFID, 2001, United Nations 2000a) while key approaches include private sector participation (eg Water and Sanitation Programme, 2001a, World Bank, 2002) and community participation (eg WSSCC, 2000, World Bank, 2001b). These approaches are particularly relevant to the Low Cost Drilling Project (LCDP), which had practical experience of dealing with them as a technology development and transfer project.

This chapter reviews a broad range of literature regarding Third World Development and Technology Transfer. In order to enable reflection on the literature in light of the findings from a practical project, this chapter draws together and condenses the literature into 16 brief principles. These principles provide a manageable bridge between the literature and the analysis of the LCDP and facilitate their reflection in light of the LCDP findings.

The chapter is divided into three sections: the first develops principles from four aspects of mainstream Third World development thinking; the second reviews and condenses technology transfer literature and the third presents the principles in a working framework.

3.2 THIRD WORLD DEVELOPMENT PRINCIPLES

3.2.1 Participation

Participation provides a way in which a context specific understanding can be formed in order to steer requisite development activities. During the 1950s, social activists and field workers attributed the failure of development projects to a lack of involvement of the beneficiaries with their design, formulation and implementation (Rahnema, 2001). This was accompanied by advocacy for the end of top-down

development strategies (Rahnema, 1995). Carmen (1996) traces the roots of 'participation in development' to the 1960s when the World Bank, USAID and other development agencies were forced to reconsider their approach in view of the *"...obvious and consistent failure of development transfer"*.

The late 1960s saw the development of 'organisational' gap theory, which identified an inappropriate relationship between centralised powerful bodies and rural communities (Catley & Leyland, 2001). This view called for decentralised local approaches and appropriate technology. The phrases 'popular participation' and 'people's participation' started to be utilised at this time (Cohen and Uphoff, 1980). Major international aid organisations now recognise that projects with stakeholder involvement and participation, can achieve significantly greater results and often at reduced monetary cost than those without (Rahnema, 2001). Thus, the principle of participation has entered mainstream development.

'Received wisdom' in development is that long term sustainability is closely linked to active participation of the poor (Annis, 1987; Rahnema, 2001). The UNDP/World Bank study of 121 completed rural water and sanitation projects in 49 countries regarding the effects of beneficiary participation in the decision making process found that *"participation contributed significantly to overall project effectiveness...[t]he proportion of water systems in good condition, overall economic benefits, percentages of the target population reached and environmental benefits rose significantly with participation"* (Narayan, 1995). Originating from grass roots level, 'participation' has become an accepted component at all levels in development policy from community Participative Rural Appraisal (PRA) to National Government participation in the World Bank Poverty Reduction Strategy Papers (PRSPs).

Despite the nigh ubiquitous acceptance of the concept of 'participation', it is not without its critics. The varied interpretation of participation may explain why it has been so universally accepted and Carmen (1996) calls for a clearer definition of participation, which does not blend the 'means to an end' attributes with power and control. Participation is used to describe a range of practices from compulsory labour to spontaneous self organisation (Chambers et al, 2001). Catley & Leyland (2001) have drawn on the work of Pretty (1994) and Cornwall (1996) to come up with seven types of community participation which range from manipulative participation to self

mobilisation and point out that *"a lack of common understanding of community participation hinders the comparison of experiences between projects and can lead to false hopes about how [it] can be used and what it can deliver".*

Rahnema (2001) voices the concern that 'participation' in which highly ideologised change agents use participatory methods is a new and more subtle form of manipulation. Carmen (1996) points out that the co-option of participation into mainstream development has not challenged the development goals of economic growth, the status quo of inequity in land ownership or the power and class differentials in society: *"...under the participation in development rhetoric, the farmer/peasant was to be distracted away from genuine (that is political) participation, and drawn towards... participation in projects designed and financed by external agencies".*

Feacham (1980) criticises the over-simplified manner in which participation is applied. He questions the practicability, relevance, cost savings and politics of participation as well as pointing to the difficulty faced by bureaucracies of remaining flexible to the participants while following standard approaches. There is often a misfit between the logical framework approaches favoured by donors and participatory approaches (Chambers, 1997). There is often insufficient participation by the beneficiaries when determining project objectives and activities (Chambers, 1997). Despite the incorporation of participation into the development rubric, external agencies still have objectives and deadlines to meet, which will influence the type of participation they can afford.

Pro-participation viewpoints are not only confined to Third World development projects. *"The technology transfer process usually involves moving a technological innovation from an R&D organisation to a receptor organisation"* (Rogers et al, 2001). A common approach to this is the "over the wall method", where a research team develops something and tosses it "over the wall" to users in the belief that it is required, complete and that the users are skilled enough to use it (Douthwaite, 2002). Rogers (1995) states that the pre-diffusion events have a strong impact on the diffusion process, adding that there are relatively few investigations of these early phases.

Voluntary participation by end users has been found to improve innovation diffusion (Niehoff and Anderson, 1964). "*The introduction of new technology...and its*

successful implementation requires the active participation of Government, managers and workers" (Ong , 1991).

There are also calls for participation in the design process. Green (1999) calls for participation in all stages of the implementation of a technology transfer project. Lysack et al (1999) and Orphwood (1990) advocate the involvement of potential users in the design of devices for the disabled, with participation not only improving the design but also elevating the social status of those involved. Douthwaite (2002) argues for a *"learning selection"* approach (see chapter 9) to catalyse innovation. Following the construction of one, or a few initial prototypes by a research and development (R&D) team, there is period of co-development by key stakeholders and the R&D team. This period is called the adaptation phase and enables people to *"make changes to a technology and then select and promulgate those that they find beneficial. This improves the fitness[4] of the technology"* (Douthwaite, 2002).

Todt (1997) is concerned about the social closure of design processes in general: *"[t]he actors involved in the design process are guided by very narrow objectives and principles which lead them to overlook the complexity of the relationship between the technical product they are working on and society"*. Todt (1997) believes that this feeds conflict and controversy between technology developers and the social system. He criticises the subsequent defensive reaction of technology developers to this controversy as well as the lack of real dialogue, and mutual learning, and insufficient serious debate. As opposing views on technology are inevitable in a pluralistic society, Todt (1997) proposes that different values, world views, problem definitions and ideas should contribute to the design process thus providing a wider perspective on the technology. He recognises lay judgement as being as valid as expert judgement due to its greater sensitivity to social and political values or future uncertainties. Shove (1998) recognises the inextricably social character of technical change. Todt (1997) considers that the participation of affected parties in the design would lead to *"better and more legitimate decisions [and] ... more stable definitions of technical systems"*.

On the other hand, Saha (1998), does not perceive participation as being conducive to technology design. Reflecting on the importance of individualism in

[4] The suitability of the technology to the environment in which it is used and hence market appeal (Doithwaite, 2002).

innovation, Saha (1998) states that *"[a] group discussing a problem rarely comes up with a high-quality solution. Creative individuals are usually persons above the ordinary intelligence who possess knowledge and experience in a wide range of fields"*. Saha (1998) states that in US firms, the earliest stages of product development are best left to creative individuals. Saha (1998) adds that Japanese firms subscribing to team approaches were very successful at commercialisation, but not innovation. Thus participation in design is considered as inhibiting individual creativity. Rogers (1995:139) states that the *"usual bureaucratic structure of an organisation is not very conducive to creating technological innovation"*, and highlights the success of closed door, highly competitive design environments. Mokyr (1990) believes that the process of inventing *"occurs at the level of the individual"* and is *"an attack by an individual on a constraint that everyone else has taken for granted"*, which does not lend itself to a broad consensus approach.

Drawing on studies of the design process, Todt (1997) describes it as a *"bricolage"*, which is not linear and orientated towards a clear defined goal, but a *"messy"* process whose final outcome is far from obvious. Some technologies, technology design aspects, cultures and individuals may favour a closed door approach, while others may be suited to being more inclusive and participatory. Todt (1997) does not expect that all design aspects should be agreed upon, but rather that participation should enable designers to be better informed and more conscious of the social aspects of technology. Todt (1997) also accepts that the margin of influence for change decreases as the technology becomes more clearly defined but does not see this as problematic, as long as the main issues are considered at the early stages. The role of participation in the technology design process is discussed further in chapter 9.

Despite criticisms of 'participation', the concept remains firm within development rhetoric and practice, and provides an approach by which individuals and society can potentially develop ownership and influence the process and outcomes of development projects and technology design. The World Bank (2001a) defines participation as *"the process through which stakeholders influence and share control over priority setting, policy making, resource allocations and access to public goods and services"*.

In developing a principle regarding the approach of development and technology transfer projects, this thesis follows the call by Carmen (1996) for clearer definitions. 'Participation' is defined as a means to an end, a process of beneficiary involvement in order to foster ownership for sustainability. Empowerment is defined as the process by which control over decision making is shared between the parties involved. This thesis subscribes to the view that participation and empowerment are requisite components of design and technology transfer in a development setting.

Principle 1: The actors who will be affected by the technology, or who can affect its uptake, must actively participate and be empowered to take part in decision making in technology design and project implementation, thus developing a sense of ownership of the technology.

3.2.2 The Private Sector

"The importance of the small enterprise to economic and social development in Africa is almost undisputed" (Rogerson, 2001), and considerable importance is attributed to the development of the private sector in the Third World (Schlupen, 2002). Micro and Small Enterprises (MSEs)[5] are estimated to comprise one quarter of the labour force in the Third World (Davies et al, 2001). They are recognised as playing a key role in the social and economic development of the Third World (Dawson, 1997), although little is known about the ways they grow and change over time (McPherson, 1996; Mead, 1999). MSEs have latterly attracted considerable interest from policy makers and scholars in the Third World (Mead, 1999) in the wake of the successes of the micro-credit approach of the Grameen Bank in Bangladesh. However, mechanisms employed to build up MSEs are not limited to credit access. They include business training and the implementation of policies which favour MSEs (eg Government departments in Ceara State, Brazil sourced goods and services from small local producers) (Dawson, 1997).

Private sector involvement comes in the form of privatisation, private sector participation (PSP) and public-private partnership (PPP). None of these terms are mutually exclusive and they can involve businesses ranging from MSEs to trans-

[5] Mead (1999) defines Micro and Small Enterprises (MSEs) as enterprises with between 1 and 50 workers.

national corporations. Britain's experience of the privatisation of state owned enterprise in the 1980s contributed to the promotion of similar measures throughout the world. Subsequently, divestiture has become a major component of economic reform programmes in the Third World. The widely held belief is that the fiscal deficit of these countries can be reduced by removing the huge financial burden of state owned enterprises on Treasuries. Furthermore, it is held that privatisation will improve the unsatisfactory performance of publicly owned and managed utilities (Ariyo & Jerome, 1999), while MSEs are considered by many as a *"source of economic salvation"* (Mead, 1999).

"[The] development of a strong private sector [has] in many respects become the super-ordinate medium-term objective of structural adjustment programmes everywhere in Africa" (Bennell, 1997). Private sector involvement is also starting to be accepted within the realms of the sustainable development approach. Interest and experience in private sector involvement in the provision of rural water supplies is increasing and some of the lessons learnt in urban and peri-urban environments have application in the rural setting. The World Bank's Water and Sanitation Programme (WSP) claims that there has been significant long term failure of water supply schemes where service delivery has involved the public sector service and external support agencies. It claims that there is growing experience which shows that *"increasing private sector delivery of rural water supplies can improve the quality and quantity of services..."* (WSP, 2001a). The involvement of the private sector in water and sanitation service delivery is becoming a requisite component of development interventions following mainstream international development policy.

Prior to 1990 almost all Third World countries depended on Government for the provision of water supply and sewerage services (Silva et al, 1998). Private sector participation in water and sanitation has risen considerably since then. The World Bank's PPI (Private Participation[6] in Infrastructure) project database, contained records of 97 projects in 35 countries in the water sector by 1997 (Silva et al, 1998).

[6] The definition of private participation is *"the private company must assume operating risk during the operating period or assume development and operating risk during the contract period. In addition, the operator must consist of one or more corporate entities, with significant private equity participation, that are separate from any government agency"* (Silva et al, 1998).

Involvement is primarily in the urban sector, with concessions as the most popular type of contract (Silva et al, 1998).

Private sector participation in urban water supply is advocated by the World Bank (2002). However, it is not without its critics. Van den Berg (2000) cites the case in Buenos Aires where the tariff structure initially favoured existing users and was skewed against new connections. This created difficulties in expanding services to the poor. In addition to these large concessions, the private sector also comes in another form. Small enterprises are particularly involved in supplying water to the urban and peri-urban poor who are not connected to municipal supplies. Water vendors, for example account for more than 30 percent of supply in Tegucigalpa, Guatemala City and Lima (Solo, 1999).

Private sector involvement in rural water supply is still in its infancy. Franceys (1997) points out that *"the international operation and maintenance contractors have only limited capacity which they are likely to focus on the larger cities in the upper-middle income countries"*. The main components of rural water provision comprise user sensitisation, construction, and maintenance. There are some precedents for private sector involvement in the latter two. In Bangladesh, it is estimated that more than 65 percent of the approximately four million tubewells have been privately installed (Robinson et al, 2000). The Water and Sanitation Programme (WSP) found that the private sector had created effective supply chains for handpumps, and that competition kept prices reasonable and products reliable (Robinson et al, 2000). Much still remains unknown with regards to tapping the potential human capital of local, rurally based artisans.

Concerns over private sector involvement in development are not restricted to the water sector. Ariyo & Jerome (1999) state that there is considerable recognition that privatisation of state owned enterprise in Africa is not what was expected. Steel (1995) argues that the conditions facing entrepreneurs in many African countries *"make simply surviving a miracle"*. Ariyo & Jerome (1999:210) point out that *"few countries in Africa possess the characteristics that make for successful privatisation. These include the absence of developed capital markets with considerable depth and adsorptive capacity, lack of appropriate legal and judicial frameworks, the generally low per*

capita income and non-conducive regulatory structures". Such problems are faced by privatised parastatals and MSEs.

The small enterprise economy is heterogeneous, with differences between location, sectors and proprietor gender (Rogerson, 2001), whether they are survivalist or growth oriented (Mead, 1999). Findings of the USAID GEMINI (Growth and Equity through Microenterprise Investment and Institutions) project, which interviewed over 20,000 small enterprises across South Africa, Kenya, Malawi, Lesotho and Botswana, as well as other studies in Kenya are that successful business is highly dependent on the location of the business premises as well as the business sector (Rogerson, 2001). Most MSEs only generate a limited income (less than the minimum wage) for their workers, the majority are very small (Mead, 1999) and businesses often end with the death of former entrepreneurs (Mead & Liedholm, 1998). Key elements of successful graduation from a micro to an established enterprise (a transition made by less than 1% across southern Africa) were found to be stable access to markets, outside access to capital and a capacity to innovate and take risks (Mead, 1994).

Access to finance is a major barrier to private sector development (Rogerson, 2001) and most research on MSEs has concentrated on the effectiveness of micro-finance programmes (Davies et al, 2001). The need for credit relates to the affordability of the business venture which is considered in Principle 14. However, studies indicate that although credit frequently reduces short term hardships, there is little evidence of it improving productivity and capacity in the form of increased technical sophistication, output, or employment (Dawson, 1997). Credit is not a panacea, and there are warnings about the failure of the 'micro-credit monoculture' (Rogerson, 2001; Buckley, 1997) and credit without parallel support (Dawson, 1997).

Evidence suggests that although survivalist enterprises often require working capital in order to sustain and augment their performance (Mead, 1999), the constraint for growing enterprises is actually market access rather than working capital (Mead, 1999). In addition, informal credit is also prevalent and the most common form of start-up funds usually come from savings, gifts and informal loans from friends and relatives (Buckley, 1997) rather than formal credit schemes while further sources include suppliers or merchants (Rogerson, 2001). Micro-finance schemes are thus not a one

stop shop to enterprise success and growth and must form part of a wider scope of consideration.

Other issues relating to MSE success include entrepreneurship, clusters and policy. Mead (1999:65) acknowledges that *"anyone working in this area knows the importance of motivation, enthusiasm, and a whole list of similar personal entrepreneurial characteristics, as determinants of success in enterprise development"*. Entrepreneurship has been found to be a matter of skills and learning capacity rather than a cultural inheritance (Rogerson, 2001). Mead (1999) suggests that the combination of education and experience have a significantly higher impact on enterprise growth than either of them on their own. McPherson (1996) found that the level of human capital, firm location, sector and proprietor gender are important determinants of growth. This contradicts Lee and Peterson's (2001) culture-based model of entrepreneurship which combines the cultural dimensions of power distance, masculinity, uncertainty avoidance and individualism from Hofstede (1980) and achievement orientation and universalism from Trompennaars (1994). Lee and Peterson (2001) do not value education and experience in enabling enterprises to be successful.

Spatial and sectoral clusters, as well as networks based on trust relationships have been found to provide entrepreneurs with information about the wider world (Barr, 1998) enhancing the competitive advantage of the cluster as a whole (Humphrey & Schmitz, 1998). A favourable macro policy environment is also important to MSE development (Rogerson, 2001).

In the past, business development services have been criticised due to their limited impact, the fact that they were supply driven and that they were too expensive (Dawson, 1997). Consequently the focus of development agencies shifted to credit schemes rather than training (Rogerson, 2001). However, new business development service initiatives have become more effective and wider in scope. They:

a) utilise a sub-sector approach for the analysis and diagnosis of constraints on MSEs and identify problems and solutions specific to the system in which they operate (Dawson, 1997);
b) find nodal points where products and services benefit many enterprises (Dawson, 1997); and

c) promote linkages and subcontracting agreements between large and small enterprises (Rogerson, 2001).

New research (Rogerson, 2001) is showing that vocational training for self-employment should be based upon traditional practices, in particular apprenticeships. McCormick (1999) identifies the underwriting of the development of new technology as a suitable area of development intervention to help technology clusters. This complements the view that the private sector can be considered to provide a suitable market for technology uptake.

In defining principles to guide private sector involvement, this thesis seriously considers:

(1) the call for a balanced approach to business development which includes technology upgrading, improved business and financial management and improved market access (Dawson, 1997);

(2) calls for analysis, eg Ariyo & Jerome (1999) who point to the urgent need for studies of the African private sector to identify their strengths, weaknesses and requirements for capacity building; Schlupen & Gibbon (2002) who advocate private sector development based on a clear analysis of the strengths, weaknesses and dynamics of local private sectors;

(3) a recognition of enterprise heterogeneity (Rogerson, 2001; Mead, 1999) and the need for intervention to adapt experience to the individual situation (McPherson, 1996; Mead 1999); and

(4) the need for some form of regulation (Ariyo & Jerome, 1999).

This leads to the following:

Principle 2: An analysis of the strengths, weaknesses and dynamics of the potential private sector technology operators must be undertaken to understand (a) target markets and (b) bottlenecks, and (c) determine requisite training and support and (d) an effective regulatory framework.

3.2.3 Change Agents and Agencies

The change agent comprises the individual, or group of individuals, who represents the change agency to the beneficiaries. They are the people on the 'front line', interacting with the beneficiaries, but usually funded by and accountable to the

change agency. In the case of an extension project, the change agents are the extension officers.

Individual change agent characteristics are cited as contributing to the likely adoption of innovations. For Rogers (1995), effort and a bias towards the beneficiaries, rather than the change agency, are very important. The change agent credibility ie a positive image in the eyes of the beneficiaries are considered significant (Rogers, 1995; Niehoff and Anderson, 1964) as is change agent homophily[7] with beneficiaries (Rogers, 1995). Cultural differences between different stakeholders inhibit technology transfer across nations (Kedia and Bhagat, 1988) while change agent adaptation to the local culture (Niehoff and Anderson, 1964) contributes to the likely adoption of the innovation. Effective communication is important (Niehoff and Anderson, 1964), particularly given the importance attributed to face-to-face contact in associative cultures (Kedia and Bhagat, 1988).

Rogers (1995) points out that the fact that change agents are situated midway between the change agency and the beneficiaries means that they face particular problems due to social marginality, and that information overload often occurs, causing ineffectiveness. Development perspectives which typically concern participatory development strategies, emphasise the importance of the independent capacities of well motivated practitioners (change agents) who should be *"given resources and considerable flexibility as long as they remain within the established parameters"* (Clements, 1999). Niehoff and Anderson (1964) also stress the importance of flexibility.

Chambers et al (2001) consider power, procedures and relationships to be the new dynamics of aid. Pointing out the gulf which can separate rhetoric from reality in the current developmental concepts of empowerment, accountability, ownership, partnership, participation, transparency and primary stakeholders, they argue that much current practice of change agencies actually prohibits the proper practising of these concepts. The dominance of controlling measures such as the need to spend money within a fixed time frame, the conditionalities of expenditure, and a rigid logical framework approach can undermine participation, ownership and self reliance. Lack of

[7] *"Homophily indicates the degree to which two or more individuals who interact are alike in certain attributes eg beliefs, education and social status"*. It is the opposite of heterophily (Rogerson, 1995).

top-down transparency, yet the requirement for transparency from the bottom up, sends signals of lack of trust to stakeholders which inhibit partnership. Chambers et al(2001) thus moves beyond the importance of considering the individual change agent's characteristics to considering the characteristics of the change agency.

Several aid agencies are taking steps to address issues of power and transparency. For example, at the donor level, DFID is forming new partnership agreements on a basis of *shared* principles with INGOs (Chambers et al, 2001). At INGO level Action Aid's new planning system encourages reporting up and down the chain, and participatory monitoring and evaluation is rapidly growing (Chambers et al, 2001). However, it remains to be seen if these measures will enable the apparently required change in relationships for a participatory and empowering form of development.

The above discussion suggests that change agent and agency characteristics both need to be considered within development and innovation diffusion. The main points are brought together as follows:

Principle 3: The change agent must (a) be credible to the stakeholders, (b) have a bias towards and some homophily with them,(c) adapt to the local culture and (d) communicate effectively.

Principle 4: The change agency must (a) be transparent, (b) show respect for the participants and (c) be able to relinquish power.

3.3 TECHNOLOGY TRANSFER PRINCIPLES

3.3.1 Introduction

*"Diffusion is the process by which an **innovation** is **communicated through certain channels** over **time** among the members of a **social system**"*, (Rogers, 1995, my emphasis). Rogers' definition provides a starting point for a review of technology development and transfer criteria, with the four elements of diffusion emphasised above considered below.

3.3.2 The Innovation and the Social System

Definitions of Appropriate Technology (AT) include references to the maximisation of social welfare, or specific characteristics, which vary (Stewart, 1987). With respect to economic characteristics *"A more appropriate technology is normally defined as: more labour-using in comparison with less appropriate technology ...; less capital using...; less skill-using; making more use of local materials and resources; smaller scale; and producing a more appropriate product"* (Stewart, 1987). Definitions of AT are relative and there are no universally appropriate technologies (Segal, 1992). It is the purpose of the AT philosophy to focus the designer on the context and its relationship to the technology, rather than focusing on the technology per se.

With no universal definition of AT, designers, change agencies and beneficiaries must determine what is appropriate for the context. The literature provides a wide range of experiences and ideas with respect to AT which can be adapted in order to determine a set of working criteria. AT aims to provide a fit between Rogers' elements of the **innovation** and the **social system**, or context, which are both considered in this section.

The following observations have been primarily drawn from Rogers (1995) and three papers, selected because of their applicability to the design of the LCDP technology. Wicklein (1998) lists seven criteria, developed by specialists in the field of appropriate technology, to judge beforehand whether a particular technology has the potential to be successful in a Third World country. Wicklein emphasises the need to balance these criteria with human needs. Orphwood (1990) and Lysack et al (1999) can augment the criteria. Their work concerns the development of aids for the disabled in the First and Third World.

Rogers (1995) considers that the following five attributes of the innovation affect adoption:

(1) the relative advantage of the innovation over what it supercedes;
(2) the compatibility of the innovation to existing values, beliefs, experience and needs;
(3) the complexity of the innovation;
(4) the trialability of the innovation and
(5) the degree to which the results of the innovation are visible.

Rogers' first attribute asserts that the innovation must have advantages over existing methods if it is to be of real value to the target beneficiaries. Although there will be cases where the technology is filling a gap rather than superceding existing technologies, the potential users will still tend to compare it with something else that they perceive to be similar. Substituting the term 'technology' for innovation leads to

Principle 5: The technology must have an advantage over existing technologies which serve a similar purpose.

the following principle:

Rogers' second innovation attribute, *the compatibility of the innovation to existing values, beliefs, experience and needs* relates to culture and needs. "*Culture is the link between human beings and the means that they have of interacting with each other"* (Hall, 1973*). "Human beings the world over have very different ideas about what is pleasant and unpleasant, polite and rude, true and false, right and wrong. All of these differences, found within a single biological species, are expressions of human culture"* (Rogers et al, 1988).

Saha (1998) claims that the values of dominance of man over nature, the supremacy of reason, an emphasis on individualism, change, hedonism and a developed aesthetic sense explain why modern technology originated in the West, and why Western companies continue to lead in terms of innovation. She calls for a cultural analysis in order to identify elements which support or challenge technology growth to ease an adjustment of values to better suit the needs of technology. Saha (1998) is biased towards technology and considers some cultural values as barriers. Missing from her paper are methods of changing these values, other than a call for their understanding.

Hofstede (1980) mapped national cultures according to four dimensions of

(i) weak vs strong uncertainty avoidance, ie the need to avoid ambiguous situations;

(ii) individualism vs collectivism, ie self interest over common interest;

(iii) small vs large power distance, ie the acceptance of unequal distribution of power by the less powerful and

(iv) masculinity vs femininity, ie the dominance of achievement of rewards, acquisition of money and status and assertiveness.

The dimension of long vs short term orientation was added later (Hofstede, 1991). Glenn and Glenn (1981) are concerned with associative vs abstractive cultures, which affect behaviour and cognition. Whereas associative cultures emphasise face-to-face communication with people with a shared context, abstractive cultures convey considerable information through the mass media (Kedia and Bhagat, 1988).

Kedia and Bhagat (1988) propose that cultural factors affect transfer of technology as follows. They propose that:

(i) process and person-embodied technologies are considerably more difficult to transfer than product-embodied technologies, as cultural (and strategic management) factors play a larger role;

(ii) similar attitudes to uncertainty avoidance between change agencies/agents and beneficiaries improve technology transfer;

(iii) technology which alters power distribution, status and rewards in countries that emphasise power distance is likely to be resisted;

(iv) individualistic cultures will be more receptive to technology transfer;

(v) masculine cultures absorb and diffuse technology more effectively than feminine cultures and

(vi) technology transfer is more likely in abstractive cultures.

Kedia and Bhagat (1988) propose that cultural differences exert a stronger influence on technology transfer between industrialised and developing countries than between industrialised countries. Although technology transfer may include a process of design in country, the culture of the urban elite designers may be considerably different to that of the beneficiaries. Cultural differences occur within as well as across nations and in-country design may be preferred but does not provide a silver bullet.

Reflecting on the cultural barriers which many Third World societies may have with respect to technology uptake provides thought provoking explanations as to why parts of the world are industrialised and hold economic prowess, while others are not, and such reflection provides possible reasons for failed technology transfer. Although helpful in conceptualising cultural differences, it should be recalled that the original diffusion paradigm was criticised for its individual blame bias (Rogers, 1995). The

cultural barriers suggested by the literature can lead to a cultural blame bias, where culture is blamed for its lack of innovativeness. As with the individual blame bias this is only part of the picture of technology uptake and should not be considered in isolation.

The cultural dimensions which are considered to be a hindrance to technology diffusion cannot be avoided in technology transfer to the Third World. This research and other AT projects are biased in favour of technology uptake, either as an end in itself or as a means, for example to reduce drudgery or poverty. They must therefore endeavour to do their best in the culture in which they operate, but need to select and design technologies with culture in mind. Thus, in drawing out a principle, it is worth considering those cultural dimensions which can be considered in design.

Wicklein recommends that *"...a design for appropriate technology must take into consideration the culture in which the technology will be used in order to provide the best type of technology for society."* He advocates that *"...designers...must incorporate an 'image of modernity', an appeal to dignity and pride...[into the technology] if it is going to meet the acceptance by the people who can benefit from it the most."* This is based on the fact that people need to feel important, and evidence that they prefer technologies which elevate rather than diminish their social status.

An 'image of modernity' does not always give rise to an elevated social status and technologies may be rejected despite their image of modernity. For example, the boiling of water in Peru was not adopted as boiled water was associated with hot substances, which in turn were associated with illness. Thus, those who drank boiled water were considered to be sick (Rogers, 1995). Although boiling was perceived as modern, it did not elevate social status. It is not modernity but social status which is fundamental to the cultural acceptability of a technology. Technologies are extremely unlikely to be adopted if they diminish the social status of the users.

Wicklein also advocates that cultures which are more collective require technologies which fit that ethos, while cultures which place a priority on individual responsibility and accomplishment require a different technology design.

The alteration of power distribution, status and rewards in countries that emphasise power distance by technology is likely to be resisted according to Kedia and Bhagat (1988). Ensuring that technologies do not disturb this status quo removes the

politics from technology transfer. This goes against Bordenave (1976) who sees the adoption of innovation as part of a wider social and political transformation. Technologies can thus be selected to either fit with existing power structures, or to challenge them. The following principle takes the line of fitting the technology to the status quo.

The above discussion concludes with the following:

Principle 6: The technology must be fit for the culture in which it is to be utilised such that (a) it must not diminish the social status of the users; (b) the collective or individual use of the technology must be compatible with local culture; (c) it must not alter the power distribution, status and reward mechanisms in place.

Returning to Rogers' concern with the compatibility between the technology and existing needs, one must question whether the technology is needed, and if so, whether it is desired and needed by the members of the social system in which it is intended to operate. An appreciation of this desirability will affect the approach of the diffusion programme. If the desirability is low to start, with considerable promotion may be required, or technology may be considered as not worth the effort of transfer.

Principle 7: The technology must be desirable to the members of the social system in which it is to be operated.

Rogers' third innovation attribute, *the complexity of the innovation* relates to Wicklein's final criterion, that of the consideration of *"single-purpose and multi-purpose technology"*. Wicklein claims that, *"whenever possible, technology should be developed to accomplish a variety of [specific] applications"* so that one technology can serve the users in a variety of ways. This contradicts Rogers, who advocates the simplicity of the innovation. Multi-purpose technologies only have an advantage if they can easily be converted from one function to another. A technology's fate lies in the hands of the users. There are many examples of their failure in the agricultural sector in developing countries (Chambers, 1997). In the case of the LCDP, the technology is designed for a very specific purpose, ie water well drilling and pump provision. The idea that this scope could be widened is highly unlikely, given such a dedicated

technology. As a result, multi-purpose-ness is not a principle which will be further explored here.

Orphwood (1990) calls for a separation between the design of the "user interface" and the "supporting features" of technology. This distinction is very useful as it provides a way of conceptualising the hardware design which explicitly recognises both the way in which the technology will be used and its intrinsic capability. Both user interface and supporting features relate to Rogers idea of *complexity*.

Let us first consider what Orphwood (1990) means by "user interface". He believes that lack of attention to the user interface is the reason that many aids for the disabled fall short of being truly effective. He demonstrates consideration of the user interface by testing the device on users in the form of a rough prototype. This then enables the design of a more effective device than in the situation in which designers base their work on specifications provided by a third party.

On the other hand, Rogers' preference for simplicity is rather subjective. Is a mobile telephone simple to operate for example? It is in fact the fit between the operation and the skills of the operators which is more important than simplicity. In addition to skills, the user needs to be able to provide the requisite organisation for the operation of the technology, whether that be two skilled workers, or a team of unskilled labour. This leads to the following:

Principle 8: The users of the technology must be able to acquire the skills and organisation required for operation of the technology.

Let us now consider Orphwood's "supporting features". Rogers' first innovation variable concerns its *relative advantage* over other technologies, but does not explicitly consider the intrinsic capability of the technology itself, nor is intrinsic capability an explicit feature of Wicklein's criteria. Wicklein considers it important to balance his criteria with human needs, but does not discuss the balance between the criteria and technical functionality. Perhaps consideration of technical functionality is considered by Wicklein and Rogers as too obvious to mention.

Orphwood (1990) and Lysack et al (1999) are explicitly concerned about functionality, which they call the "supporting features" of the technology. Lysack et al (1999) cite one reason for the failure of wheelchairs in Indian villages as inadequate

attention paid to the functional needs of the technology. The appropriate technology approach primarily advocates changes to devices in order to fit in with the environment. In the case of well drilling technology, the physical environment is unchangeable and beyond human control. It is the capability of the technology which determines its applicability to the environment, ie where it can be deployed. It is important that the capability is considered explicitly and is compatible with the desired use. The importance of compatibility is raised by Rogers, but in connection with culture, rather than other environments, such as the physical environment. This leads to the following principle which stipulates that the hardware capability must be fit for its physical purpose.

Principle 9: The technology must be able undertake the task that it is designed for.

Rogers' fourth innovation attribute is its trialability, and he generalises that an innovation's trialability positively influences its rate of adoption. Trialability is influenced by a number of factors including the social, physical and institutional environment.

Systems independence is one of Wicklein's criteria which *"...relates the ability of a technology to stand alone...with few or no other supporting facilities or devices..."* and he states that the criterion should be mainly applied to the cost of necessary supporting materials and equipment as they may provide financial barriers to uptake. Wicklein goes on to say *"...technological advances should only be selected [or by implication developed] if the supporting facilities and devices are already in place, or if only moderate changes and improvements are required for implementation".* Thus the system's independence will affect the trialability of an innovation.

Systems independence overlaps with Wickleins criterion *risk factor*, which he divides into internal and external risks. Collins English Dictionary (1992) defines risk as *"the possibility of incurring misfortune or loss".* The *risk factor* thus covers aspects of the technology as well as the context in which it is to operate. With regard to external risk, Wicklein prefers very little dependence of the technology on external support systems to keep it functioning. Wicklein's internal risk means the chance of failure of the technology within the production system, ie the direct risk associated with operation of the technology. The external - internal split of risk is artificial as the consequences of an internal failure depend upon the externalities. Wicklein then

continues by advocating the need for an element of risk in order to challenge the local economic and production systems as he believes that this enables the technology to gain local ownership.

Trialability is primarily associated with risk. However, ease of operation will also influence trialability, as technologies which require considerable training for use cannot be easily tried by the non-initiated. Operation is covered in Principle 8. The risk element is considered in the following:

Principle 10: The risks associated with the utilisation of the technology package must be acceptable to the users.

Returning to *systems independence*, the nature of some new technologies is such that the operators will always be subject to a certain degree of dependence. Strict adherence to *systems independence* would exclude most non-indigenous technologies. Determination of an acceptable type and level of dependency is more realistic. The benefits of the Village Level Operation and Maintenance (VLOM) concept of handpumps were discussed in section 1.2.5 . Of particular importance is the availability of the required materials and spares, and the ability of the technology to be maintained locally. This leads to the following two, linked principles:

Principle 11: Any supporting materials or consumables required to operate the technology package must be available.

Principle 12: Maintenance and repair of the technology must be feasible.

Rogers generalises that the observability and visibility of an innovation positively influences its uptake. He illustrates his point with a number of examples: HIV/AIDS prevention, in which an unseen virus creates difficulties for the uptake of safe sex; mobile phones, which can be seen, and thus easily emphasise the status of the user illustrates the importance of observability. A huge advertising campaign is likewise easily seen. Rogers merges several issues within this generalisation as he mixes the observable benefits of the innovation to oneself with the visibility of the innovation to others and through advertising. Although they all relate to visual stimuli, they are different concepts and can even contradict one another. Take the example of hand washing for health reasons. Advertising can raise the profile of the issue and

make it very visible, but may not make the benefits any more real than they were before the campaign. On the other hand, the wearing of spectacles is visible to others, but does not elevate the social status of most teenagers in the UK when they start to wear them. These concepts should be separated as follows:

a) visibility of the innovation to others which elevates social status;
b) obvious benefits of the innovation;
c) advertising is part of promotion, and is discussed below.

Rogers points out the importance of mass media in providing knowledge of the innovation, but Kedia and Bhagat (1988) highlight the importance of face-to-face communication in the associative cultures which concern this research. Niehoff and Anderson (1964) state the importance of demonstration of the innovation to recipients. This leads to the following:

Principle 13: The technology must be promoted and demonstrated to the potential users.

Rogers does not explicitly consider the cost of the innovation, although this is a fundamental component of the AT literature. Wicklein's criterion *cost of technology* states that *"in order for an appropriate technology to be helpful in meeting basic needs, the cost of the device must be such that the people in developing countries can afford it*". This requires consideration of the required technical functionality as well as the financial means of those affected by it. In the case of a technology which is providing a service, the affordability by both the operators and the clients of the service need to be considered. The financial cost of a technology does not just include the cost of purchase, or hire of technology, but also the cost of running the business. This is encompassed in the following:

Principle 14: The capital and running costs of the technology must be within the means of the potential operators and clients.

Wicklein states that *"wherever and whenever possible...[it is preferred that] the technology should have design characteristics which allow for a continuation of development"*. In this way, the technology will be able to evolve within the society it is designed to benefit. This can enable the technology to be copied and modified locally for local use. Arguably, if a technology evolves within the society in which it is used, it

can be considered sustainable, if sustainability is considered dynamically, rather than statically. This *"evolutionary capacity*" is considered by Wicklein to be an important attribute of the technology and Rogers acknowledges that different technologies lend themselves differently to modification. This requires questioning, as, without local institutions or individuals with interest, time and money to invest in such a venture there will be no evolution. Thus evolutionary capacity is as much a factor of the context as of the technology. This calls for the use of the following:

Principle 15: The technology must be adaptable and the local institutions able to facilitate its evolution.

3.3.3 Communication

Communication relates to the diffusion practices or approach. Rogers (1995) claims that studies of how the social or communication structure affects the adoption of an innovation are few relative to other aspects of diffusion research. He defines social structure as the expected pattern of social relationships, eg hierarchy in an organisation, and communication structure as the informal, interpersonal networks which determine who interacts with whom. He concludes that the innovativeness of individuals is affected by their social system and their individual characteristics.

Bordenave (1976) is particularly concerned about social structure and considers the adoption of innovations to be part of a wider social transformation, and thus sees diffusion as political. He advocated for diffusion research in Latin America (read Third World) to move on beyond the typical research issues of:

(a) How are innovations diffused?
(b) What are the characteristics of innovators?
(c) What role do opinion leaders play in diffusion?

to:

(d) diffusion and adoption as a problem-solving system, ie understanding the real needs of the client;
(e) the structural framework in which the innovation takes place, ie the influence of society's social structure over individual decisions;
(f) the infra-structural aspects of adoption, eg adverse market, transportation conditions;

(g) the pedagogical aspects of diffusion, ie teaching-learning experience;
(h) the study of global strategies through action research, ie planning, producing and evaluating change while changing.

Shove (1998) points out the need to attend to the institutional and organisational contexts of decision making in order to identify conjunctions of interest for plausible and socially viable opportunities for technology uptake.

Given the fact that this thesis is concerned with innovation diffusion in a developmental context, literature concerning mainstream development practice is drawn upon for consideration of the communication process. The principles for this are thus developed in 3.2.1 which is concerned with participative development.

3.3.4 Time

Time is one of Rogers' four elements of diffusion. Within the element of *time* he considers the trajectory of the innovation-decision process (from first knowledge to adoption or rejection); the innovativeness of an individual, or other adoption unit (early adopter, early majority, late majority or laggards depending on the rate of adoption) and the rate of adoption (the number of members of a system which adopt the innovation in a given time period) (Rogers, 1995). Rogers (1995) recognises that adoption rates for the same innovation vary between the type of innovation decision (individual or group), and the nature of the social system in which it is diffused.

There is considerable variation in the rate of adoption for different innovations, individuals, groups and social systems. As the rate of adoption is affected by a multitude of factors, it is very difficult to predict accurate time horizons for early adoption and wider uptake of an innovation. The point in time at which adoption or uptake is measured can affect whether the diffusion of an innovation is considered successful or not.

Douthwaite (2002) states that a time span of fifteen years was required by manufacturers of wind turbines to learn from experiments before reliable computer models could be used for improving the design. Douthwaite (1995) adds that *"this time span was also required to allow the socio-ecomomic environment for the technology to coevolve"*.

Chambers (1997) voices concern about the pressure to disburse and spend, which are common in donor funding, especially the multilateral banks. Meanwhile

Government officials strive to spend and achieve targets by the end of the financial year. In both cases delays are generally considered as slippage rather than opportunities for participation and learning (Chambers, 1997). However, rapid identification of projects and rushed development intervention reduces the scope for learning and the consideration of the wider institutional, cultural, socio-economic and political context. Douthwaite (2002) compares the Danish and American wind turbine industries and concludes that programmes driven by budgetary time frames rather than how a technology actually works inhibit product design and uptake of the innovation.

In order to develop an improved understanding of the sequence of events within the innovation-decision process, Rogers (1995) recommends a dynamic process involving qualitative research rather than the one-shot quantitative surveys which currently dominate diffusion research.

In technology transfer, there are three time considerations which stand as important. The first is the fact that technology development, adoption and uptake take time, and what may be considered as failed diffusion may actually be measured against an unrealistic time horizon. Second, different stages of the diffusion process take different amounts of time. Third, timing is key to successful uptake (Niehoff and Anderson, 1964). A great innovation launched at an inappropriate time, can become inappropriate. These three considerations lead to the following:

Principle 16: Adequate time and appropriate timing of the technology transfer process and its component stages must be allowed for.

3.4 THE FRAMEWORK

The principles which have been extracted and developed above, from a range of literature concerning Third World development, diffusion of innovations and technology transfer fall into one of the following two categories:

a) the **process**, ie the *way in which* the development intervention is undertaken or
b) the **interface**, ie *attributes of the technology with respect to the physical, political, economic and social context.*

The principles are drawn together in a framework shown in Table 3.1.

Although the framework separates the principles into two categories, there is no indication of the importance of one principle relative to another. Neither does the

framework indicate if all, most, or a few key principles are requisite for successful technology transfer. The framework is not intended as a guide for best practice to be applied mechanistically to all technology transfer projects. Rather it is summary of a large body of literature, interpreted by an individual and a useful checklist for planning and implementing technology development and transfer projects. It provides a basis from which to reflect on the findings of the field project which provides the basis for the research in this thesis.

The subsequent chapters of this thesis analyse the technology, three stakeholder groups (private sector, public sector and communities), and the project process. Several principles are reflected upon in the conclusions at the end of each chapter. Each principle is only reflected upon once, in the chapter shown in the right hand column of Table 3.1. Although several principles could be discussed in multiple chapters, the single most appropriate chapter has been selected for discussion to avoid undue repetition.

Table 3.1: Working Framework - Technology Development and Transfer

Process Principles			**Thesis Chapter with Discussion**
Participation	1	The actors who will be affected by the technology, or who can affect its uptake, must actively participate and be empowered to take part in decision making in technology design and project implementation, thus developing a sense of ownership of the technology.	9. Process
Private Sector	2	An analysis of the strengths, weaknesses and dynamics of the potential private sector technology operators must be undertaken to understand (a) target markets and (b) bottlenecks, and (c) determine requisite training and support and (d) an effective regulatory framework.	6. Private Sector
Change Agent	3	The change agent must (a) be credible to the stakeholders, (b) have a bias towards and some homophily with them, (c) adapt to the local culture and (d) communicate effectively.	9. Process
Change Agency	4	The change agency must (a) be transparent, (b) show respect for the participants and (c) be able to relinquish power.	9. Process
Promotion & Demonstration	13	The technology must be promoted and demonstrated to the potential users.	9. Process
Time	16	Adequate time and appropriate timing of the technology transfer process and its component stages must be allowed for.	9. Process
Interface Principles			
Advantage	5	The technology must have an advantage over existing technologies which serve a similar purpose.	5. Technology
Culture	6	The technology must be fit for the culture in which it is to be utilised such that (a) it must not diminish the social status of the users; (b) the collective or individual use of the technology must be compatible with local culture; (c) it must not alter the power distribution, status and reward mechanisms in place.	7. Public Sector
Desirability	7	The technology must be desirable to the members of the social system in which it is to be operated.	7. Public Sector
Operation	8	The users of the technology must be able to acquire the skills and organisation required for operation of the technology.	6. Private Sector
Capability	9	The technology must be able undertake the task that it is designed for.	5. Technology
Risks	10	The risks associated with the utilisation of the technology package must be acceptable to the users.	8. Community
Affordability	14	The capital and running costs of the technology must be within the means of the potential operators and clients.	6. Private Sector
Availability	11	Any supporting materials or consumables required to operate the technology package must be available.	6. Private Sector
Maintenance	12	Maintenance and repair of the technology must be feasible	5. Technology
Evolution	15	The technology must be adaptable and the local institutions able to facilitate its evolution.	9. Process

4 The Context - Uganda and the Low Cost Drilling Project

This chapter sets out the context of this work. Key environmental, socio-economic and cultural aspects of Uganda are introduced, national rural water policy and programmes are described, and the Low Cost Drilling Project is summarised.

4.1 INTRODUCTION

Uganda, having suffered many years of civil war since its independence, is now on the whole at peace, with a growing economy, although it still remains one of the poorest countries on earth. Despite the improvements in the last twenty years, safe water access within 1.5 km of the home averaged 50% in the rural areas in 2000, with considerable variation across the country (MoFPED, 2000). This low coverage presents an enormous burden and heavy economic cost for most rural families, and places Uganda as one of the least served countries for safe water access in the world. The current Government is highly committed to improving access to safe water in rural and urban areas and has considerable donor support to do so.

Groundwater is considered to be an important water resource for domestic and agricultural supply in Uganda as in much of Africa. Polluted surface waters, long distances to traditional sources and scattered rural populations make groundwater sources fitted with handpumps a good option which has the potential of being contaminant free and close to the users. In addition, there was a felt gap in the ability of current technologies to provide low cost, shallow water sources in the regolith (see box 5.1 for definition).

Decentralisation, privatisation, the commitment to appropriate technology, the hydrogeological potential, the increased funding of the rural water sector over the next 15 years as well as the weaknesses in current water supply technologies provided fertile soil in which to sow the seeds of the Low Cost Drilling Project (LCDP). However, the rapid changes in policy since the early 1990s have resulted in a very dynamic environment, which institutions and individuals are struggling to keep up with. Such a dynamic environment presents challenges to the uptake of new technology.

4.2 SELECTION OF COUNTRY OF OPERATION

The location for the research project, referred to as the "Low Cost Drilling Project" (LCDP) was open to being one of Kenya, Ghana or Uganda. In November 1998, two project team members visited these three countries to determine their potential for the LCDP. They were seeking a country where there was:

- a potential market for a new low cost, shallow water well drilling technology;
- an active private sector with interest and potential to take up the technology commercially;
- manufacturing potential for the rig to be locally built and
- a committed local organisation, preferably the Government, which would fund the in-country testing of equipment yet to be designed.

Ghana was found to have potential, with interest from private sector well diggers, a reasonable manufacturing potential and a keen interest from Government and NGO stakeholders. However, no one was willing to provide a financial commitment to support the test drilling activities. Kenya was industrially well developed, but there was lack of enthusiasm for the LCDP and the private sector was not very active in water source construction.

In contrast, Uganda, with its commitment to private sector water source construction (and privatisation in general), and low cost technology in the water sector was very quick to show a keen interest in the LCDP. The team was ultimately persuaded to stay by the Government of Uganda's Directorate of Water Development (DWD). It was the Assistant Commissioner for Rural Water's statement *"we must not be afraid to fail"*, expressing the desire to collaborate, despite the fact that the technology, not only new but yet unproven which convinced the team that they should operate in Uganda. Shortly afterwards, DWD and UNICEF, administering Swedish Aid for International Development (SIDA) funds in rural water supply agreed to join hands with the LCDP, not only to fund the experimental drilling, but also provide a context in which the project should operate, that of the Water and Environmental Sanitation (WES) Programme in Mpigi district. The LCDP commenced in Uganda with commitment from Government stakeholders.

4.3 UGANDA

4.3.1 General

Uganda is an agricultural country in the heart of East Africa (Figure 4.1) with an estimated population of 24.7 million (Uganda Bureau of Statistics, 2002) which is growing at 3.1% per annum (UNDP, 2001). In 1999 Ugandans had a life expectancy of 43 years (compare with Germany's 78 years), which is one of the lowest in the world. An estimated 8.3% of the adults are infected with HIV (UNDP, 2001) and it is said that no family in Uganda has been spared from the effects of AIDS which includes caring for an estimated 1.8 m orphaned children.

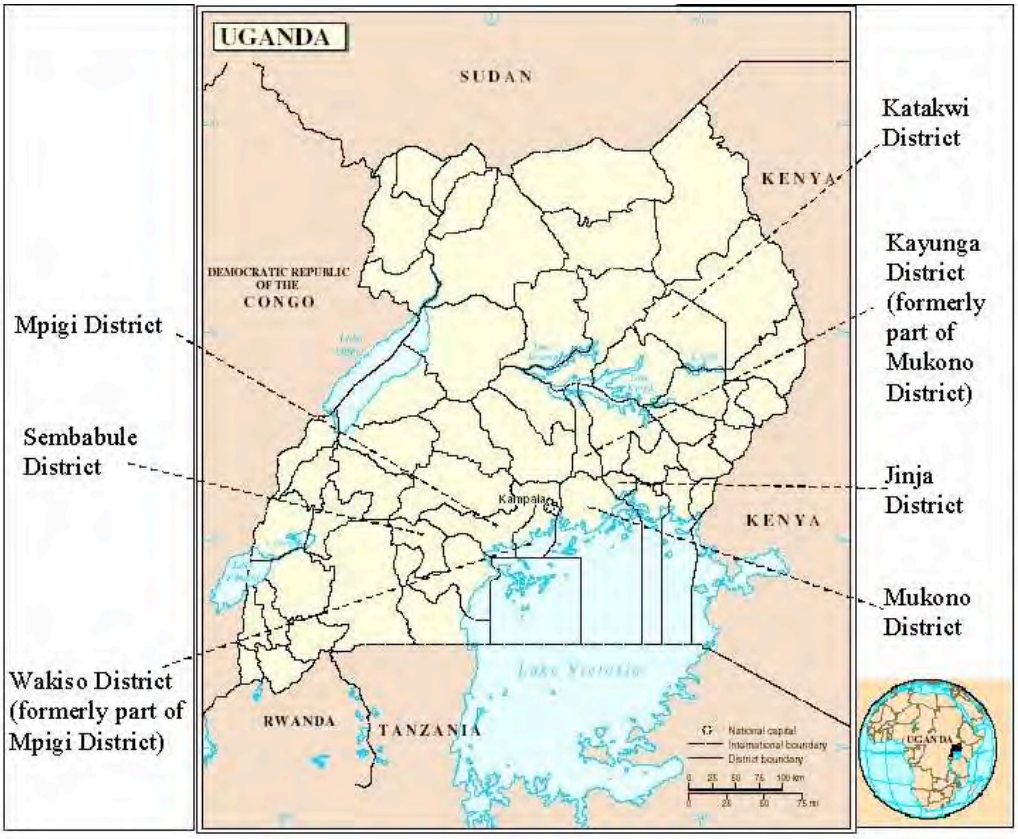

Figure 4.1: Map of Uganda (with District Boundaries, 2002

The World Bank development indicators of 1999 show that the Ugandan Gross National Income was $320 per capita (Germany $25,620) while the Gross Domestic Product (GDP) was $6.4 bn (Germany $2,100 bn). Uganda holds position 141 out of 162 on the Human Development Index with a value 0.435 (UNDP, 2001), which is up

from 0.384 in 1985. An estimated 30% of the population are undernourished and the under five mortality rate is estimated to be 13% (UNDP, 2001).

Uganda has been subject to immense suffering since gaining independence in 1962. An estimated 500,000 Ugandans died during the course of terrorism and war, with up to another 1m fleeing their homes. Prior to the colonial administration, each nationality had its own governing system, which ranged from monarchical, central Kingdom of the Baganda to highly de-centralised "republican" organisations in the non-kingdom areas of the North-east and South-west (Lubanga, 1996). Milton Obote became the first Prime Minister after independence in 1962, and the economy was considered successful until Idi Amin's military regime took power in a coup in 1971. Amin suspended the constitution, abolished parliament, dissolved district councils and ruled the country by decree. The regime was overthrown in 1979, and was followed by several short-lived Governments until the Uganda Peoples Congress, under Milton Obote regained power in 1980 after disputed elections. The priority of the second Obote regime was to achieve national integration, unity and development through a centralised planning and development policy. However, it was said that there were more violent deaths in this period than under Amin (Clarke, 1983).

The National Resistance Movement (NRM) was formed in 1980, as a result of the disputed election results and fought a protracted guerrilla war. Although the Okello military junta seized power in 1985, 1986 saw them overthrown by the NRM, which has remained in power for the last 17 years, under President Yoweri Museveni. Most of the country is now at peace, although there is still internal conflict, particularly in the north and west of the country.

Following the collapse of the economy during the Amin and Obote II regimes, there has been considerable recovery. The growth of the GDP in Uganda has averaged 6.4% p.a. over 1990 to 2000, compared to 1.6% in the remainder of sub-Saharan Africa while per capita income has grown by almost 50% (FAO, 1998). However, the country is still heavily burdened with external debt, has a very low tax base and is thus reliant on external funding, which allows external agencies to exert powerful influence on Government economic and social policy (Carl Bro International, 1995).

Having adhered to structural adjustment policies, Uganda has become the darling of the International Monetary Fund (IMF). As the first country to benefit from

the Highly Indebted Poor Countries (HIPC) initiative, the country had $650 m of its $3.25 bn total external debt forgiven (FAO, 1998). Uganda will also benefit from the Enhanced HIPC Initiative (World Bank, 1999).

The people of Uganda comprise a variety of ethnic groups, of which the major ones are the Baganda, Bunyoro and the Batoro. Although English is the official language, Nilotic and Bantu languages are spoken in the north and south respectively. There is considerable cultural diversity within Uganda. In terms of religion, 10% of the country are Muslim, 50% are Christian (Catholic and various Protestant denominations) and 40% are traditional (mostly animist) (New Internationalist, 1996).

89% of Uganda's population live in rural areas and the economy is heavily dependent on agriculture (FAO, 1998). Most agriculture is performed on farms of less than 2 ha, using family labour and non-mechanised methods. Subsistence agriculture accounts for about two-fifths of agricultural output and one-fifth of total economic output (FAO, 1998). Of the rural population, 90% are subsistence farmers or fishers (FAO, 1998). The survival of rural Ugandan citizens through the many years of civil strife was due to the fact that they could rely on their subsistence agriculture.

Coffee accounts for 60% of the country's export revenue, which also depends to a lesser extent on tea, sugar, tobacco and cotton as export crops. All of these are subject to the volatility of international markets. Manufacturing and mining generate 12% of the export revenue. Uganda imports all its vehicles and petroleum, and to service the manufacturing that is undertaken in the country, virtually all the machinery, equipment and spares are imported. Key components of the manufacturing sector include food, beverages, textiles, leather, footwear, wood and furniture, and mining (including salt).

Up until 1972, virtually all Ugandan business was dominated by the Asians, descendants of migrants brought to East Africa by the British to construct the railways. Following their expulsion by Amin, many businesses ceased to exist, while others were transferred into Ugandan hands. Although most businesses are now Ugandan owned, some are once again in the hands of returned and new Asians. Many businesses in Uganda run informally, and it is estimated that currently about 24% of the economy operates outside monetary channels (FAO, 1998).

In terms of infrastructure, the principal and trunk highways have been restored but much work and funds were needed to enable the feeder roads to be passable all year round.

4.3.2 Physical Environment

Uganda was called *"the Pearl of Africa"* by Winston Churchill and there are few people who visit who would disagree. Uganda is a landlocked country which lies on the east of equatorial Africa bordered by Tanzania, Kenya, Rwanda, Congo and Sudan. Most of the 235,759 km^2 of Uganda is well watered and fertile, with the exception of the semi-desert in the extreme north east. Almost 17% of the country is covered by water. 12% of the country comprises forest reserve and national parks. Most of the country lies at an altitude of over 1,000m, and the topography is generally rolling, with the exception of the Rwenzori mountains in the west, the Kigezi region in the southwest, the Virunga range in the south and Mount Elgon in the East (Briggs, 1998).

Tempered by altitude, Uganda's equatorial climate has a daily maximum of between 20°C and 27°C, and a minimum of between 12°C and 18°C. Most parts of Uganda receive an annual rainfall of between 1,000 and 2,000 mm per year, with the exception of the dry north where it can be as low as 100 mm. Rainfall patterns vary regionally, but generally there are two wet seasons, that is from mid-September to November and March to May.

The Ugandan geology is described in chapter 5.

4.4 GOVERNMENT POLICY

The top stated priority of the Government of Uganda (GoU) is poverty alleviation, with improved coverage and access to safe water considered to be key elements towards the elimination of poverty (GoU, 1999b). The Government is active in both rural and urban water supply and sanitation. Given the context of the research project, this section focuses on rural domestic water supply.

4.4.1 Domestic Water Policy

The water sector is one of the five stated priority sectors of the Government with the strong commitment to the provision of safe water in communities reflected in the Constitution, (GoU, 1995) as well as several policy documents (Uganda Water Action

Plan 1995, Water Statute 1995, Poverty Eradication Action Plan (PEAP) 1997, National Water Policy 1999 and the Rural Water and Sanitation Implementation Strategy and Investment Plan 2001. The National Water Policy (GoU, 1999a) states that domestic demands are the first priority in the water sector.

The Government target was to achieve 75% coverage of safe drinking water and sanitary excreta disposal facilities by 2000, and 100% by 2015. Safe water coverage was estimated at 47% by June 1999, and 50% in June 2000 (MoFPED, 2000). There is considerable variation between the districts, with coverage as low as 18.4% in Sembabule (Figure 4.1) in 1999. Overall Uganda is one of the least served countries in the region (MoFPED, 2000). Despite the low current coverage, the Rural Water Sector Reform of 2000 considered the 2015 targets achievable provided new strategies and implementation methodologies are adopted.

The Government strategy for the provision of safe water, as detailed in the PEAP includes a community based, demand driven approach with communities involved from the early stages of planning and design. Communities are to be mobilised and are expected to participate in the development and maintenance of their water sources in order to establish ownership of the facilities. The local Government structures (Box 4.1) are supposed to facilitate the transfer of demand for water source construction from village to district level. Communities are expected to contribute in cash or kind towards rural water supplies prior to construction, with the contribution dependent on technology choice (ie a percentage of the construction cost). Operation and maintenance costs are expected to be met by the community unless costs are unreasonably high (GoU, 1999a).

4.4.2 Decentralisation

Decentralisation has been encouraged by the NRM since it took power in 1986, with implementation of the policy starting in 1993. Decentralisation aims to *"...[encourage] good governance, increased participation in an informed decision-making process by the people through devolution of powers to the appropriate level of Governance"* (MoFPED, 2000). The 1997 Local Government Act paved the way for full devolution of powers to the popularly elected local Government. *"The decentralisation reforms in Uganda are among the most comprehensive public sector reforms seen in any country...[and include] political, administrative and financial*

decentralisation..." (Ruwasa, 1995). However, "*service delivery at district level has been constrained by lack of appropriate structures and systems; inadequate financial and human resources; poor remuneration; inadequate technical and managerial skills and inadequate physical facilities, equipment and infrastructure"* (MoFPED, 2000). In addition, the varied accounting and reporting procedures for different donor funded projects complicate the operations at the Districts, resulting in a drive for harmonisation of related programmes (MoFPED, 2000).

Box 4.1 summarises the local government structure. Key levels in terms of planning and finance of infrastructure are the LC 3 and LC 5, with most of the powers, functions and responsibilities essentially at the District. The locally elected politicians, councils and committees have been given extended political powers to oversee the civil servants and guide the local development process.

The local councils (LCs) and committees form a hierarchical structure that stretches from village to district level as follows:

LC 1 - Village council (all villagers over 18 years), and having a committee[a]

LC 2 - Parish council (all members of the village committees), and having a committee[a];

LC 3 - Sub-county council (all members of the parish committees), and having a committee[a];

LC 4 - County council (all members of the sub-county committees), and having a committee[a];

LC 5 - District council comprising elected members from the LC 3 councils. This is the supreme political organ in the District and is presided over by the District chairperson.

[a] Elected executive committee of nine members

Box 4.1: Ugandan Local Government Structure

4.4.3 Privatisation

The Civil Service Reform Programme, endorsed in August 1993, and launched in November 1997 has included the streamlining of the civil service as well as privatising functions considered to be better provided for by the private sector. Thus the GoU's role is shifting from the role of service provider to that of facilitator/enabler. Various aspects of the water sector are being privatised; in particular design and construction, operation and maintenance, training and capacity building, and commercial services (GoU, 1999a).

The combination of low public service salaries, streamlining and privatisation has resulted in many retrenched and still employed civil servants becoming active as

private sector water and sanitation companies. Most of the artisans who were directly employed by the GoU as labourers have been retrenched. Rather than forming their own companies, which is an expensive and bureaucratic task, most of these artisans are working as labourers for the companies formed by civil servants or politicians.

Although private sector water supply is common practice in the urban sub-sector, it is new to the rural sub-sector (Boumokama, 1998). Under the Rural Water and Sanitation East Uganda (RUWASA) project (see 4.5.1 for description) the production of sanplats[8] for latrines was mainly undertaken by the private sector from 1991. Privatised maintenance of handpumps and spare part distribution and protection of springs had been initiated by 1996. Private sector water source construction was introduced in 1996, with tendering and contract management for borehole rehabilitation and deep and shallow well drilling undertaken by the RUWASA Project Office initially and responsibility handed over to the District Tender Boards (DTB) in 1998. The Water and Environmental Sanitation Project (WES) (see 4.5.1 for description) and Poverty Action Fund (PAF) Conditional Grants (see 4.5.1 for description) introduced private sector source construction in 2000.

4.5 DOMESTIC RURAL WATER SUPPLIES

4.5.1 Projects and Finance

Rural Water and Sanitation projects are intended to cater for the 89% of the Ugandan population who live in rural areas. The main public funded rural water supply projects, in which donors linked up with the Ugandan Government were:

- WES (Water Environmental Sanitation) and
- RUWASA (Rural Water and Sanitation East Uganda)

WES covered 34 districts from 1995 to 2001 with an annual budget of $7m, supported by UNICEF, SIDA and the GoU. WES was based on a decentralised, District led approach rather than individual projects in specific locations. The work was primarily directed at increasing capacity-building, improving drinking water (by providing protected springs and hand dug and hand augered wells, gravity flow schemes and borehole rehabilitation) and sanitation.

RUWASA covered the remaining 10 districts in Eastern Uganda. Phase I ran from 1991 to 1995. Phase II covered 1996 to 2001 and had a total budget of $41m from DANIDA. RUWASA's work included rural domestic water supply (spring protection, hand dug and hand augered wells, deep boreholes, gravity piped schemes, borehole rehabilitation), rural sanitation, hygiene education and sanitation in primary schools.

The development of the Poverty Eradication Action Plan[9] (PEAP), and qualification for the Highly Indebted Poor Countries Initiative (HIPC) reduced the Government's foreign debt repayments. The Poverty Action Fund (PAF) was created in 1998/99. It channels HIPC, other debt relief funds, donor budget support and the Government's own resources into the key sectors identified in the PEAP (Craig & Porter, 2002). One of these key sectors is rural water supply (MoFPED, May 2000). The PAF funds are being utilised to accelerate the decentralisation process, with about 75% of the PAF budget transferred to local Government (Craig & Porter, 2002). The PAF transfers are in the form of conditional grants which can only be used for pre-defined investments in activities which support the PEAP. Releases to the Districts are conditional on the submission of work plans, budgets and expenditure reports (Craig & Porter, 2002).

WES finished in December 2001 and RUWASA was to be phased out in November 2002. These water and sanitation projects were replaced by decentralised activities using the PAF conditional grants. Further rural water projects include borehole drilling and rehabilitation by several international NGOs. The Lutheran World Federation, CARE International, World Vision International, Associazione Volontaria per il Servizio Internazionale (AVSI), WaterAid, Plan International, Associazione Centro Aiuti Volontare (ACAV), International Cooperation for Development (ICD) were the main international NGOs involved in the Ugandan water sector (GoU, 1990; Boumokama, 1998).

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[8] Sanplat stands for sanitation platform. It is an improved latrine slab with smooth, sloping surfaces, elevated foot rests and a drop hole.

[9] The Poverty Eradication Action Plan (PEAP), was initially produced in 1997 and revised in 2000 (IMF & IDA, 2001). The Ugandan Poverty Reduction Strategy Paper (PSRP) is a summary of the PEAP. It has four major pillars: (i) creating a framework for economic growth and transformation; (ii) ensuring good governance and good security; (iii) directly increasing the ability of the poor to raise their incomes; (iv) directly increasing the quality of life for the poor.

4.5.2 Technology

Technology options in the Ugandan rural water supply sector include borehole drilling, protected springs, shallow wells, gravity flow supply, valley dams and rainwater harvesting systems (GoU, 2001b).

There is a pervading opinion that most springs across the country have been developed, and few are remaining (GoU, 2001b). In addition, hand auger drilling and hand digging are not able to penetrate the hard lateritic layers in the regolith. Thus there is a requirement for other technology options such as that developed through the LCDP to provide alternative low-cost sources.

4.6 THE PROJECT: PRIVATE SECTOR PARTICIPATION IN LOW COST WATER WELL DRILLING

The project, entitled "*Private Sector Participation in Low Cost Water Well Drilling"* (LCDP) was conceived by Prof. Richard Carter (Carter, 1997) following observations, experiences and research which indicated that there was a lack of an *appropriate "off the shelf"* technology to provide shallow wells at low cost in sub-Saharan Africa. Funding for the Project was obtained under the Department for International Development (DFID) Engineering Division Knowledge and Research (KAR) scheme, under the theme *"W4: to raise the well-being of rural and urban poor through cost effective improved water supply and sanitation"*. Project funding commenced in July 1998.

4.6.1 Low Cost Drilling Project Objectives

The LCDP set out with the objectives of designing a new, low-cost water well drilling rig, bringing about its manufacture in sub-Saharan Africa, and enabling uptake by small, local contractors. The target outputs were as follows:

1. designed, tested and documented low-cost drilling rig;
2. the local manufacture of the rig;
3. the uptake of the rig by small contractors and their training in its use and
4. sustainable uptake mechanisms in place.

It was stated that despite the fact that the project was dependent upon the success of the technology, *"the real proof of success would be the stimulation of local manufacturing and contractor businesses and the supply of water to users at an*

affordable price" (Carter, 1999a). The project objectives were not only to support, understand and feed information into the project activities, but also to inform and empower the stakeholders.

4.6.2 Stakeholders

The LCDP was concerned with technology development for local uptake by the private sector. The technology was intended to provide a service to communities, the cost of which would generally be subsidised by another party. Thus the LCDP concerned a wide range of stakeholders who have been categorised in the following groups:

1. *users of the technology to provide a service*, eg local contractor businesses and NGOs;
2. *beneficiaries of the service*, eg individuals, communities and institutions;
3. *clients for the service*, eg local and central Government, donors and NGOs;
4. *suppliers of the equipment*, eg traders and manufacturers;
5. the *LCDP team* comprising project manager, drilling consultant, research assistant and local consultants and
6. *organisations to support uptake*, eg credit institutions, associations, training institutions, Government and NGOs.

The LCDP had no budget of its own for testing the new technology in Uganda. However, funding was secured through the establishment of partnerships with DWD and Mpigi and Mukono District Government. These partnerships enabled the technology to be initially deployed under the auspices of the WES project and later through District water provision from the Poverty Action Fund Conditional Grants. The LCDP was thus dependent on national and local Government and the donors for funds and the context in which to operate the equipment. Consequently, certain individuals within the DWD, Mpigi, Mukono and the donors participated considerably in LCDP decision making and action. Other individuals participated to a lesser extent and in other ways, (eg advisory roles). Although the participatory approach of the LCDP proved beneficial in many respects, it was not without its difficulties. These issues are discussed in chapter 9.

4.6.3 Project Logical Framework and Expenditure

Table 4.2, shows the project logical framework, and Table 4.1 sets out LCDP expenditure and funding sources.

Table 4.1: Low cost Drilling Project Expenditure and Funding Sources[10]

Expenditure ($) - Funded By DFID					
	7/98 - 3/99	**4/99 - 3/00**	**4/00 - 3/01**	**4/01 - 6/01**	**Total**
Personal Emoluments (UK)	$34,646	$49,324	$42,535	$16,614	$143,118
Consultancy/LCDP Team (Uganda)	$8,400	$22,084	$40,173	-$1,978	$68,679
Capital Equipment	$9,800	$13,419	$19,694	$269	$43,182
UK and International Travel	$9,262	$8,051	$6,467	$1,864	$25,644
In-country travel	$1,400	$6,619	$8,533	$115	$16,667
Subsistence	$9,450	$16,799	$25,690	$797	$52,737
Communication	$350	$1,131	$2,338	$22	$3,840
Dissemination	$0	$1,965	$0	$588	$2,553
Conference fee	$0	$0	$0	$0	$0
Overheads	$5,586	$8,822	$9,201	$1,273	$24,882
Totals	**$78,894**	**$128,214**	**$154,630**	**$19,564**	**$381,302**
Expenditure ($) - Funded by DANIDA					
		12/99-6/00	**7/00-12/00**	**1/01 - 6/01**	**Total**
Equipment		$2,496	$304	$0	$2,800
Monitoring		$1,593	$5,256	$5,618	$12,467
Siting		$1,680	$0	$1,315	$2,995
Business Training		$0	$4,210	$4,743	$8,953
Reporting		$2,907	$0	$3,380	$6,287
Totals		**$8,676**	**$9,770**	**$15,055**	**$33,500**

[10] The budgets are in accordance with (i) the memorandum of Understanding between the Low Cost Drilling Project, Mpigi District and the Director of Water Development and (ii) an agreement with Mukono District. The funding came from a number of Government sources through ongoing projects. As there was no central point where records of expenditure could be accessed, the extent of expenditure is not known.

Table 4.2: Low Cost Drilling Project Logical Framework

NARRATIVE SUMMARY	MEASURABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
Goal : Well-being of rural and urban poor raised through cost-effective improved water supply and sanitation (TDR Theme W4).	Ten low cost water wells in use by families as main source of small scale irrigation and drinking water by end 2001.	Feedback from manufacturers and contractors, documented in project reports.	That farmers and communities will manage their water use effectively.
Purpose: New very low cost water well drilling rig manufactured, adopted by contractors, and being promoted beyond end of project.	At least two contractors have successfully completed 5 wells each, at realistic economic cost, by end of project. Further contracts are in pipeline.	Project reports including financial summaries from manufacturers and contractors.	Demand increases and credit continues to be available. Support to private sector and local Government continues. Regulation mechanisms in place.
Outputs: 1. New rig designed and tested, and design and operation fully documented 2. Manufacture and marketing initiated 3. Contractors trained in use of new machine. 4. Sustainable uptake mechanisms in place	1. Five wells drilled to 20m in a range of ground conditions by end of first phase. One manual with drawings produced. 2. Production rig manufactured by developing country company, to satisfactory quality standards, by end of second phase. 3. One training workshop for contractors completed. 4. TEMBA registered, active in project, and promoting its services	1. Phase 1 report and rig design and operation manual. 2. Phase 2 report. 3. Phase 3 report 4. Project Progress Report, TEMBA first year annual report	Appropriate physical conditions for completion of wells at 10 sites. Stable economy to ensure design continues to be low cost. Manufacturers and contractors stay in business.
Activities: 1.1 Identify local research institution and manufacturing partner. 1.2 Review all previous work on very low cost drilling (international and in the region). 1.3 Design and construct prototype. 1.4 Field test and modify design. 1.5 Finalise design and complete drawings and documentation. 2.1 Supervise in-country manufacture of first rigs. 2.2 Market new rig locally. 2.3 Identify possible contractors. 3.1 Train contractors in use of rig. 3.3 Establish small number of contractors in business with new rig. 4.1 Assist in establishment of TEMBA office and start-up costs 4.2 Progressively transfer ownership of project concept, and responsibility for project activities to TEMBA	Budget Staff costs: £61,055 Materials: £24,732 T&S: £67,744 Industrial Partner: £45,000 Local Consultant: £56,368 International tel/fax:£2550 Conference fee: £250 Dissemination: 1500 Overheads: £19063	1. Design and operation manual for rig. 2. Existence of locally manufactured rig and publicity material. 3. Final report on contractors' operations; papers in international "water" literature. 4. TEMBA progress reports	Basic geological data exists to aid site selection. Suitable ground conditions exist for field tests. Suitable local manufacturer exists. Suitable local contractor exists. Demand for low cost wells exists or can be stimulated TEMBA can create business opportunities which extend beyond year one of operation.

4.6.4 Project Team

The LCDP project manager worked at Cranfield University, and had extensive experience of rural water supply through research and consultancy in this field over 25 years. He was based in the UK throughout the duration of the LCDP but visited the project eleven times for one to two weeks each in the three years.

The drilling consultant had 27 years experience in the water well drilling sector including experience in Africa and Asia in emergency relief. He ran his own business supplying drilling equipment and well consumables. He had experience of drilling equipment design and undertook most of the new drilling rig design work, wrote the rig specifications and supervised the manufacture of the rigs. He spent most of his time in the UK, with five visits to Uganda to train the drill crew, review the design and investigate local manufacture.

I studied Mechanical Engineering, worked in the Information Technology industry for two years and worked and travelled in Asia for one year. I had just completed my MSc in “Community Water Supplies" before starting to work on the LCDP. I initially worked on engineering analysis in the UK, and subsequently led the Ugandan team when the LCDP shifted its centre of gravity from UK to Uganda. From that point on, I spent considerably less time on the engineering, with most of my efforts being utilised to understand the Ugandan context, co-ordinate the LCDP activities and manage the research in Uganda.

Four Ugandan consultants (with community development, small business, irrigation and hydrogeology specialisms) were contracted to undertake preliminary studies in Uganda, two of whom remained very involved in the LCDP and were commissioned to undertake further consultancy work. They gradually became decision makers on the project and ultimately set up an NGO, TEMBA (Technology Mobilisation and Business Access) to continue working in the areas of need identified by the research.

The community development specialist was a trained social worker with 10 years experience of work on the social side of water and sanitation in Uganda. He was very well respected in the sector and had many contacts among NGOs and with Government. Following the initial studies, he took responsibility for water quality

testing, co-ordination of siting and negotiating with central and district Government either alone, or together with the Ugandan team leader.

The small business specialist acted as Principal of a Ugandan College of Commerce and undertook consultancy services. He had trained a range of artisans and businesses throughout Uganda in marketing and entrepreneurship for several years. He was able to make his students understand issues which contribute to the success and failure of Ugandan business. His work on the LCDP commenced with obtaining company profiles and undertaking SWOT analyses and progressed to undertaking training needs assessments and training of small businesses in the water sector. He also investigated credit opportunities in Uganda.

The project manager, drilling consultant, community development specialist, small business specialist and team leader formed the *LCDP team.* The *Ugandan LCDP team*, were a subset of the above, comprising the community development specialist, the small business specialist and the team leader. They met regularly for updates, debate and delegation of tasks.

Additional members of the LCDP team from July 1999 to September 1999 included two MSc students from Cranfield University researching for their theses. "The Role of the Private Sector in the Provision of Rural Water Supplies – An Insight into Uganda" (Littlefair, 1999) was based upon interviews with several informants as well as discussions with the community development specialist. The other students' work (Snell, 1999a) was broader, and he worked alongside the small business specialist, undertaking the SWOT analysis, investigating a typical small Ugandan business and reviewing hand auger programmes.

All of the aforementioned individuals undertook research as well as promotion of the new technology and the LCDP concept. The promotion was an ongoing process throughout, and built up considerable interest from a wide range of individuals and organisations in Uganda.

In addition, a Ugandan tool maker and fitter worked directly for the team leader initially to determine a manufacturing strategy for the rig and subsequently as an engineering assistant, including monitoring the rig performance. He took on the direct responsibility for rig hire beyond the end of the LCDP funding in June 2001 .

4.6.5 Overview of the Low Cost Drilling Project

This section presents a summary of the LCDP which provided the vehicle for the research presented in this thesis. Key events are listed in Table 4.3 and illuminated in the discussion which follows. The short length of this discussion (six pages) cannot do justice to the work which was undertaken by the LCDP team and partners over the three year project duration. The discussion simply provides the reader with an overview of the LCDP, as (s)he moves on through the subsequent analytical chapters.

Table 4.3: Summary of Low Cost Drilling Project Activities (July 1998 to June 2001)

TIME	ACTIVITY
Year 1: July 1998 - June 1999	- Selection of country of Low Cost Drilling Project (LCDP) operation; - Baseline studies of community, businesses, hydrogeology and irrigation potential in Ugandan undertaken; - Design and manufacture of the first Pounder Rig and import into Uganda; - Two short visits to Uganda by the UK team; - Agreement signed between LCDP, Directorate of Water Development (DWD) and Mpigi District Government signed for rig test in Uganda
Year 2: July 1999 - June 2000	- Relocation of LCDP team leader from UK to Uganda; - Field trials with the first Pounder rig in Mpigi District; - Design review; - National (Ugandan) workshop to discuss technology, context and LCDP; - Design and manufacture of the second Pounder Rig; - Liaison with DWD over hire agreement for the second Pounder rig; - Preparation for private sector operation of the second Pounder Rig; - Training needs assessment and business training of Ugandan water and sanitation and construction businesses and NGOs;
Year 3: July 2000 - June 2001	- Preparation for private sector operation of the second Pounder Rig; - Establishment of Technology Mobilisation and Business Access (TEMBA), a Ugandan NGO to continue to work in fields identified by the LCDP; - Training needs assessment and business training of Ugandan water and sanitation and construction businesses and NGOs; - First Pounder Rig used briefly in Mpigi District; - Second agreement signed between LCDP, DWD and Mpigi District for Pounder rig use by the private sector; - Study of local manufacture of Pounder Rig; - Monitoring of completed Pounder and non-Pounder shallow wells; - Import of second Pounder Rig to Uganda; - Commercial drilling with second Pounder rig;
End June 2001	- End of LCDP phase I.

Year 1 (July 1998 – June 1999)

The end of 1998 to the start of 1999 saw the focus of the UK work on the technology with theoretical engineering analysis and experimental work being undertaken in parallel. At the end of a visit to Uganda in November 1998, for the

country selection, four baseline studies were set up to verify and build upon the anecdotal impressions with respect to the Ugandan context. The studies (Carter, 1999a) were undertaken by local consultants who had been recommended to the LCDP team.

They were reviewed by Carter and Danert in March 1999 and revealed that:

(1) some hydrogeological potential for shallow wells existed in Uganda;
(2) there was demand for shallow wells from communities;
(3) there was limited potential for irrigation wells and;
(4) small private companies, many with a foot in Government, were starting to emerge in response to privatisation strategies.

During this visit a tripartite Memorandum of Understanding between the LCDP, DWD and Mpigi District Local Government was specified and formalised. Under this, it was agreed that the test drilling would be supported, and undertaken under the WES programme in Mpigi District (**Error! Reference source not found.**). Limited investigation was undertaken regarding potential rig fabrication and several stakeholders were met and introduced to or updated on the LCDP progress.

By June 1999, the first Pounder Rig (Figure 4.2), had been designed.

Figure 4.2: The First Pounder Rig in Operation

Year 2 (July 1999 – June 2000)

July 1999 saw the centre of gravity of the LCDP shift to Uganda, and I relocated from the UK to Kampala. The topics for subsequent study in Uganda were determined

in a consultative meeting with the LCDP team and key individuals from DWD. The two Cranfield MSc students, teamed up with the Ugandan consultants to investigate the following:

(1) the private sector in water and sanitation;

(2) experiences of hand augering and

(3) community attitudes to shallow wells.

The investigations were also utilised to promote the LCDP, and the interest in the LCDP was utilised to undertake the research. A significant number of potential rig users, well funders, well users, and a wider range of individuals and institutions with potential interest in the LCDP were informed and consulted in the months between June and October 1999. Thus, considerable understanding of the Ugandan context was built up, many contacts were established and expectations of the project grew. In addition, the Ugandan LCDP team developed, with all its members having a say in LCDP operations, rather than the individuals merely working as consultants *to* the project.

The first rig (Figure 4.2) was transported to Uganda in July 1999 and cleared through customs by DWD/UNICEF as agreed in the Memorandum of Understanding. Test drilling was undertaken by the Mpigi District hand auger crew, who were trained by the drilling consultant. Initial crew payment problems had to be sorted out as this aspect had not been adequately covered in the Memorandum of Understanding. Within a 3 week period, 6 holes were drilled, of which 4 were paid for by local Government under the WES programme.

Detailed discussions were held with DWD regarding the unorthodox pump installation (see chapter 5) proposed by the LCDP. Concerns regarding the quality of such installations, and the water quality continued to be expressed by DWD and district staff. The need for an appropriate siting methodology also became apparent. In addition, the investigations regarding private sector contractors revealed weaknesses in their business practice. These were considered to have the potential to undermine the success of Pounder drilling as a business venture. Thus, the LCDP decided to undertake training to improve their business skills to provide a stronger foundation for uptake of the rig. Funding for the above emergent issues was obtained from DANIDA in Uganda.

The test drilling period highlighted the need for suitable contracts and payment methods. The uncertainty of finding water when drilling, unfamiliarity with the

capabilities of the new technology and fear of corruption allegations rendered payment of the drill crew a difficult issue for the Government to resolve. Considerable discussions with the key stakeholders from August 1999 to the end of phase I in June 2001 were undertaken.

November 1999 saw the return of the drilling consultant to Uganda to undertake a review of the rig design (Ball, 1999). The review comprised observations of the drilling and interviews with the rig operators and other stakeholders. The findings fed into the design of the second rig. During this visit, a one day workshop, attended by the LCDP team, and 69 delegates from DWD, the District Water Offices, private companies, NGOs, donors and academic institutions was also held (Carter, 1999c). The workshop comprised presentations, a rig demonstration and discussions of pertinent issues faced by the LCDP. Following the workshop, the LCDP team planned the future direction for the project, including the decision that the second (yet to to be designed and built), would be the final, commercial rig. In order to enable it to operate in a real commercial environment, the rig would operate fully within the private sector.

December 1999 to February 2000 involved the design of the second rig (a period which became extended until October 2000). I left to the UK in December to work on my thesis and returned to Uganda in March 2000. I found considerable hostility from the principal contact at DWD (WES Programme Officer for Water) to the agreement between the LCDP and the selected rig hirer. This had been set up by the drilling consultant and small business specialist in November 1999 following limited consultation. The bottom line was that DWD was not prepared to support the LCDP with the agreement made. This contentious issue kept the team leader liaising between Uganda and the UK until June 2000. The LCDP finally followed the advice of DWD to hire the rig to the contractors as a project rather than involving a third party and back tracked significantly, including writing a letter of apology.

Other activities from April to June 2000 involved the preparation for the first commercial drilling. Time was spent working on the contract document for Pounder wells, following-up Mpigi and Mukono Districts, RUWASA and DWD regarding the funding and facilitation of contracts, and undertaking business training for the two contractors selected to be the first to drill commercially with the rig. Further activities included the monitoring of the Pounder wells, informing the network of project

activities and plans, and keeping up with the continuous changes taking place in the Ugandan water sector.

The project manager's visits to Uganda provided support, ensured that the work was on track, and enabled funding proposals to be brainstormed.

Year 3 (July 2000 - June 2001)

TEMBA (Technology Mobilisation and Business Access) is an NGO formed by the community development and small business specialists in order to continue with the type of work that they were undertaking with the LCDP, i.e. pulling together the technical know-how, communities, Government and the private sector in water supply. The LCDP was able to secure an increased budget from DFID to provide start-up funds for TEMBA.

Work to register, plan and find an office for TEMBA commenced in June 2000, as well as continuing to seek agreements with District Government for the commercial drilling and undertaking the training needs assessment of other Ugandan water sector contractors. After a break from Uganda in August 2000 to touch base with the UK team, I focused on finishing the well specification, supporting TEMBA to set themselves up and following up Mpigi and Mukono Districts.

After six months of lying idle in Mpigi district stores, the Pounder rig was utilised in June 2000 to drill wells in Katabi sub-county, Mpigi District. However, due to hard formation, collapse, and fine material which could not be removed by the rig, no successful water source was completed. Mpigi District voiced interest in continuing to use the rig, but claimed to be handicapped by a lack of materials for pump installation. The original materials (brought in by the LCDP) had finished, and DWD had no pumps in stock. I thus procured the required materials from DWD funds, but the rig was not utilised by the end of phase I in June 2001, despite the signing of a second MoU between the LCDP, DWD and Mpigi in September 2000.

In October 2000, a study into local manufacture was undertaken by a Ugandan fitter and tool maker after which he continued to provide technical assistance.

The RUWASA programme had been followed up as a partner for the LCDP commercial drilling since December 1999, but efforts were abandoned in September 2000 as they had persistently failed to express serious interest in collaboration. Following the advice of DWD, Mukono District local Government (Figure 4.1) were

sought as partners. The Community Specialist chased the District for several months to agree on the collaboration, and to sign an MoU. Although the MoU was never signed, the District officials agreed to collaborate. However, they selected their own contractor to undertake the drilling. Thus the contractors who received training in business skills by the LCDP did not end up undertaking commercial drilling in the LCDP duration.

Discussions were held with the Water, Health and Mobilisation Offices and the way forward was planned together, including mobilisation, siting, contractor selection, contractor training and drilling. October to December 2000 focused on putting everything in place for the commercial Pounder drilling to commence in November.

The second rig (Figure 5.3) landed in Uganda in mid November and was made ready for drilling. In comparison to the first prototype, significant modifications had been undertaken to the frame, the drill pipe diameter was increased and some additional features were added to the functionality (discussed in chapter 5).

The second rig was first demonstrated on five day business training course for contractors involved in water and sanitation and other construction work. The participants were from Mukono and Mpigi Districts, and Kampala, and included companies which had been in contact with the LCDP from December 1998, when the first baseline study was undertaken.

In preparation for the commercial drilling in Mukono, I provided some background regarding the drilling method and well design to the contractor. In addition, the costs of constructing the water source with this method were calculated by myself and the contractor. The problem of a suitable contract and payment method had to be navigated. Mukono District, utilising Poverty Action Fund (PAF) money to fund the contract had no budget for dry wells, and were mandated to pay a fixed amount for each source. It was finally decided to start drilling, and deal with problems as they arose, followed by a review in January 2000.

Commercial drilling commenced in December 2000. The contractor received on site training and support from the drilling consultant until the end of December. Three wells were drilled in two villages. The experience of drilling dry wells raised concern over payment arrangements and drilling was stopped in order to allow a solution to be determined. Two months passed before drilling recommenced. Discussions regarding the dry wells between the LCDP and District revealed that the District blamed the

LCDP siting methods. They thus commissioned a known hydrogeologist to undertake the siting of new wells.

Commercial drilling in Mukono recommenced in February 2001, and two successful water sources were drilled from five attempts. The contractor subsequently branched into other geographical areas and drilled two successful wells (out of four attempts) in Jinja District as well as undertaking some siting work in Katakwi District for WaterAid Uganda (see Figure 4.1 for map). Shortly before the end of phase I in June 2001, the Pounder Rig was placed in the hands of the engineering assistant, who was given the responsibility for hiring out the rig for a six month period on behalf of the LCDP.

Another five day business training course for Mpigi District contractors, including a rig demonstration, took place in February 2001. The course was attended by contractors working for Mpigi District and companies which had responded to adverts. Although the LCDP focus was on Mukono, plans were made for commercial drilling in Mpigi District. With the District staff overloaded with other work, the LCDP undertook mobilisation activities on their behalf. After problems obtaining community and sub-county contributions had been surmounted, new hurdles arose. In fact, phase I of the LCDP came to an end in June 2001 with no commercial drilling having taken place in Mpigi District.

DWD continued to express an interest in continuing to develop and test the Pounder rig in a subsequent phase. At a small consultative workshop in June 2001, the LCDP team was mandated to write a report which would act as the basis for the funding of the next phase. This having been undertaken, it remains to be seen whether funding will continue for the LCDP in the future.

After June 2001

Since the LCDP came to an end in June 2001, the LCDP team have not been able to secure funds to continue the work. Part of the reason given by the European bilateral donors is that they now have re-directed their attention from project funding to primarily budgetary support to the Government.

However, a study of shallow wells in Uganda was undertaken in October 2002 for the Government, which included an analysis of the Pounder wells. The project manager also visited Uganda in October 2002 in connection with the LCDP and other

research proposals. He was received with enthusiasm by DWD and the other partners and commented that *"although a long time has passed since June 2001 for us, it seemed to be like yesterday for the people at DWD"* (Carter, 2002a). DWD and other stakeholders are keen that the LCDP moves into a second phase. Funding options are still being explored.

5 Analysis of the Technology

This chapter describes the new technology and analyses its performance in Uganda in relation to hydrogeology, users of the equipment, existing technologies and stakeholder perceptions. A broad range of non-technical issues which impinge on successful technology uptake are thus introduced.

5.1 INTRODUCTION

Improved water supplies in rural Uganda comprise rainwater harvesting, spring protection, gravity schemes and ground water sources. The latter category consists of large diameter hand dug wells, which can take weeks, or even months to dig; hand augered wells, which can only penetrate soft formations, and conventional deep wells, which are very expensive and limited in terms of where they can be located due to the access requirements of the large equipment. The Pounder technology was therefore conceived to fill a gap between existing hand dug/hand auger technology and conventional deep wells.

Although the Low Cost Drilling Project (LCDP) outputs were to design and make a low cost drilling rig available for use by private sector operators in Sub-Saharan Africa (Table 4.1), the scope of the research extended beyond the drilling rig and its operators.

In terms of technology, the drilling rig was the focus of the work. However, the drilling rig cannot be considered in isolation from the well it provides, and the pump which can be installed depends on the rig capability, in particular the drilling diameter. The scope of the technology thus includes the Pounder rig (the most prominent component) and the well which its use makes possible. The well includes the pump and the materials (linings, gravel packs, sanitary seal and concrete apron) collectively referred to subsequently as well consumables.

In terms of stakeholders, the rig operators were the focus of the work. However, as the Pounder rig is a service technology, its deployment cannot be considered in isolation from those whom it serves. The technology was primarily intended for the provision of community water supplies. Thus, the community members were primary stakeholders. Due to design constraints, the full cost of the well proved to be out of reach for all but a minority of communities. This further widens the scope of

stakeholders under consideration to include organisations which subsidise the construction of these wells.

This breadth of scope in terms of the technology and stakeholders suggests that the technology development and transfer may require the consideration of technical, as well as stakeholder aspects, and the interface between them. This chapter provides an analysis of the Pounder technology by considering stakeholder perceptions of shallow well drilling; the operating principles of the technology; technology performance; well siting; manufacture and supply; and a comparison of the Pounder technology with existing groundwater technologies in Uganda. Through this analysis, the technical issues identified as key to successful adoption are set out and a broad range of non-technical issues which also require consideration are revealed. This sets the scene for the analysis of the wide ranging issues in the subsequent chapters of this thesis.

5.2 STAKEHOLDER PERCEPTIONS

5.2.1 Perceptions of Shallow Well Drilling

Hand auger equipment is not able to penetrate the hard laterite or "boulders" (unweathered rock fragments) which are common in Uganda (Box 5.1). The Pounder rig was specifically designed to overcome this limitation at a significantly lower cost than conventional deep drilling, which, in Uganda, typically costs $7,000 to $10,000 for a completed well. This improved capability in shallow well drilling was perceived to be very important by Ugandan stakeholders. However, it was one of several concerns with respect to shallow drilling technology which are given in Table 5.1.

Table 5.1: Stakeholder Perceptions of Shallow Well Drilling Technology in Uganda

ISSUE	EXAMPLE STAKEHOLDER COMMENTS
Insufficient technical capability	• *"the Tanzanian auger did not do very well"* (DWD, 2001b); • *"we had discounted shallow wells due to the [nature of the] overburden"* (DWD, 1999b); • District X did not undertake hand augering due to the fact that there are political problems when the equipment does not deliver (DWD, 2000e); • Lack of full acceptance by communities and policy makers of shallow well technology is in part due to its inability to penetrate hard layers and problems of hole collapse (Luutu, 2001).
Poor water quality from shallow wells	• *"... hand augering and back-filling still gets contaminated so beware!"* (DWD, 1999b) • *"they think that [shallow wells] are bad quality.. I guess, it is particularly among those that know deep drilling"* (DWD, 2001b); • *"... the water quality or rather pollution ... people are now getting sceptical and*

	say 'will it not it be contaminated?'" (DWD, 2001a).
Problems of construction supervision	• *"Unlike hand dug wells, where you can look down, you cannot easily determine the depth of an augered well"* (Comment 5.1).
Settlement patterns	• *"We had discounted shallow wells due to the .... nature of settlements"* (DWD, 1999b) • *"Most people [live] on the hills but the [shallow] water wells are in the valleys .... Do we get the people to move?"* (DWD, 1999d). • *"locations close to the communities (in Mukono) were usually underlain by hard soils which could not be easily penetrated by an ....auger"* (Tindimugaya, 2000)
Stakeholder deep well bias	• *"policy makers have to be convinced a shallow well is just as good and long term as deep well"* (Danida, 2001a); • *"but still the bias [in DWD] was very much, is very much on deep well drilling "* (DWD, 2001f); • *"people are more aware of deep [drilling]"* (DWD, 2001a); • DWD want motorised drilling (Comment 5.11).
Lack of knowledge by stakeholders	• People associate drilling with deep wells and big rigs (DWD, 1999d); • *"people don't know anything about shallow wells. So the problem has been you design a programme and you may even think you drill shallow wells where they are not useful"* (DWD, 2001b).

Of the six issues which concerned stakeholders about shallow well drilling (Table 5.1), two (*insufficient capability* and *poor water quality*) relate directly to the technology, although the mention of political problems when the technology does not deliver suggests that the effect of insufficient capability is not only a technological issue. The issues of a *deep well bias* and *lack of knowledge* relate to the organisations and individuals who fund and support the deployment of the technology. *Problems with supervision* is both a technological as well as an organisational issue. It relates to the institutional willingness and capacity to supervise different shallow drilling technologies as well as the technical requirements of different methods. *Settlement patterns* is technological (ie where the equipment can provide a source) and relates to the end users of the well (ie where they live).

The stakeholder perceptions of shallow well drilling technology show that the introduction of a new technology in this area requires consideration of technical, social and institutional issues. This point is strengthened when the hand augering experiences under the Ruwasa programme are examined.

Hand augering of shallow wells was introduced by Ruwasa in 1991 as an alternative to deep drilling. The overall success rate[11] out of the 502 attempts made by the end of 1995 was 51% (Ruwasa, 1996). However, between 1996 and May 2001, only 16 attempts were made, of which 7 were successful (Ruwasa, 2001). Mukono

[11] Defined by Ruwasa (1996) as wells completed with hand pumps with a yield equal to or over 700l/h

District, for example, did not commission any hand augering in 2000/1 despite having previously used this technology (observation[12]). These figures indicate a sharp decline in use of the hand auger equipment. Deep drilling did not suffer from this decline in use.

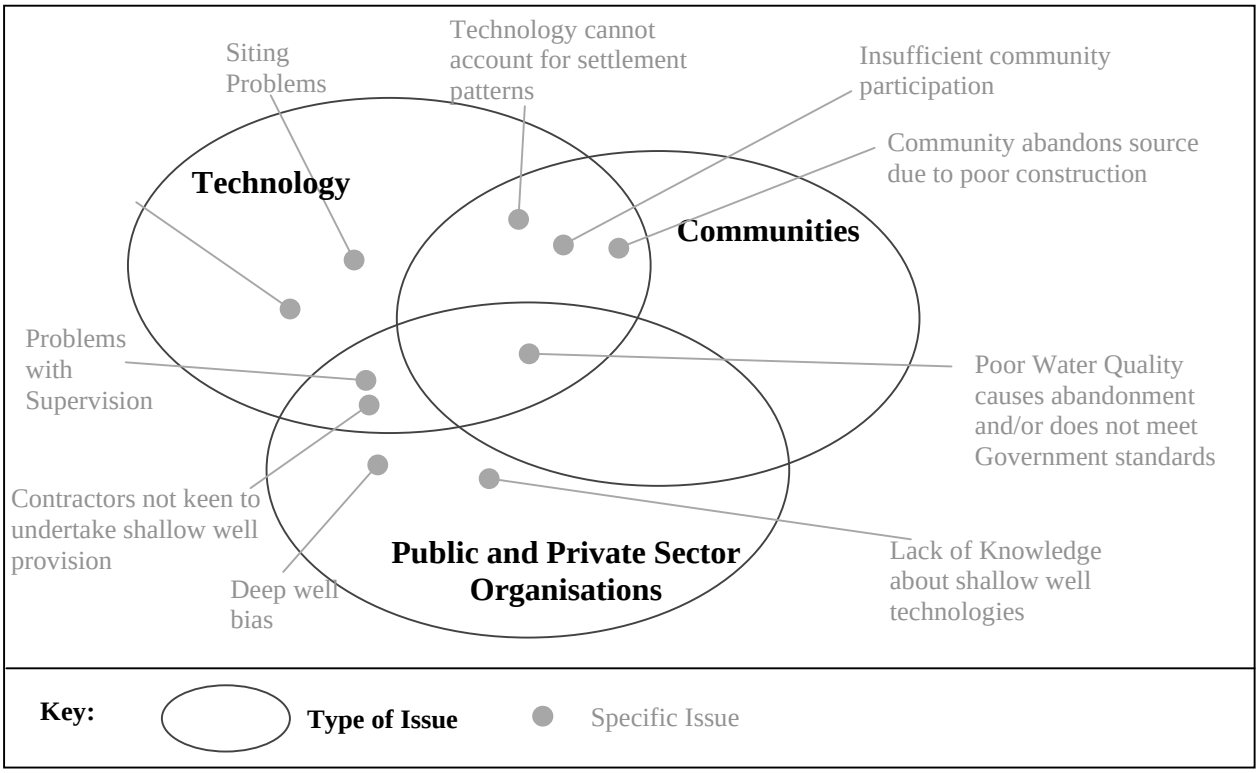
The Government of Uganda (2001c) claimed that the potential for shallow wells was lower than anticipated and that deep boreholes had to be drilled instead of most of the planned shallow wells. However, hydrogeological problems are not the only challenge with hand augering. Danida (2001b) suspected that the factors which contributed to the reduction in hand auger attempts were quite complex. Ruwasa (1996) stated that the problems encountered with hand augering include siting, construction quality, water quality and social aspects. Auger sites would be abandoned due to hard formations which could not be penetrated. Water sources were abandoned due to turbid water, the consequence of holes not being plumb, poor gravel packing and/or poor well design. Water quality not conforming with Government of Uganda (GoU) standards, and insufficient community participation in source construction were also cited as issues (Ruwasa, 1996). The introduction of private contractors may have exacerbated these problems. It was suggested (Danida, 2000c) that it was difficult to persuade contractors to undertake shallow drilling. The fact that the Ruwasa programme changed from using direct labour to private contractors in 1996, which corresponds to the decline in hand augering suggests that private sector involvement may have had a negative impact on shallow well drilling attempts.

The issues which may inhibit shallow water well drilling are wide ranging. Figure 5.1 provides a preliminary categorisation of the issues raised by the Ugandan stakeholders and through the consideration of hand auger drilling under the Ruwasa project. The issues are categorised according to whether they relate to the technology, to organisations funding and deploying the technology, to the communities who are the intended beneficiaries of the well, or a combination of these. The remainder of this chapter focuses primarily on the technological issues although the overlap between the issues is indicative of the difficulty in considering the technology in isolation of the wider context. The preliminary representation of Figure 5.1 is developed and enhanced

[12] Personal observation during water source planning meetings for F/Y 2000/1.

by the end of this chapter in light of the analysis of the Pounder technology, leading to the modified classification in Figure 5.7.

Figure 5.1: Preliminary Classification of Potential Issues to be Considered for the Development and Transfer of New Shallow Well Technology



5.2.2 Confidence in the Pounder Technology

The LCDP was perceived by some stakeholders as a way of promoting and improving the status of shallow well drilling. *"... I was looking at the [LCDP] as a way of promoting shallow well drilling in general because it has sort of taken a nose dive. In around may be mid-nineties it was being promoted but now the preference [has changed] from shallow well drilling to deep bore hole drilling. So I was looking to [the LCDP] as also a vehicle that can be used to promote the technology*" (DWD, 2001a). "*When such projects [make] shallow well drilling ... cheap and successful, then we will be able to identify the areas where it is suitable*" (DWD, 2001b).

Indeed, by the end of the three year LCDP funding period, the Pounder rig appeared to have built confidence in shallow drilling. *"Seeing how much we were getting disorganised by [not finding a simple and cheap way of drilling] and by hand auger equipment. I was staring to lose faith....but now there is real hope. We may have*

a solution which is not so expensive..." (DWD, 2001c). *"I am more positive that shallow wells can be constructed using low cost technology"* (DWD, 2001b). However, enabling the uptake of the new technology requires considerably more than building up confidence in shallow well drilling.

5.3 PRINCIPLES OF THE POUNDER TECHNOLOGY

5.3.1 The Asian Sludging Method

The Pounder Rig is an adaptation of the Asian sludging method (Figure 5.2), which uses galvanised water pipe, a pipe coupling, a bamboo lever and pivot, and the skill of the operators to rapidly drill through soft alluvial material. The drilling method involves reciprocating a water filled pipe in a water filled hole using the lever. The palm of the operator's hand acts as a flap valve across the top of the pipe. The hand is held tightly across the pipe on the upstroke and thus holds water in suction. On the downstroke, the operator lifts his hand and releases the water from the top of the pipe. The water thus discharged contains drill cuttings, which have been sucked up from the bottom of the pipe. By thus removing material, the pipe progresses down and drills a hole. The diameter of the hole is slightly larger than the diameter of a pipe coupling, which is attached to the bottom of the drill pipe. A full description of sludging is given in Ball & Danert (1999a). A sludged well for irrigation in North East India can be completed in one day and, when fitted with locally made materials, can cost as little as $6 plus the cost of the pump (Ball & Danert, 1999a).

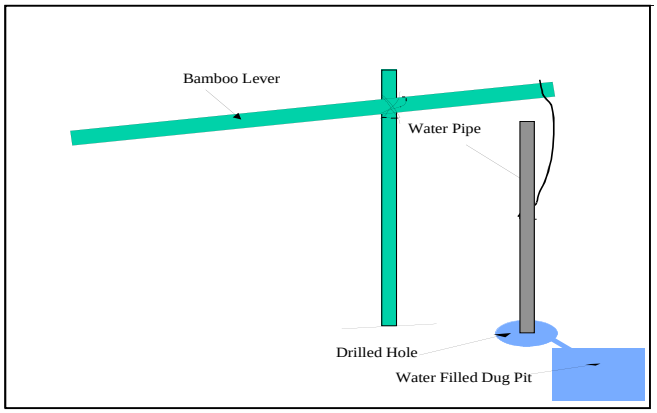


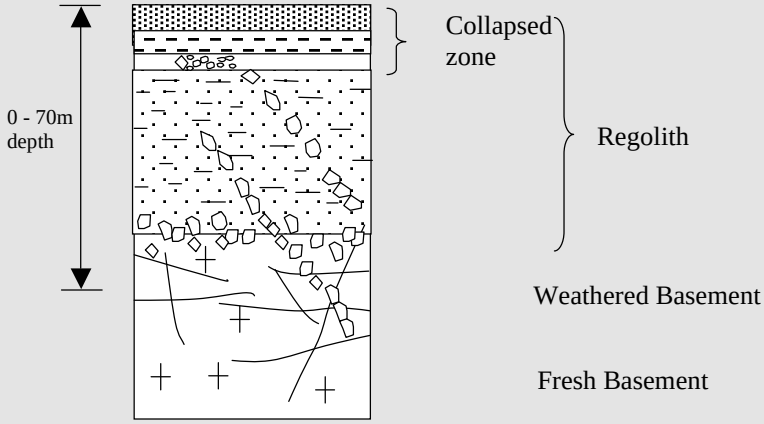
Figure 5.2: Schematic Diagram of Asian Sludging Equipment

5.3.2 The Pounder Drilling Method

The Pounder drilling method builds on the principles of Asian sludging but has been designed to penetrate not only soft material, but also some of the harder material common in Uganda which Asian sludging and hand augering cannot drill. This harder material comprises layers of laterite and boulders (Box 5.1).

The Crystalline Basement Complex of Africa comprises meta-sedimentary, meta-igneous and igneous rocks (Key, 1992). This heterogeneous Basement material tends to have extremely low primary porosity but high secondary porosity and permeability. Extensive chemical and some physical and biological in-situ weathering of this material has decomposed the upper layers into an unconsolidated mantle known as regolith.

The figure below shows a general profile of the regolith, which can extend down to tens of meters. The collapsed zone includes surface soils and layered features such as laterites, illuviated clay layers and stone lines (Wright, 1992) as well as quartz grains and sand sized fragments (Taylor & Howard, 1999). Laterite is a soil residue comprising secondary oxides of iron or aluminium or both (Lapidus, 1987). It can occur as a very hard band up to several meters thick, pisolithic layers or as softer clay-rich bands within the regolith.



Regolith Profile (adapted from Wright, 1992)

The regolith profile is not as predictable as suggested by the figure above. The weathering process can vary in the small scale (Wright, 1992) and thus the lithology exhibits considerable heterogeneity both vertically and laterally. This variability extends to regolith permeability, which is affected by rapid throughflow channels including stone lines, basal breccia, residual quartz bands/veins, biological features and ex-solution piping which can intersect the regolith (Wright, 1992).

The regolith generally provides the available water storage for the Basement fracture aquifers and may have sufficient transmissivity for shallow wells and boreholes (Wright, 1992).

Box 5.1: Ugandan Regolith Hydrogeology

This demand on rig capability meant that the Pounder rig components had to be strong enough to withstand considerable impact. Stronger drill pipe and drill bits were thus used instead of the water pipe and pipe coupling used in sludging; the bamboo lever was superceded by a steel frame and the operators hand by a mechanical flap valve. Several additional mechanisms were introduced to improve the operation of the technology. Detailed design drawings are given in Ball & Carter (2000). The Pounder rig is shown in Figure 5.3. Box 5.2 provides an outline of the technology operating requirements.

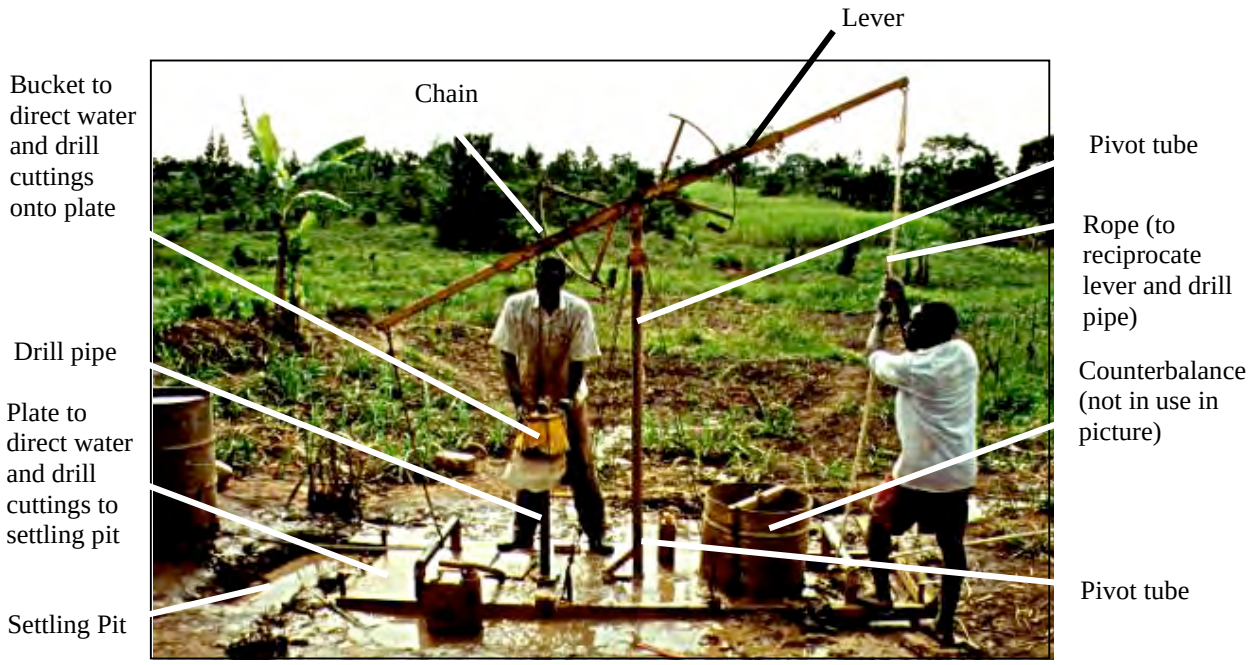


Figure 5.3: Pounder Rig II in Operation

Drilling principle: the Pounder drilling method involves reciprocating a water filled *drill pipe* (components in *italics* are shown in Figure 5.3) in a water filled hole. The drill bit, at the base of the drill pipe loosens the formation, which is carried up inside the pipe due to the operation of a flap valve at the top. This valve holds the water and drill cuttings in suction on the upstroke, and releases them on the downstroke. The water and cuttings thus emitted from the top of the pipe are directed on to a *plate* by a *bucket*. The water and cuttings flow from the plate to a *settling pit*, from which the water is recycled.

Transport: the Pounder rig fits into a pickup truck and can be manhandled (carried or wheeled) to the drill site.

Setting up: the rig frame rests on robust timber planks and must be levelled to prevent bending or overload when drilling. A *settling pit* is dug at the borehole end of the chassis along with a wide channel down the side which connects the settling pit to the borehole. The *pivot tube* is fitted in the centre of the frame and the lever is bolted in place.

Setting Conductor Casing: the conductor casing is driven into the ground through the hole in the chassis to start the drilled hole.

Drilling: drilling should commence with the minimum diameter drill bit. Once the hole has been drilled to depth the hole can be reamed open to 100 mm diameter. The drill pipe is attached to the lever via a *chain* and reciprocated by raising and lowering the lever via *ropes* at both ends. Drill pipe is added as the hole is progressed. A *counterbalance* can be fitted to the lever to aid in lifting the drill pipe as it becomes heavy. Water must be added to the settling pit as the drilling progresses due to increased water requirements as the hole deepens and due to losses into the formation. Sufficient water is crucial to the drilling operation as it removes the spoil from the hole and holds the hole open. In order to prevent hole *collapse* a minimum of 3m of water above the water table should be maintained at all times.

Well Development: once the well has been drilled and the below ground well components installed, the well is developed. This is undertaken in order to provide a clean water source, and prevent the ingress of fine material into the well. Well development involves repeated plunging of the well followed by pumping until the water clears.

Box 5.2: Pounder Rig Operation and Well Development (adapted from Ball & Carter, 2000)

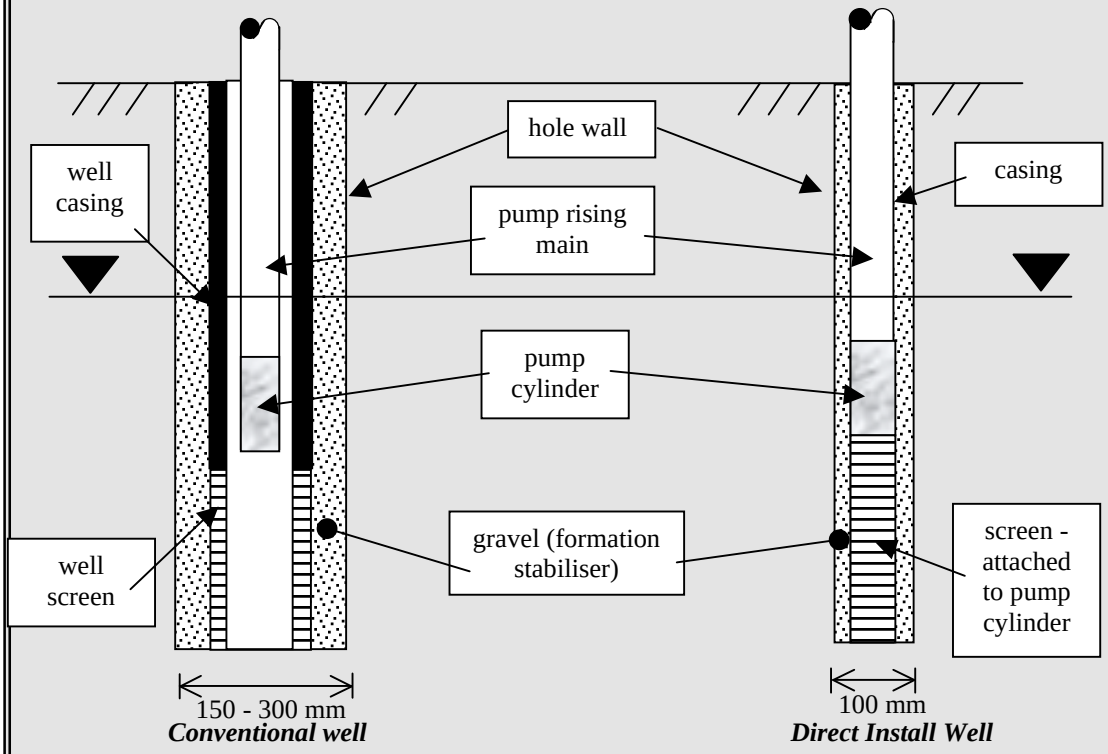
5.3.3 The Pounder Well

As the Pounder rig is a hand operated technology, the extent to which it can penetrate hard material is limited by human energy. A medium sized compressor used in conventional deep well drilling can deliver 60 kW, which is equivalent to approximately 600 adult operators working continuously. In contrast, the Pounder rig, with four to eight operators has much less energy at its disposal. In order to minimise energy requirements, the Pounder rig was designed to drill at a maximum diameter of 100 mm. This requires the removal of 25% of the material which must be removed from a 200 mm diameter hole (the size of drill bit introduced into Uganda in 1992 drilled by the hand auger equipment (Ruwasa, 1996)).

As a result of this smaller diameter hole and use of the Ugandan standard U3 pump, the pump cylinder and rising main are directly installed into the hole rather than hung inside a cased hole (described in Box 5.3). Although the direct install method is

not original (it has been used for the Tara pump in Bangladesh), it was a novel installation method in Uganda.

"Conventional" shallow wells in Uganda are augered at a diameter of 150 to 300 mm. The U3 (based on the India Mark III) rising main and pump cylinder is hung in a cased and screened hole as shown below left. The Pounder well was drilled at a diameter of 100 mm. The rising main, cylinder and screen were attached and were inserted directly into the drilled hole. This method is known as "direct install" (below right) in which rising main doubles up as well casing, while the screen is attached to the cylinder as a tail pipe.



The direct install method works out cheaper than the conventional method as the drilling is faster (smaller drilled diameter) and less materials are required (no additional casing material). However, the rising main and cylinder are permanently installed into the ground. The U3 rising main in the conventional installation is galvanised steel whereas uPVC is used in the direct install well.

Box 5.3: Conventional and Direct Install Wells

5.4 PERFORMANCE OF THE POUNDER TECHNOLOGY

5.4.1 Background

The Pounder technology was developed from a concept into a working product within the three year LCDP duration. Figure 5.4 provides an overview of the technology design and test process, showing stakeholder input at each stage.

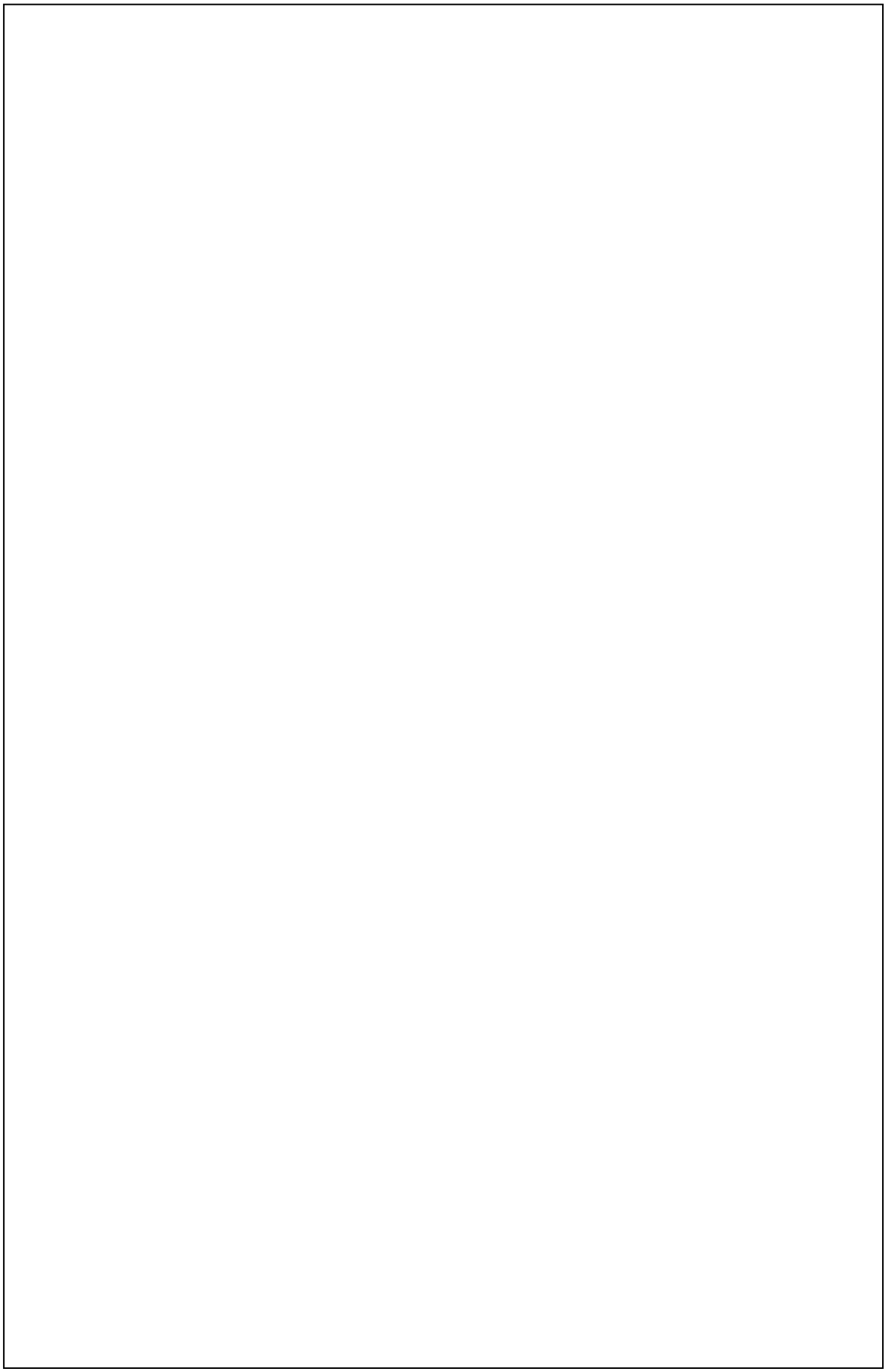


Figure 5.4: Chronological Overview of the Rig Design and Test Process of the Low Cost Drilling Project (LCDP) in Uganda

As the variable and unpredictable hydrogeology of Uganda (Box 5.1) cannot be replicated in the laboratory, the Pounder rig required extensive field trials in order to investigate its performance and facilitate design improvements. Due to limitations in the LCDP funding arrangements, trial drilling was undertaken under the auspices of ongoing Government water supply projects. The rig was first deployed in Uganda through a set of field trials of a prototype machine (Pounder rig I) within the Water and Environmental Sanitation Programme[13] (step 4A in Figure 5.4). The rig was operated by a crew who normally undertook hand auger drilling directly for District Government. A second, improved rig (Pounder rig II) was utilised by private enterprise, who were contracted to District Government to drill community wells (step 8A in Figure 5.4).

5.4.2 Rig Deployment

Table 5.2 summarises Pounder rig deployment between August 1999 and June 2001 (see Ball & Danert (1999b); Danert & Carter (2001) for full details of rig deployment). A total of 29 holes were drilled, of which 3 were specifically intended to train the crew in the use of the equipment. These have been included in the table below as they would have been completed to water sources if possible. 2 holes were drilled specifically to investigate depth and rig performance in very hard rock. Of the remaining 24 holes, 9 were successfully completed with handpumps, with another successful hole not completed with a handpump for reasons which lie beyond the scope of this thesis.

Table 5.2: Summary of Pounder Well Drilling Between August 1999 and June 2001

Site Details/Drilling Equipment	**Pounder Rig I**	**Pounder Rig Ii**
Crew training site	2	1
Test for depth	1	0
Test for hard rock	1	0
Completed sources with handpump	5	4
Completed sources without handpump	0	1
Failed due to hole collapse/loss of circulation	4	1
Failed due to low yield	2	1
Failed due to hard formation	4	4
Total number of sites attempted	**17**	**12**

[13] Described in section 4.5.

The figures in Table 5.2 summarise the deployment of the Pounder rig II up to June 2001. Pounder rig II continued to drill after the end of LCDP funding in June 2001. Another 3 attempts were made, of which 2 were successful. The other well failed primarily due to lack of community participation in the construction (Okwi, 2002).

5.4.3 Rig Performance

The Pounder rig can provide successful water wells and is capable of penetrating some of the laterite formation, common in Uganda, giving it an advantage over hand augering and hand digging. However, cases were found where the formation was too hard to penetrate in a reasonable time either because the laterite was too thick, or due to the presence of boulders. When the rig was performing well, it drilled considerably more quickly than hand augering and hand digging (Ball and Danert, 1999b). This can be attributed to the smaller diameter holes drilled, to the cutting technique and to the simultaneous removal of cuttings when drilling.

It was acknowledged by the operators and technical assistant that Pounder drilling appears much simpler than it actually is. Determining whether water had been struck, and if it was sufficient to be developed into a successful well was difficult for the operators. As the drilling fluid (water) in the hole tended to mask the presence of an aquifer, the operators had to ascertain the sub-surface formation by examining the drill cuttings, observing the behaviour of the drilling equipment and keeping a close eye on the level of the drilling fluid. In contrast, hand augering and hand digging provide the operators with much clearer indications of whether an aquifer is present or not. Sufficient know-how amongst the operators to understand the productive zones and describe the cuttings was lacking. Considerable training and support is required to develop these skills. Although operator skills improved with time, the heterogeneity of the regolith (Box 5.1) meant that each site tended to have its own particularities, providing new challenges for the crews.

Further problems experienced with the operation of the Pounder rig are given in Box 5.4. Insufficient labour for the drilling operation was observed to be a potential barrier for the technology deployment. This is a cross cutting issue which Ugandan stakeholders cited as a problem for other shallow ground water technologies (5.2

The difficulties in determining whether a hole would provide a productive water source were exacerbated by the contractual agreements between the rig operators and their clients. In Uganda, shallow well drillers were generally not paid for wells which did not become successful water sources. This means that the rig operators stood to lose out for the inherent unpredictability of the regolith (Box 5.1) due to contract terms. These issues are explored further in chapters 6 and 7 which consider the rig operators and their clients respectively.

the flap valve did not always seal properly, particularly in sand where regular rinsing was required in order to remove the debris from the surface. This led to intermittent drilling which slowed the operation down considerably and required one dedicated individual to be on standby to rinse;

several holes suffered from excessive loss of drilling fluid (loss of circulation). In cases where the loss of water into the formation could not be replaced rapidly enough, the drilling was abandoned. In some cases, insufficient labour to fetch water exacerbated this problem. In other cases losses were so massive that even a diesel pump may not have supplied the requisite amount. The addition of guar (a thickening agent) and sawdust sometimes helped to reduce these losses. Although sawdust is readily available, the long term availability of guar is not guaranteed. Loss of circulation was also one of the reasons for hole collapse (see below);

several holes collapsed during the drilling operation, and holes left overnight would often partially fill up again. As a Pounder well, drilled in the partially hard formations of Ugandan regolith can rarely be constructed in one day, the hole must often be left overnight. The gradual reduction in water levels overnight means that there is insufficient hydrostatic head to keep the hole open. Ideally, this should be manned throughout.

Box 5.4: Problems with the Operation of the Pounder Rig

Penetration rates varied considerably, with values from as high as 6m/h to zero or less (hole collapse) depending on the formation and drilling operation (Ball & Danert, 1999b). This, combined with the variation in water table levels and regolith permeability, which affects depth requirements, means that there is considerable variation in the time taken to complete the drilling activity. This variation is at odds with payment conditions, which follow a fixed price regime. This problem is explored further in chapter 6.

5.4.4 The Pounder Well

"[Sustainable development] is an ideal which now guides much of contemporary thinking about, and public policy with regard to science and technology" (Mitcham, 1995). Indeed, the sustainability, (read longevity) of the Pounder well is paramount if communities are to continue to benefit from the water source improvement in the long

term. In addition to the complete breakdown of the source, completed wells can be abandoned by communities due to unacceptable water quality (eg iron or the ingress of fine materials). Source breakdown can be a result of inadequate pump maintenance and/or poor well construction. These issues are discussed in chapter 8 as they relate to the interface between communities, clients and those constructing the water source. Meanwhile, this section considers water quality and the current Pounder well design.

High iron content in pumped water can be due to naturally occurring iron in the ground, corrosion of pump components or a combination of both. Aggressive groundwater (often indicated by acidity, with a pH<6.5) causes corrosion problems (Langenegger, 1994). As this is a problem in some parts of Uganda in both deep and shallow wells (Ruwasa, 1998) hand pumps and well linings made from appropriate materials should ideally be installed.

The pH of wells monitored by the LCDP in Mpigi District over a period of 15 months was found to be consistently below 5.9 while similar values were found in Mukono (Rwamwanja, Danert & Carter, 2001) indicating aggressive groundwater. The pump cylinder installed in the Pounder well comprises cast iron with a brass liner, both of which have both been shown to corrode in aggressive waters (Langenegger, 1994). This renders the longevity of the permanently installed U3 pump cylinder in the Pounder well questionable.

The Pounder wells constructed in Mukono district suffered from the ingress of fine material (mica), causing cloudiness in the water. However, it remains unclear whether this ingress is due to the geological formation, the well design, the well development or some combination. High turbidity has also been observed in hand auger wells (Luutu, 2001) but this could also be attributable to one or a number of the causes above.

If the ingress of fine material is an unavoidable aspect of some geological formations, alternative drilling locations, or indeed alternatives to shallow ground water sources need to be sought. The 100 mm diameter hole of the Pounder well allows 10 - 25 mm of gravel to be placed between the hole and screen. In order to ensure a continuous layer of gravel in an annulus, it must be at least 75 mm thick (Driscoll, 1986). Consequently the gravel in the Pounder well acts as a formation stabiliser rather than a gravel pack. Well development (described in Box 5.2) after drilling is important

in order to clean the well and prevent the ingress of fine materials by developing the well naturally. However, due to a number of social and institutional factors, this is often not considered as a priority compared to constructing new sources. Further research into well development, and into the comparison between ingress for direct install, conventional and hand dug shallow wells is recommended in order to develop a greater understanding of the issue of ingress.

Faecal contamination of very shallow groundwater is considered to be a problem in Uganda (Table 5.1), particularly in peri-urban and urban areas. Concerns about high levels of contamination in Kampala discouraged the LCDP from undertaking Pounder well drilling in the municipality (Rwamwanja, 1999a). In order to investigate this aspect of water quality, monitoring of shallow wells (Pounder and non-Pounder) was undertaken over a period of 15 months.

The results (Figure 5.5) indicate that all of the Pounder wells showed values below 50FC(Faecal Coliform)/100ml (the Ugandan standard for untreated supplies), while all but one of the values was below 20FC/100ml, indicating very low faecal contamination. The results for the non-Pounder wells were not as good with nine values (out of 43) exceeding the 50 FC/100ml standard. However, 30 values lay below 20 FC/100ml, and 22 values lay below 10 FC/100ml. Two of the 5 non-Pounder wells showed high counts.

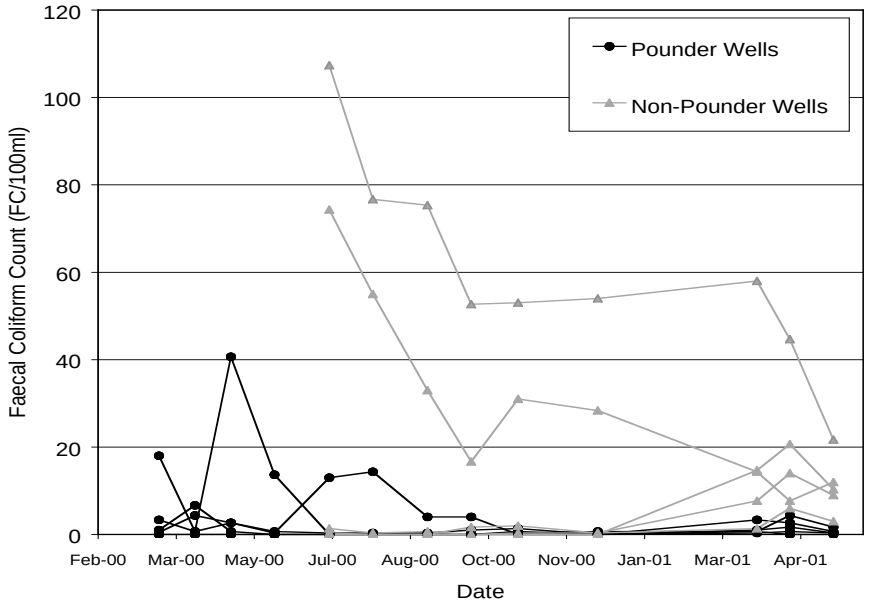


Figure 5.5: Faecal Coliform Counts, Shallow Wells, Katabi Subcounty, Mpigi District

5.4.5 Financial Aspects of the Technology

Rig

The actual cost of manufacture of the Pounder rig was not released by the UK supplier. Table 5.3 shows the price which the LCDP paid for the second rig, which was entirely sourced and manufactured in the UK. However, it is unclear to what extent this reflects the true cost as the supplier claims to have not included all costs (eg jigs and fixtures) incurred in this price. In addition the supplier was paid for consultancy work, which overlapped with manufacture to a certain extent. Determining the rig cost is further complicated by the fact that cost depends upon the quantity manufactured.

Table 5.3: Invoice for Pounder Rig Supplied to Uganda

ITEM	PRICE ($)	UNIT	QUANTITY	PRICE ($)
Basic Pounder Frame	3,080.00	piece	1	3,080.00
BP drillpipe	91.00	piece (3m)	10	910.00
Surface Casing	72.80	piece (1m)	10	728.00
60 mm button bit	207.20	piece	1	207.20
69 mm button bit	231.00	piece	1	231.00
82 mm button bit	249.20	piece	1	249.20
100 mm button bit	294.00	piece	1	294.00
Export Packing	315.00	no.	1	315.00
Airfreight	1,648.75	no.	1	1,648.75
Sub-total				**7,663.15**
Clearing Charges and VAT	1,415.56	no.	1	1,415.56
Total				**9,078.71**

The figures given in Table 5.3 can thus only be used as indicative values. Cost also depends on where the equipment is built as labour and material costs vary between Europe and Africa. The absence of a clear cost indication means that in the case of components which can be manufactured in Uganda as well as the UK, further work is required in order to make detailed cost comparisons.

Rig cost remains an important, unfinished issue. The inability of the LCDP team to provide key Ugandan stakeholders with a rig cost became a source of frustration, which may have sent out signals of secrecy and lack of trust. The long term effects of this on future collaboration with Ugandan stakeholders is not known.

However, the indicative cost of US$9,000 in Table 5.3 is higher than most Ugandan contractors can afford. Consequently, mechanisms such as credit, hire, or hire

purchase are required to ensure that the rig is affordable. These mechanisms are explored in chapter 6.

Well

The direct cost (excluding a margin for profit and overheads) of a sample Pounder well, comprising six days drilling to 18m has been estimated to be $1297 (based on prices in November 2000). As this amount is beyond the reach of most Ugandan communities, the sources need to be subsidised. The implications of this are discussed in chapter 8.

The percentage breakdown into labour, transport, drilling equipment hire, pump and well consumables is given in Figure 5.6. The pump represents the highest proportion of the well cost at 42%, some $550. The fact that the pump accounts for such a high proportion of the well cost provides considerable financial incentive to reduce it, unlike the previous situation with deep wells.

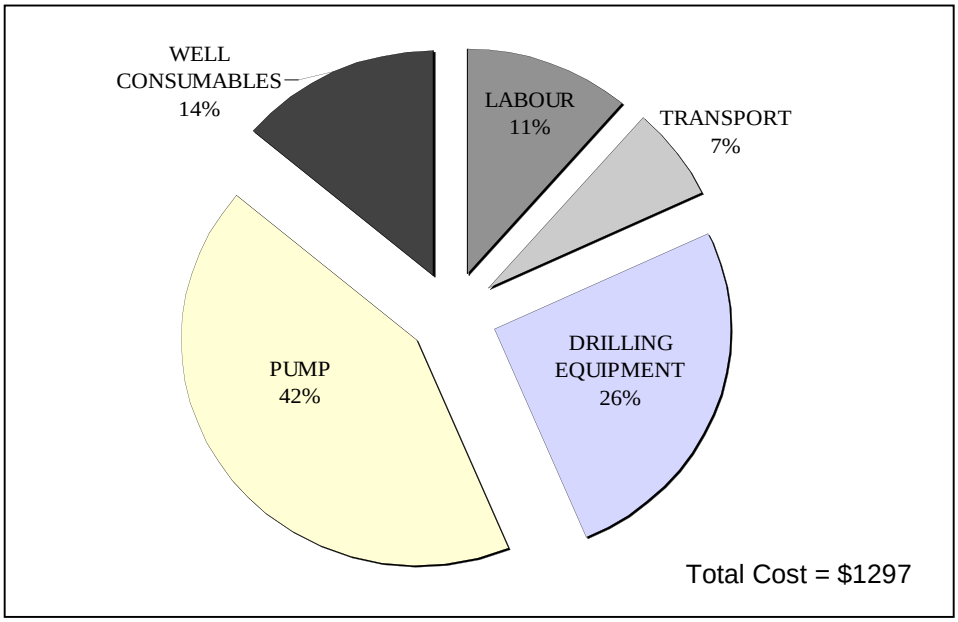


Figure 5.6: Breakdown of Estimated Direct Costs of a Pounder Well: 6 days drilling, 18m depth, 65 km from base

The installation of an alternative pump of significantly lower cost[14] in the Pounder well would have a considerable impact on the well cost. However, alternative

[14] such as the rope pump, which retails at $110 in Nicaragua (WSP, 2001b).

pumps cannot be considered in isolation of source sustainability, in particular the availability of spares and maintenance know-how. This issue is discussed further in chapter 8 which examines the technology uptake from a community perspective. In addition, the use of alternative pumps has implications for Government of Uganda pump standardisation policy. Consideration of this issue is presented in chapter 9, which focuses on the *process* of technology development and transfer, in particular stakeholder participation.

5.5 WELL SITING

5.5.1 Background

Drilled holes which cannot be developed into productive water wells incur a cost, causing financial loss. Well siting techniques which can reduce this loss are thus welcome. The regolith heterogeneity and unpredictability (Box 5.1), coupled with conditions which stipulate that wells will only be paid for if they are developed into productive water sources further contribute to the desire for well siting methods which reduce risk of well failure.

5.5.2 Existing Shallow Well Siting Practices and Attitudes

Despite the difficulties of relating the output of geophysical data (typically from electrical resistivity and electromagnetics) to the heterogeneous regolith formation (Box 5.5), resistivity soundings are still utilised in some parts of Uganda to site shallow wells (observation). Contracts for this work range from $110 per sited well to $750 depending on whether equipment is borrowed at no cost or charged fully, and depending on the level of professional fees (Carter, 2001). Small augers and joggle pumps are also utilised to determine the sub-surface formation prior to drilling for approximately $55 per day (Mukono, 2000e; Comment 5.12).

Despite the existence of these methods, hand auger siting practices tend to involve drilling wells in the valleys to minimise the chances of encountering impenetrable formation and maximise the chance of striking a productive aquifer (Box 5.5).

When shallow well technology was introduced into Uganda, well construction would commonly be recommended near unprotected traditional wells and swamps. The presence of a near surface water table inhibited the formation of hard lateritic layers. These could not be penetrated by the hand drilling and such site selection virtually guaranteed the presence of water. In general sites were selected 5 to 20 m upgradient from the existing source (Ruwasa, 1996). From 1992, auger well sites were determined by previous deep drilling descriptions and shallow well resistivity proofing. However, lack of equipment, and insufficient correlation between resistivity reading and penetration results led to siting problems (Ruwasa, 1996).

Box 5.5: Shallow Well Siting under the Ruwasa Project

5.5.3 Pounder Well Siting Experience

The LCDP developed and tested a Pounder well siting methodology involving three stages: a detailed desk study; field reconnaissance and water source mapping; and test drilling with a small diameter auger (Tindimugaya, 2000). However, the methodology was constrained due to regolith variability over very short distances; scant data; and the inability to penetrate hard formations or drill through sand and gravel with the test auger equipment (Tindimugaya, 2000; Luutu, 2001).

Stakeholders tended to perceive the solution to siting problems in terms of a piece of technology. *"There needs to be a test drilling equipment which confirms to the same specifications as the [Pounder Rig]"* (Comment 5.2). *"[Siting] requires some light exploratory drilling equipment"* (Comment 5.3). *"We may have to go for practical well surveys using mini [rigs]"* (Comment 5.4). These statements, all made by individuals who are knowledgeable about drilling perceive the solution to the problem of siting Pounder wells to be in the form of a miniature Pounder rig. Implicit in these statements is the idea that such equipment would be cheaper to use and quicker to set up than the full size Pounder rig.

Another solution for well siting is the suggestion to use in situ test pumping to reduce the risk of installing a pump in an unsuccessful hole: *"I think there is need to put some [temporary] pumps [before completing the well] to try to solve the risky problem of drilling and then finding no water. It will encourage the contractors to be active, knowing that if there is no water [they can abandon the hole]"* (Comment 5.4). However, this Pounder rig design feature remains untested and is controversial. The water which would be test pumped is what currently prevents the hole from collapsing, and the use of temporary casing remains untested.

5.5.4 Recommendations for Future Pounder Well Siting

A scaled down Pounder rig would not be able to drill as deep as the full size version due to pipe friction, and is unlikely to be ergonomic. Improving Pounder well siting is not just a matter of developing the right piece of technology but requires consideration of financial, community and policy issues.

Carter (2001) presents an economic model of well siting based on existing siting costs in Uganda (given in 5.5.2), cost estimates of Pounder drilling and the knowledge that two holes drilled only a few meters apart can vary widely in yield. Carter (2001) concludes from the model that *"the reliability of siting procedures is crucial. Cheap, low reliability siting is worse than no siting at all"* and in relation to shallow wells drilling (but not deep well drilling) *"only if blind success rates fall below about 30-40% is investment in scientific siting financially worthwhile"*. From a financial point of view, Carter (2001) thus recommends that drilling failure is merely considered as an alternative to more expensive siting. This argument supports a strategy of deployment of the Pounder rig as a siting tool, and only completing a well if it is likely to provide a successful water source. This has the added advantage that if yield is too low for a Pounder well, the source may be able to be developed into a hand dug well.

However, siting cannot only be considered from a financial point of view. Given that communities participate in their water source improvements, one must question how many holes can realistically be trial drilled before the burden upon them becomes unacceptable. In addition, the rig operators would need to be paid for their siting efforts, and clients would need to know how much to pay. Such changes to payment conditions require significant policy changes.

One of the concerns raised by stakeholders regarding shallow well drilling was that people live up the slopes but shallow well technology can only provide sources in the valley bottoms (Table 5.1). Although the Pounder technology may be able to address this problem in terms of technical capability, attitudes and practices with respect to risk of failure, siting and its payment will need to be altered if these capability improvements can be harnessed. Insights into the process of changing attitudes and behaviour are discussed in chapter 9.

5.6 TECHNOLOGY MANUFACTURE, SUPPLY AND AVAILABILITY

5.6.1 Background

As the Pounder technology comprises the rig, well and pump, consideration of the technology manufacture and supply needs to embrace this scope. This section considers the manufacture and supply of the rig, pump and well consumables.

5.6.2 The Pounder Rig

As discussed in 5.3.2 the Pounder Rig design was driven by capability requirements. The consideration of the availability of rig components in Uganda was secondary to designing a rig with the requisite strength. However, ensuring full local manufacture of the Pounder rig was considered very important by most Ugandan stakeholders. Potential Ugandan manufacturers were frequently suggested and the LCDP team were regularly quizzed about progress towards local manufacture.

The current Pounder rig design does not lend itself to *full* Ugandan manufacture. The drill pipe, pivot tube and button bits cannot currently be manufactured in Uganda (Box 5.6). The drill pipes comprise standard "wireline" drilling pipes and are readily available on the international market in the UK, USA and South Africa. The drill bits have been designed specifically for Pounder drilling and are thus only available on order.

> The drill pipe, drill mast and drill bits, along with a number of other components cannot readily be manufactured in Uganda. The drill pipe and drill mast comprise high carbon steel tubing with tapered threads, which cannot be manufactured to the requisite tolerance given the current levels of expertise and equipment available in Uganda. The drill bits are constructed from a hardened steel body with tungsten carbide inserts inserted at angles to the longitudinal axis. This requires computer numerical controlled (CNC) machines, which are not available in Uganda. They also require threading to the tolerance of the drill pipe.

Box 5.6: Manufacture of Pounder Rig Drill Pipe, Button Bit and Pivot Stand

The specialist drill bits have to date only been manufactured by one UK based supplier. This monopoly on bit manufacture coupled with a refusal to supply any more has enabled the manufacturer to control the equipment supplies and prevent further Pounder drilling from taking place in Uganda now that the first set of drill bits have

been worn to destruction. This contentious issue is complicated by the unresolved question of whether the drill bits should be redesigned, given the wear which has been observed or whether further trial drilling in Uganda should be encouraged and bit wear resolved with time. This experience highlights a weakness in (i) the LCDP, which did not work in collaboration with local suppliers and manufacturers and (ii) the LCDP process and funding arrangements, which did not enable these issues to be resolved to a satisfactory conclusion. These weaknesses are explored in chapter 9.

The unavailability of Pounder rig spares in Uganda also sheds light on issues of intellectual property and public domain design. At the LCDP outset, it was agreed that the Pounder technology would be a public domain design. Rig drawings and basic operating instructions (Ball & Carter, 2000) have been made freely available through the internet. However, given that Ugandan manufacturers may not be familiar with design drawings and that details regarding rig manufacture (eg jigs, fixtures and intricacies) have not been supplied, the freely available rig drawings do not enable the Pounder rig to be readily manufactured in Uganda. Lack of information regarding suppliers of components which are not readily available in Uganda provides another barrier for local manufacturers and suppliers.

The current Pounder rig design, coupled with lack of spare drill bits and lack of freely available information regarding why components have been designed in a particular way also inhibits evolution of the technology in Uganda. Local champions who are familiar with and interested in the technology have been prevented from developing their own solutions to weaknesses in the technology. Control over the technology is not in Ugandan hands, and additional resources are needed to progress the situation. Chapter 9 examines the difficulty of handing over control in further detail.

5.6.3 The Pump and Well Consumables

In contrast to the Pounder rig, the Pounder well was designed with the component availability in Uganda in mind. Although the U3 pump comprises 42% of the well cost, it is readily available in Uganda. The demand for the pump by the Government of Uganda ensures that there is a sizeable market for it, rendering its supply financially viable. Proposed changes to the well design need to balance issues such as longevity and cost with the availability of pumps and spares. Although it may be desirable to install a different pump in the Pounder well in order to reduce cost and

prove that such a well design can provide a productive water source, the sustainability of this water source must be considered. Chapter 9 reflects on the difficulties of determining the degree of innovation and change that a relatively small project can expect to achieve.

5.7 FURTHER RESEARCH INTO THE POUNDER TECHNOLOGY

Table 5.4 provides a summary of current knowledge and knowledge gaps of the Pounder technology. Although the drilling undertaken between 1999 and 2001 showed that it could provide successful shallow water sources in various formations, including laterite, and drill to a depth of at least 20 m, a number of rig design features remain untested. Their ability to further enhance the rig performance and ease operation requires further research.

The Pounder rig was conceived so that all the components could be replaced when worn, as is the case of bicycles or car engines. Thus, provided that the components could be acquired and properly fitted, the rig has a very long life. Unfortunately, the limited rig use means that a detailed analysis of rig longevity cannot yet be undertaken.

Table 5.4: Summary of Knowledge and Unknowns of the Pounder Technology

RIG CAPABILITY	**RIG I**	**RIG II**
Penetration of laterite	✓	✓
Penetration of hard rock layers without loss of drilling fluid circulation	✗	unknown (internal flap valves not tested)
Drilled Diameter	100 mm	100 mm
Depth	20 m	> 20 m (limit has not been established)
Support soft formation:		
water table > 3 m	✓	✓
water table < 3 m	✗	unknown (temporary casing not tested)
Vertical drilling with good alignment	✗	✓
In-situ yield test	✗	unknown (internal flap valves not tested)
Rig longevity	Flap valve required frequent replacing; considerable wear on the body of the drill bit and buttons falling out. The bits were ultimately destroyed during drilling; some wear on rubbing parts of the rig.	
Geographic scope	Mpigi District: 17 attempts - 5 successes; Mukono District: 5 attempts - 2 successes; Jinja District: 4 attempts - 2 successes; Katakwi District: 3 attempts	
Well Capability		

Water Quality: Clear water supply	Ingress of fine material in some wells.
Water Quality: Faecal contamination	Acceptable
Well longevity	Corrosion of galvanised materials; corrosion of pump cylinder not known

Despite the limited number of holes drilled, wear was observed on a number of components. The flap valve wore out regularly but could be replaced from locally available materials. However, the drill bits, which wore to destruction during the drilling, were not readily available in Uganda or on the international market.

The deployment of the Pounder rig was limited to a few wells in Mpigi, Mukono, Jinja and Katakwi Districts which exhibited varied drilling success and construction times. This limited geographic scope requires expansion in order to develop an understanding of where the equipment can be deployed nationally and where is most suitable.

The effect of geology, well development and well design on the ingress of fine materials should be examined in further detail to determine the suitability of the technology to provide a water source which is not turbid. In addition, given the potential corrosion of the pump cylinder, ongoing monitoring needs to be undertaken to determine well longevity.

The small number of holes drilled, many of which have been for training purposes, renders success rate figures rather meaningless. Given the emphasis on success rates by the Ugandan Government, a more extensive drilling programme should be undertaken to provide an indication of how the Pounder technology compares with hand auger drilling and hand digging in terms of capability.

The excerpts given in Box 5.7 are illustrative of a consensus among stakeholders in June 2001 favouring additional testing of the technology. However, this consensus does not automatically result in a agreement regarding *how* further testing should be undertaken. The opinions of the stakeholders regarding the extent of technology trials and the type of stakeholder participation in them varied considerably. Chapter 9, which reflects on the participative process of the LCDP considers the trade off between stakeholder participation and technology test during the LCDP.

"We have not drilled enough holes in enough different places. Everyone would recognise that.....The design is not finished" (Comment-5.6).

" you have to invest more into the development because some people will continually ask has this thing been tried and tested. Is it reliable, is it worth our money? So we need to put in more time. This cannot be compressed. We need to put more time on the testing so that we can say, yes this thing has worked for 20 wells, for 40 wells, or two years, whichever is more appropriate. So that they visualise and say with 40 wells I can make this profitable" (Comment-5.7).

"To me [the rig] is suitable although yesterday I was trying to look at that map you have on the wall. In reality we do not know [where it can drill]. We have hit a number of dry wells, but we don't know" (Comment-5.8),

"Then of course I think it will continue to be taken up in future if many trials can be carried out to demonstrate its affordability..." (Comment-5.9).

*"The Project should have sampled further afield, say in other districts, ie five holes per district to get a better understanding of its wider applicability" (*Comment-5.10)

"There needs to be more work done, more testing, taking time to drill and all that." (DWD, 2001c).

"...I think it will be continue to be taken up in the future if many trials can be taken up to demonstrate its applicability" (DWD, 2001a).

Box 5.7: Perceptions of the Status of the Technology in June 2001

5.8 CONCLUSIONS

This chapter highlights multiple issues which affect the likelihood of technology adoption in Uganda. These issues are not only directly related to the technology. In fact, Pounder technology cannot be considered in isolation from the future rig operators; the clients who pay for the service it provides; the end users of the wells; and the process of introducing the technology to Ugandan stakeholders.

The three principles in Table 3.1 which relate directly to the findings presented in this chapter are *capability, advantage and maintenance*. These are discussed below.

The principles of capability (number 9 *"The technology must be able to undertake the task that it is designed for"*) and advantage (number 5: "*The technology must have an advantage over existing technologies which serve a similar purpose"*) inter-link.

Table 5.5 provides a summarised comparison between the Pounder technology and existing groundwater technologies in Uganda. The Pounder equipment has extended the potential for shallow well provision as it can penetrate the laterite formation which hand augering and hand digging cannot. The Pounder rig is capable of drilling faster than the other shallow well technologies at a similar cost of construction. At this level, the technology is capable of undertaking the task that it was designed for. However, what the technology was designed to do shifted as the LCDP progressed. Consequently defining whether the technology can undertake the task that it was designed for has proved to be difficult. This difficulty raises the profile of the importance of the project *process* in considering technology design and transfer. This is examined in chapter 9.

The Pounder technology has an advantage over existing technologies which serve a similar purpose. However, the technical capability of the Pounder technology and its advantage over other methods raises issues which affect the likelihood of the technology being adopted in Uganda. In particular, the ability of the rig to drill in a wide range of hydrogeological conditions is coupled with a certain degree of risk.

An evaluation of the feasibility of technology maintenance (principle 12: "*Maintenance and repair of the technology must be feasible")* has been hampered by the limited technology use. This aspect requires further research. However, the principle of maintenance required component availability, which remains problematic after the completion of the first phase of the LCDP in June 2001. Availability is explored further in chapter 6.

Figure 5.7 draws together the many issues which have been raised in this chapter as key to successful technology adoption. The issues are categorised according to whether they pertain to the technology itself; the organisations which use or fund the deployment of the technology; and the communities, who should benefit from the service which the technology provides. Colour coding is used to differentiate between issues which the new technology can address and those which remain unknown, or

which are barriers to successful technology uptake in Uganda. Links between issues are also shown. Figure 5.7 is not a final categorisation, rather a stage on from the preliminary categorisation in Figure 5.1. as a result of the research findings presented in this chapter. This categorisation sets the scene for the subsequent three chapters of this thesis which consider the three stakeholder groups in Figure 5.7.

Table 5.5: Comparison of Pounder Drilling with other Ground Water Provision Technologies

Issue	Technology			
	Deep Drilling (DTH)	**Hand Augering**	**Hand Digging**	**Pounding**
Capability				
Depth (common use)	>1000 m (>100 m)	< 20 m	>100 m (<30 m)	minimum of 20 m
Drilling Time	1- 5 days	5 - 7 days	7 - 28 days	1 - 14 days (can drill 13 m in 1 day in favourable conditions)
Material				
Soft/Medium - Clay, Sand	✓	✓	✓	✓
Medium/Hard - Marrum, Laterite	✓	✘	sometimes	✓
Hard - Bolders	✓	✘	✘	✓
Very Hard - Basement Rock	✓	✘	✘	✘
Deal with well collapse.	✓ (only with simultaneous casing)	✘	✓	sometimes - hydrostatic head; don't know - temporary casing
Drilling Diameter; Casing Diameter		Drilling 250 mm holes; Inserting 125 mm casing.	Digging at 1m;	Drills 100 mm Casing 75 - 80 mm
Cost				
Equipment	>$140,000 (large rig); $14,000 (small rig)			
Well (incl. pump)	$7,000 - $10,000	~ $1500	~ $1500	~ $1500
Operation				
Equipment		Digging tools; concrete rings; de-watering pump.	Hand auger equipment	Pounder Rig and tools; water for drilling
Water	✘	✘	✘	✓
Transport	Truck and trailer	Truck	Truck	Pickup
Siting	Geophysics	Test augering	Test augering or pilot pounder hole	Pilot pounder hole
Labour req.		2 skilled labourers	2 skilled; > 4 unskilled	3 skilled; > 4 unskilled

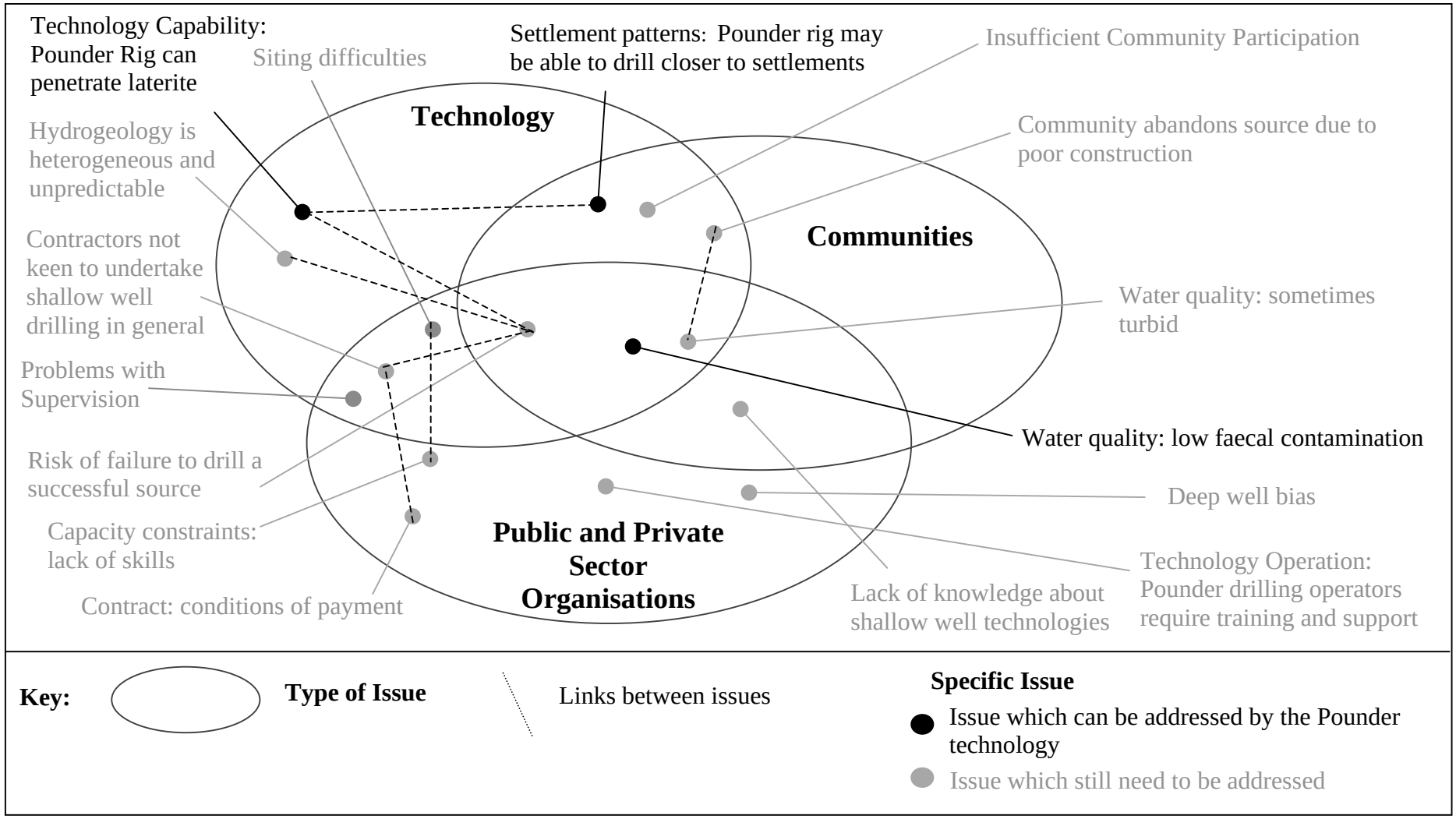


Figure 5.7: Modified Classification of Issues which Relate to the Development and Transfer of the Pounder Well Technology

6 Private Sector Analysis

This chapter analyses a sample of Ugandan private sector operators involved in water and sanitation and other construction activities. A series of interdependent issues which affect the wellbeing of the enterprises and opportunities and challenges to the early adoption and sustainable uptake of the new technology are presented.

6.1 INTRODUCTION

"Small and medium enterprises [SMEs] operate in such a complex environment and confront a diverse array of constraints; it is chimerical[15] *to search for a single constraint, common to all countries which, once realised, will lead to the rapid development of SMEs. Not only is there substantial variation among countries as to which constraint is binding, the release of one constraint is likely to bring to the forefront some other constraint whose inhibiting influence had not previously been evident" (Rogerson, 2001:132).*

This chapter is based on knowledge developed through multiple in-depth encounters with Ugandan private sector organisations and is written with the principles (developed in chapter 3) in mind. Sections 6.2 to 6.6 discuss the findings of the action research and section 6.7 reflects upon the relevant principles in light of the research findings.

The purpose of researching the private sector was to understand the opportunities and challenges to sustainable uptake of the new technology by small businesses. The focus on Ugandan commercial enterprises as technology operators was not only a stated objective of the LCDP, but it ties in with the trend in international development policy and the Ugandan policy context: *"We are trying to involve the private sector. That is our policy, the donors and also Danida is behind the Government in attention to [them]"* (Danida, 2001a) and *"...favour of use of the private sector is on"* (DWD, 2001a).

The introduction of the new technology actually became the entry point from which to research the private sector and facilitate the technology adoption. This is illustrated by a series of steps in Figure 6.1. This research and facilitation took the researcher on a safari through the environment in which the private sector operates, thus

[15] Chimerical: wildly fanciful; imaginary (Collins, 1992)

revealing interdependent issues relevant both to their wellbeing and to sustainable technology uptake. This is akin to climbing the steps and thus being able to examine the weave of the roof in Figure 6.1.

Although the commercial enterprises were the target technology operators, the Ugandan water and sanitation (watsan) sector also includes NGOs, a number of which were included in the research. All of the organisations were situated in the capital, Kampala, and the two adjoining districts of Mpigi and Mukono (Fig 4.1). Kampala is home to the Government of Uganda's Directorate of Water Development (DWD) and many other organisations in the water sector. It is also a magnet for the educated and wealthy and thus unlikely to be representative of the country as a whole. Consequently, this research provides insights into their world rather than a comprehensive analysis of the national situation.

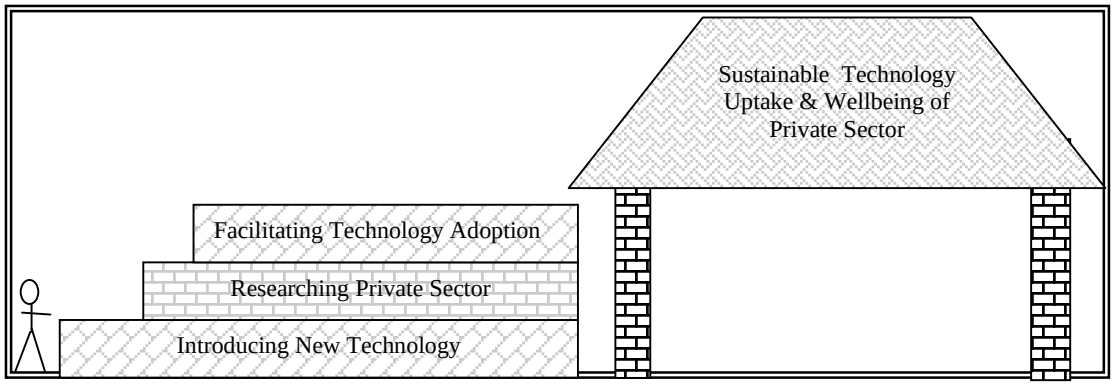


Figure 6.1: The Private Sector Research Process

The commercial enterprises and NGOs researched undertook spring protection; hand digging, hand augering and motorised drilling of shallow wells, "conventional" drilling of deep wells and construction of gravity fed systems. Several companies were also active in latrine and building construction. The Pounder technology was introduced to provide an alternative technology for the provision of shallow wells. Its advantage was that it could drill more rapidly and penetrate a wider range of formations than other shallow well equipment. The purpose of the new technology was thus not completely new to the contractors, unlike say irrigation equipment to a farmer who has never even watered his crops manually.

There were several hand auger rigs in Uganda, mostly in the hands of District Governments, commercial enterprises and NGOs. District based auger rigs were often lent out to contractors. Motorised rigs appeared to be primarily owned by the private

sector, in particular one Botswana based company. The conventional drilling equipment was all in the hands of several large commercial drilling companies, and Central Government. The Government indicated that they wished to sell this equipment to commercial enterprises in 1998 but this had not happened by June 2001. Some of this equipment was disused, while other rigs were lent out to employees for private work or hired to contractors (Snell, 1999a).

The Pounder Rig was thus entering a technological environment where alternative equipment was available in Uganda, some of which was available at subsidised rates, or at no cost to the contractor.

This chapter comprises four main sections followed by conclusions. The first section provides an overview of the issues which affect the private sector's access to markets. The second reveals some of the business tactics which the enterprises in Uganda deployed. These two sections thus provide rich detail about the context in which the enterprises operate. The third section provides a brief overview of what happened in terms of the early adoption of the technology during the LCDP. The fourth section builds on the previous three and looks forward. The issues relevant to sustainable uptake of the technology by the Ugandan private sector are presented. Finally the conclusions link the findings presented in the chapter to the principles developed in chapter 3.

Figure 6.2 provides the reader with a conceptual overview of this chapter. The intention of the figure is to enable the reader to visualise the whole chapter, which, due to the quantity of data is rather lengthy and potentially confusing.

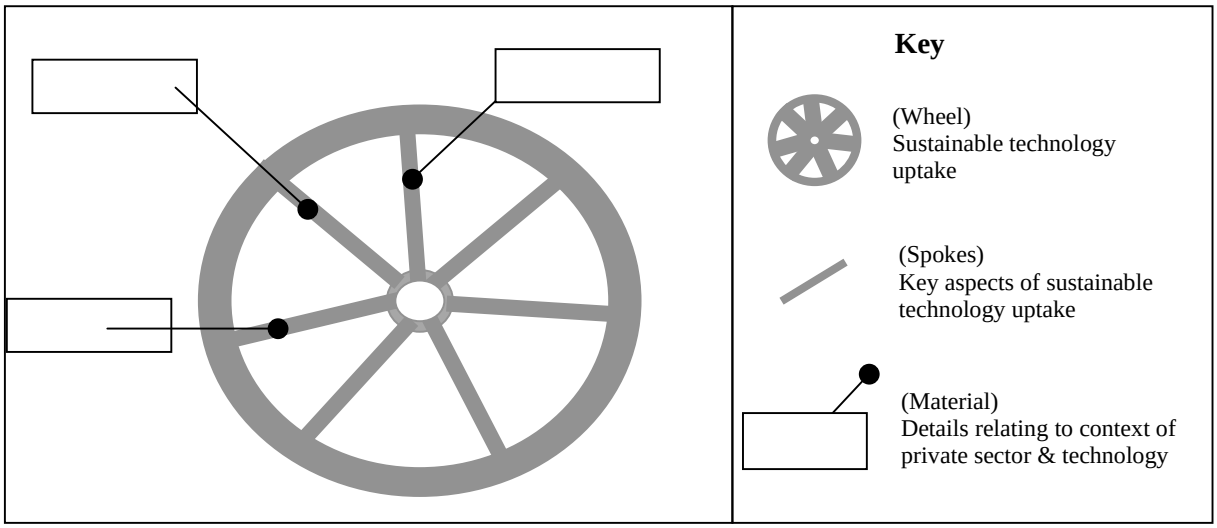


Figure 6.2: Schematic Diagram of Analysis of Private Sector and Technology Uptake

The *wheel* represents the sustainable uptake of the technology as a whole. The *spokes* represent key aspects of this uptake which have been identified through the research. The *material* represents further detail of these aspects relating to the new technology and/or the context. In order to summarise the findings in this chapter, a filled in version of Figure 6.2 is provided in section 6.7.

6.2 DATA SOURCES

The LCDP was in contact with 35 commercial enterprises and 6 NGOs involved in water and sanitation and building construction over a two and a half year period. The type of contact and hence depth of research undertaken with these organisations varied and is summarised in Table 6.1. Several companies and individuals fell into more than one type of contact.

Given the particularly sensitive information contained in this chapter and the promise of confidentiality, all quotations have been made anonymous, as elsewhere in the thesis (discussed in 2.3.3). The names contained within text boxes have also been altered.

A large proportion of the data was collected by other LCDP team members than the author. Due to difficulties with written communication much of this was extracted orally. The research into the commercial enterprises and NGOs was undertaken over an extended period of time, enabling trust to be built up between the researchers and the organisations. There were generally one or more introductory meetings during which the researcher tried to break down the initial barriers and enabled the parties to get to know each other. This was particularly important, as many companies initially perceived the LCDP as a competitor rather than a research project.

Table 6.1: Contact with the Ugandan Private Sector

Organisation (No.)	Contact Period	Description of Contact
Commercial Enterprises (2)	Nov 2000 - June 2001	Direct and indirect participant observation of commercial drilling with the Pounder rig, and in planning and debriefing meetings. Informal discussions and one semi-structured interview.
Artisans (5)	Sept 1999 - June 2001	Direct and indirect participant observation of artisans operating the Pounder rig as labour for government and commercial enterprises. Informal discussions and one semi-structured interview.
Commercial Enterprises (3)	July - Aug 2000	Indirect and some direct participant observation in one to one business training by LCDP business trainer.
Commercial Enterprises (Several)	March 99 - June 01	Direct contact with individuals in government who also run commercial enterprises.
Commercial Enterprises (16) NGOS (2)	Nov 98 - Mar 99	Baseline study undertaken by the LCDP business trainer.
Commercial Enterprises (6) NGOS (1)	July 99 - Sept 99	Swot analysis undertaken by LCDP business trainer and Cranfield University MSc student.
Commercial Enterprises (7) NGOS (1)	September 2000	Training needs assessment undertaken by LCDP business trainer
Commercial Enterprises (8) NGOS (1)	November 2000	Direct and indirect observation of a five day business training course given by LCDP business trainer, LCDP team leader and external consultant.
Commercial Enterprises (9) NGOS (5)	December 2000	Half day meeting to discuss training needs.
Commercial Enterprises (9) NGOS (5)	February 2000	Direct and indirect observation of a five day business training course given by LCDP business trainer, LCDP team leader and external consultant.
NGO (1)	March 99 - June 01	Participant observation of LCDP team setting up an NGO.
Commercial Consultants (4)	Sept 00 - June 01	Participant observation of consultants to the LCDP.
Commercial Enterprises (12) NGOS (2)	June 2001	Secondary Sources following interviews by LCDP trainer and external consultant.

6.3 MARKET ACCESS FOR WATER AND SANITATION ENTERPRISES

6.3.1 Background

The Ugandan market for shallow groundwater sources comprises: (i) public-(Government and Donor) and NGO-funded community wells for domestic purposes; (ii) wells for institutions; (iii) wells for wealthy individuals and (iv) agricultural wells. In general, communities could ill afford the full cost of sources being constructed under Government programs (see 8.4.2). The research focused on public-funded community sources and a one-off international NGO-funded community source.

Private contracts for rural water source construction activities commenced in 1996 under the Ruwasa programme, and in 2000 under WES. Private sector participation in water source construction in Uganda was thus in its infancy and starting to grow during the research period. *"Nearly every day there seems to be a sign on the road to Luzira of new consultants or drilling companies who have set up. And there is more retrenchment on the way also [in] the public service. More people will be moving into the private sector"* (DWD, 2001f). They have little choice, given the policy environment. Many active watsan commercial enterprises researched were set up by current or former employees of donor funded watsan projects or Government. Some company directors have a foot in District or Central Government as well as in the private sector (illustrated by Box 6.1).

Michael (not his real name) has a technical background and was employed by the Government as soon as he left university. He has never had to look for a permanent job, but set up a profit making company specialising in water and sanitation. He cannot afford to live on his Government salary, which he augments with income from the company. Through contacts, and with a good reputation he is able to secure well paid work for the company, although he must be careful as to which work he undertakes to avoid corruption allegations. Although he has full time employees in the company, he is still very busy juggling Government and private sector work. The company has an office, transport and limited equipment.

Box 6.1: Example of a Government Linked Water and Sanitation Enterprise

The *types of enterprise, tendering process, networks, corruption, the commercial enterprise/NGO status of the private sector and their financial conditions* were found to be the major factors both enabling and inhibiting access to the public-funded market and are discussed below.

6.3.2 Types of Enterprise

The literature refers to both SMEs (Small and Medium Enterprises) and MSEs (Micro and Small Enterprises). Mead (1999) defines an MSE as employing less than 50 workers, with micro employing less than ten. However, the LCDP research found considerable variation between different companies employing less than ten individuals in terms of skills, experience, equipment access, contracts undertaken, support and liquid capital and companies which Mead (1999) would define as medium are large companies in the Ugandan context. Consequently, four alternative categories of artisan,

small, medium and large have been defined to reflect the Ugandan scene (Table 6.2). These categories are subsequently used throughout the thesis.

Table 6.2: Water and Sanitation Enterprise Categories in Uganda - Focus on Groundwater technologies

LCDP Category	Skills & Experience	Equipment	Contracts	Support	Liquid Capital	Mead (1999) Categories
Large	Generally deep drilling skills and experience.	Own equipment such as conventional. drilling rigs (Ssebalu, 1999).	Have capacity to obtain and fulfil large contracts for central Government and INGOs (Ssebalu, 1999).	Often have foreign support (Ssebalu, 1999).	High	Medium /Small
Medium	May have deep and shallow drilling skills and experience.	May own site survey equipment or light drilling equipment.	Have their sights set on penetrating the market of the large category.	Tend to be well connected to central Government.	Medium	Small
Small	Some have experience of deep drilling but most only of shallow drilling.	Less equipment than the "Medium" category. Usually hand digging tools only. Other equipment is hired.	Less turnover of work than the "Medium" category.	Likely to be connected to District Government	Low	Micro
Artisan	Hand digging, shallow drilling and spring protection experience.	None	Provide labour for the medium and small categories. Are paid subsistence wages.	Include retrenched GoU labour and thus have contacts. Rarely organised into companies	None	Micro

Box 6.1 and Box 6.2 provide examples of Ugandan medium enterprises, which generally have their sights set on penetrating the market of the large category, and tend to be well connected to central Government. One medium contractor purchased two conventional drilling rigs within the LCDP duration, bringing their total up to three. Some politicians also run companies, although few of these are considered to have technical know-how (Comment 6.1). These tend to be small and medium according to the categories of Table 6.2.

Markus set up the company with his family after leaving university with a technical diploma. He undertakes work in water and sanitation and building construction. Since starting the business with very little capital, he now has a truck and car and estimates his working capital to be $28,000, which is usually tied up in a number of jobs. He experiences problems when payment takes considerable time and will always check before answering the telephone, given that there are usually suppliers demanding payment and clients demanding his service. He does not have an office, rather works from his car with his mobile phone. He has bank accounts in several towns and keeps petty cash on his person from which to pay for equipment, materials, labour and other expenses. Markus employs labour as he requires, and undertakes contracts for Government in three districts, NGOs, institutions and individuals. Although VAT registration could benefit his profit margins, he has avoided it due to the fact that the revenue people are "complicated" and he often buys in the name of another VAT registered company with whom he is acquainted.

Box 6.2: Example of Medium Watsan Enterprise

Many of the medium, small and artisan categories comprise retrenched workers from local and central Government. Box 6.2 provides an example of a medium enterprise, while the example in Box 6.3 is illustrative of a small contractor.

Company C was set up at the request of the district, and has been undertaking construction work for them, sharing and spending the profits and then looking for funds once the next job comes up. The company does not work in any other districts, but has income from activities outside the enterprise. The company employs no full time staff and rents a room in a hotel as required.

Box 6.3: Sample Small Watsan Contractor

The LCDP set out with the objective of trying to enable artisans to take on the new technology. This was also hoped for by individuals and organisations in Uganda eg *"...groups of artisans and technicians and plumbers who have some experience of the hand augering. Maybe they could come in and take this technology forward"* (DWD, 2001f), but he expressed uncertainty with respect to how to proceed with this group. The Government and UNICEF expressed an interest in training local artisans to work at local Government level, but were unsure of how to target and inform these individuals (DWD, 1999a) while WaterAid (2000) knew that artisans existed but did not know how to work with them.

In light of the relatively high cost of the new technology (5.4.5), attention rapidly shifted to the small and medium category of companies which had already been formed and had significantly more financial capital and education than the artisans, and were better networked.

6.3.3 Tendering

Contractors in Uganda are required to competitively tender for public works. Not only do tender documents vary between departments and Districts (Ssebalu, Danert & Kakooza, 2000 and observation[16]) but they can also be difficult to understand (DWD, 2001a & observation[17]), thus excluding those without sufficient tendering skills and knowledge, who may nevertheless have technical competence.

Contractors tend not to take the tendering process seriously due to irregularities in the process (Ssebalu & Danert, 2001). *"Tendering would be easy if it was only about the money!"* (Comment 6.2). Observation[18] suggests that Uganda is used to personal contact rather than a competitive market. This is confirmed as follows *"a certain amount of mutual back scratching, while trying not to upset too many people, occurs when work is distributed"*(Comment 6.3). District staff prefer to share out the work between those who have tendered, rather than select one or a few companies to construct several wells each (Comment 6.4; Comment 6.5). Under Ruwasa, the local councillors started their own companies and the work would be divided into ten contracts, with one given to each councillor, rather than the best company undertaking the work (Comment 6.6).

The tender board may comprise politicians with insufficient communication skills or knowledge to evaluate the tenders (Ssebalu, Danert & Kakooza, 2000). One District, new to the tendering process, claimed to have awarded contracts to all who tendered so that they could determine the quality of the work, and on that basis be more selective in future (Comment 6.7). The mechanism for tender evaluation is thus not entirely price based. It has been suggested that there is in fact considerable social responsibility in the distribution of work with Joe obtaining the contract this time as John had it last time, despite the fact that John is cheaper (Comment 6.8). The LCDP team leader observed one District trying to share out the drilling of 5 wells between three companies.

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[16] Personal observation of different tender documents both within and between District Government.

[17] Comments made by participants during business training courses and artisans through informal discussions.

[18] Personal observation that more than 10 people were observed as obtaining employment through contacts compared to one without connections. Most of the contractors undertaking contracts for the public sector which were researched "knew someone".

6.3.4 Networks

Uganda is a small country and individuals in the water supply sector are in close contact with one another, or at least know of each other. Up to 1997, when the civil service started to be streamlined and Government staff were "retrenched", all Ugandan hydrogeologists could only work for DWD and water engineers for DWD or National Water and Sewage Corporation (Comment 6.9). Many of these skilled personnel had either been retrenched, or were facing possible retrenchment, and were starting their own private enterprises.

Both company-Government and inter-company networks exist in Uganda. Box 6.1 exemplifies the former while the latter may share staff, land, equipment and money as well as sub-contract work to and from each other (Ssebalu, Danert and Carter, 2001; observation[19]). For example, the phrase "brother and sister" was used to describe the relationship between two such companies. Also, more than one company was started following the request of District officials or politicians who told them that they would provide them with contracts (Ssebalu & Danert, 2001). Some companies are reliant on networks to the extent that they do not actively seek work elsewhere (Ssebalu, Danert and Carter, 2001; observation[20]). Given the anti-corruption emphasis, under which Government employees cannot always openly undertake private contracts in their area of jurisdiction, networks enable the work to be redistributed accordingly. It may be that this enables work to be apportioned amongst locally based companies rather than being taken up by outsiders. Theoretically, Central Government-linked companies have an advantage under decentralisation as they can tender for work throughout the country - the Districts are not directly under their jurisdiction.

Networks result in companies tending to work repeatedly for the same Districts. *"I have a firm base in that District"* (Comment 6.10). Although this may reduce the uncertainty of obtaining work it is difficult for companies to access the public-funded market in new locations unless they are networked (Comment 6.11; Comment 6.12 Comment 6.13). The majority of the companies in contact with the LCDP requested it to find them jobs (Ssebalu and Danert, 2001), illustrating the emphasis placed on

[19] Direct observation and informal discussions with contractors from 1999 to 2001 at various locations including company premises and site visits.

[20] Informal discussion with contractors from 1999 to 2001 and during business training courses.

personal contacts for obtaining work. Networks are an integral part of Ugandan culture. A Ugandan *with* influence is generally expected to use it to provide for their friends and family *without*. Box 6.4 provides an example of the use of networks in setting up a business.

Brian has a technical diploma and worked as a labourer for Government since leaving college until he was retrenched. Subsequently he obtained work from contractors and Government as and when there was a need and was often without employment for considerable periods. He informed me that having realised that the profits go to the contractor and a minimum salary to himself, he has managed to set up a company with a Jim, who is connected to District Government. They have also brought Marc into the company due to his connections to those who can give them work. It is unclear if the enterprise is actually Brian and Jim's, or if they are merely the front for someone else. They approached the LCDP for work.

Box 6.4: The use of Social Capital by Artisans Setting up a Company

Company-Government and inter-company networks are a key component for business success and growth in Uganda, as summarised by a participant of one of the business training courses: *"Having realised that in order to survive, the contractors must act as a pack of hyenas rather than as solitary lioness hunters....they can have better advocacy roles, resource mobilisation and increased collaboration between themselves if they are to contribute...efficiently and effectively"* (Comment 6.46).

Networks are a key component of the concept of social capital, which overlaps with the central terms and concepts of social network analysis (Schuller et al, 2000). Social network analysis recognises that the contacts, ties, connections and group attachments which relate one agent to another cannot be reduced to the properties of the individual agents themselves (Schuller et al, 2000).

The types of network which can be found in the Ugandan watsan tend to cluster around District and central Government. Some individuals have one foot in one or more commercial enterprises and the other in Government (the LCDP team nicknamed these individuals "foot-in-foot-out"). Other commercial enterprises are run by individuals who are former Government employees and thus well connected. Some companies are run by individuals who have not worked for Government. However, these companies tend to have connections with Government personnel or politicians in one or more Districts. Trust, obligation and kinship link the actors who share information and work flows. Some individuals have more connections than others, and

can thus access more work. Some individuals are more powerful than others. For example, a high position in Government, or membership of a tender board is likely to affect the influence that this individual can exert over others in the network.

6.3.5 Corruption

Collins English Dictionary (1992) defines *corrupt* as*: 1. open to or involving bribery or other dishonest practices,* while to bribe is *to promise, offer or give something, often illegally, to procure services or gain influence.*

Corruption, as defined above, is rife in Uganda, from petty corruption such as a few dollars paid to the traffic police for an offence (or the misfortune of being stopped!), to large bribes paid for Government tenders (eg $80,000 for a $2 m job, Comment 6.14). Uganda ranked joint 88th out of 91 in Transparency International's Corruption Perception Index 2001 (Transparency International, 2001). *"Corruption is big in Uganda"* (Comment 6.15). It has been suggested that every company in Uganda needs to be corrupt to survive (Comment 6.16) while one company claimed that they had managed to avoid bribery by working directly for international agencies (Comment 6.17). It should also be noted that paying and receiving bribes are not limited to Ugandan Government and companies only (Comment 6.18; Comment 6.19).

The implications of corruption in Uganda are considerable. Corruption in the justice system and police is the reason repeated by Ugandans for the killing of thieves on the spot if they are caught (observation[21]; Informants[22] in 2000 and 2001). The Ugandan water sector contractors who compete for public contracts are affected by corruption. If you do not pay before winning the contract, you may have to pay afterwards and the person who awarded the job will expect a reward, often prior to the commencement of the work (Comment 6.20). Even people whom contractors might not see take their share of the bribe (Comment 6.21; Comment 6.22). Despite the tendering process, which includes the public opening of tender documents, a whole series of other dealings are going on in parallel (Comment 6.23). However, the bribes must go to the

[21] Eyewitness of thieves chased, hauled out of their cars, beaten on the streets.

[22] Regular accounts from staff, friends and colleagues of thieves being caught, beaten and then burned, or shot on the spot.

right people, so successful bidding requires contacts and there are occasions when someone pulls the plug on the whole deal.

Corruption prevents contractors from tendering for work with certain Districts for a number of reasons. Officials can be unrealistic about the level of bribes which contractors can afford to pay. One contractor estimated that 25% of the contract price is typically required to secure work (Comment 6.24). Bribes may have to be shared out among many. Even the Chief Administrative Officer, who may not be seen may take a share of the bribe (Comment 6.25; Comment 6.26). The enterprises may not know who to bribe (they need the correct network). And finally, someone else may simply pay more.

Corruption also affects workmanship, and sometimes contractors do not finish jobs because they run out of funds due to excessively high bribes (Comment 6.27). Corruption renders the planning of profit margins difficult (Ssebalu, Danert & Kakooza, 2000).

Corruption in Uganda also takes the form of "underground movement", an expression used by District civil servants, which refers to the pressure exerted by politicians on contractors to undertake jobs at unrealistically low prices with the bait of future work (Ssebalu, Danert and Kakooza, 2000). Some contractors prefer private work over Government work in order to avoid corruption (Ssebalu, Danert and Carter, 2001).

The Inspector General of Government investigates corruption scandals as part of the Government's official anti-corruption policy, and civil servants fear corruption allegations. The research team faced concerns over corruption allegations during negotiations regarding equipment hire with DWD. The plan was to place the drilling equipment in the hands of a private company and ask it to pay back later, in instalments, from money obtained from hiring it out. Government officials strongly opposed this proposal, which, although well intended was considered as being easily misconstrued as corrupt. Another example of this fear was when one of the contractors, selected by the LCDP team to drill Pounder Wells in a District, pulled out for fear of corruption allegations. *"People are going to jail for corruption!"* (Comment 6.28).

6.3.6 Commercial Enterprise/NGO Status

Many Ugandan NGOs have been active in the watsan sector prior to, and since, privatisation, utilising funds from international NGOs, donors and Government. There is considerable expertise within such organisations (eg Busoga Trust, Kigezi Diocese and Buso Foundation) . However, there is now an overlap between the commercial enterprises and NGOs, and in some cases, both compete for public contracts. Due to the possibility of cross-subsidies, and tax exemption, NGOs are able to charge less for the work which they undertake, thus creating unfair competition with the commercial enterprises. In response to this situation, at least two Districts were not awarding public contracts to NGOs at the time of this research (Mpigi, 2000a; Luwero, 2000). Meanwhile one NGO, the Busoga Trust, was changing status from an NGO to a commercial enterprise in order to qualify for Government funded work.

The future of directly funded NGOs in the Ugandan water sector is uncertain. Discussions with DFID (2000b) highlighted the push towards basket funding for the water sector with considerably less funding available to NGOs. However there are large increases in budgets in the decentralised water sector, which the Districts are expected to spend and there is a lack of skilled watsan commercial enterprises. Thus the skills which the NGOs have are much needed in Uganda. The formation of a Ugandan Secretariat for Water and Sanitation NGOs (UWASNET) in 2001 may enable the NGOs to lobby for public works.

6.3.7 Financial Conditions

It was found that the enterprises faced a number of challenges in order to maintain sufficient cash flow and thus survive or grow. Considerable trust was required between the suppliers and contractors in order to avoid paying for materials immediately (personal communication[23]). District interpretations of the PAF Conditional Grants meant that no advances are paid to contractors until completion of works (Danert, 2000b). This prohibits artisans and poor companies from obtaining work because they do not have the cash flow to purchase requisite materials and equipment (Comment 6.29). This differs from the centrally managed gravity schemes, construction of which is paid in stages (Danert, 2000b). The GoU demands a

withholding tax of 4% of the contract price (GoU, 1999c) while delays of several months for payment of the other 96% from Government are not uncommon (Gentex, 2000) and contractors claim that private clients rarely put money up front (Snell, 1999d). In the case of companies which are VAT registered, the inland revenue only refunds VAT once a sum of $2,800 has accrued.

Lack of sufficient capital was cited in the baseline study for all four of the profit making companies as a business weakness, while the two foreign donor supported NGOs were perceived as having sufficient capital (Ssebalu, 1999a). Our SWOT analysis (Snell, 1999d) found that five out of six of the profit making companies initially studied had a low capital base, which prevented them from (a) acquiring more equipment and (b) obtaining credit. Insufficient cash flow was also cited as a reason for companies not completing jobs (Ssebalu, Danert & Kakooza, 2000 and Mukono, 2001b).

Accepting that lack of capital could be a key factor in inhibiting technology uptake, formal credit schemes were investigated and it was found that there was a "missing middle" between micro-credit (up to $1000) and large loans (typically exceeding $250,000) (Snell, 1999a). Consultation with the credit organisations revealed that they were not sensitive to water and sanitation construction companies as potential clients (Ssebalu, 1999b).

6.4 BUSINESS TACTICS

6.4.1 Background

An entrepreneur is defined as *"the owner or manager of a business enterprise who, by risk and initiative, attempts to make profits"* (Collins, 1992). Given the fact that all but one of the companies researched had survived to the end of phase 1 of the LCDP, while some were observed to be growing from briefcase companies to office based ones, the obvious conclusion is that these companies are so far, and to a certain extent, successful entrepreneurs.

The tactics which this research found the businesses to employ included different ways of obtaining work, culturally based financial management, patronage,

[23] Discussions with the three large well consumable suppliers in 2000 and 2001.

and having fingers in many pies. Planning and record keeping were not commonly deployed tactics. These are discussed below.

6.4.2 Obtaining Work

The official access to the public-funded market was through the tendering process, but to penetrate this market, enterprises were found utilising a combination of other business tactics:

1. the use of Government-linked networks (eg Box 6.1);
2. obtaining the spill-over work from other companies (Snell, 1999d; Ssebalu, Danert & Kakooza, 2000);
3. the payment of "gifts", or bribes (Comment 6.30; Comment 6.31);
4. subcontracting from politicians (personal communication[24]).

In the case of non-public markets, tactics included:

5. the use of scouts to find work, who were paid commission (Comment 6.32; Comment 6.33) and
6. working for little profit to establish themselves (Snell, 1999d; Comment 6.34).
7. Some companies simply hope that one thing would lead to another (Snell, 1999d).

Other strategies such as newspaper adverts or the display of goods on the roadside were found to be rarely utilised (Snell, 1999d; Ssebalu & Danert, 2001; observation[25]).

Two NGOs informed the LCDP that they set up the organisations so that they could obtain funds, as illustrated by Box 6.4. Not all NGOs or CBOs in Uganda set up with obtaining funds at the forefront of their minds, but it does happen, and its extent is not known.

Nigel and Simon (not real names), qualified in water engineering were keen to undertake some work in their area and looked for donors. They were put in touch with an overseas donor, set up an NGO and designed a project to provide water. This project was subsequently funded, and as a consequence, a well was dug and pipes laid to pump water to an overhead tank. This water is sold to the community at $0.028 per 20l jerry can. Their turnover has been estimated to be $2835 per annum, from an initial investment of $1700 to top up the donation of $12,000. The NGO has a "voluntary" committee of eleven, seven of whom are apparently active, and all of whom have other jobs. The NGO was also supposed to plant trees, collect plastic bags and undertake educational activities, but has not to date. They would like more donor funds to extend the water supply system.

Box 6.5: Example of an Enterprising Ugandan NGO

[24] Discussion with Government staff and commercial enterprises.
[25] Personal observation through visits to company premises.

6.4.3 Finance

Companies in Uganda mainly collapse due to financial problems, personal difficulties and poor planning (ACLAIM, 2000). *"Some of these local contractors do not know how to calculate, they don't know how to estimate, they don't know how to come up with bills of quantities"* (Comment 6.35). The enterprises researched were generally not aware that all their actions had financial implications (Kakooza, 2000a). Observations during the business training confirmed these statements.

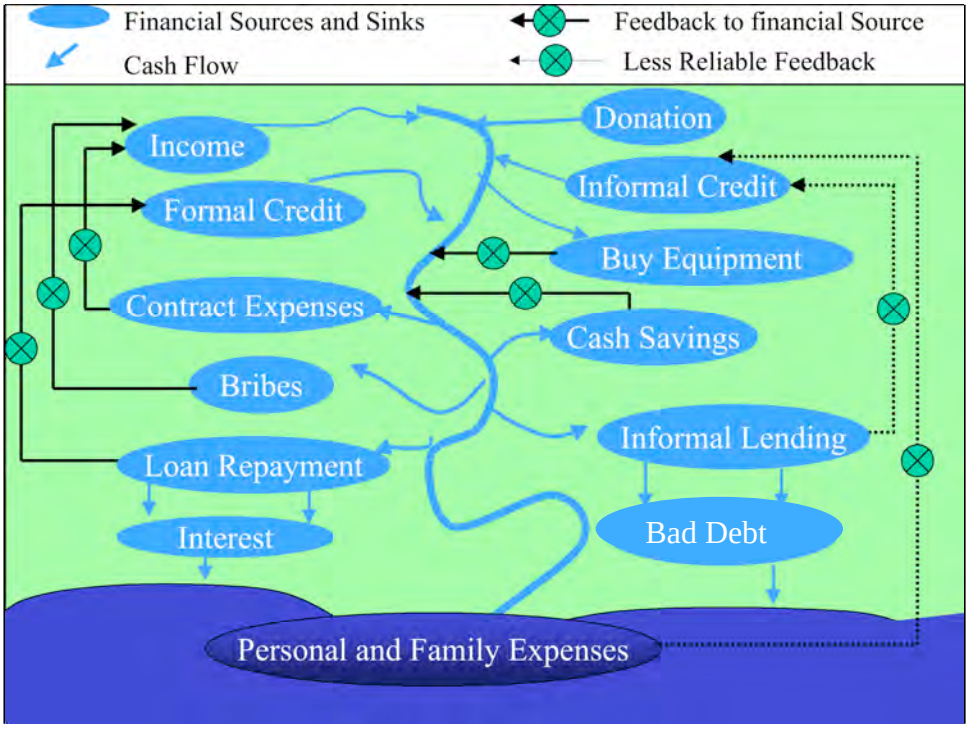

Figure 6.3: Potential Flow of Finance Through Watsan SMEs

Figure 6.3 uses the metaphor of a river, flowing downstream and into the sea with its tributaries, distributaries and lakes to illustrate cash flow through the enterprise. Just as the water stagnates if the river stops flowing, businesses cannot survive without cash flow. The figure distinguishes between fresh and salty water, where the salty water (dark shade) is no longer useful, representing the cash which leaves the business ie personal and family expenses, the interest on formal loans and bad debts from informal lending.

In general, the enterprises studied were found to operate their finances informally. Personal and business funds, for example were very often mixed and very

few directors drew salaries, but preferred to draw their personal and family income as required from the company income (Ssebalu, 2000a). Returning such funds to the business can be very difficult, analogous to the high energy requirements for desalination. However, at least one well connected enterprise would rely on a network of people for informal credit when funds were required (Ssebalu, 2000a). Another enterprise, which similarly sunk income into the family stated that they frequently lost contracts as they could not raise capital when needed (Ssebalu, 2000b).

Many enterprises had little or no savings. The collapse of three Ugandan banks in 1999 reduced confidence in cash savings in the bank. Informal lending, and the purchase of equipment were found to be two common tactics of cash disposal, although problematic when liquid capital is required and not forthcoming from debtors or realisable from the physical assets. Attitudes to formal credit were that it was too expensive and risky, with contractors preferring informal means such as borrowing from friends and family (Ssebalu, 2000b).

6.4.4 Patronage

In a country where there is such extreme poverty, high unemployment, no social security, as well as a high value placed on kinship, patronage is important. Thus, a Ugandan with income will generally be paying his own children's school fees, as well as others beyond his immediate family. It is unusual to find anyone *with* income who does not accommodate close or distant relatives *without.* The social pressures to conform to this are considerable, rendering it difficult for enterprises to hang on to cash or to charge family and friends for goods and services from the business.

People will go to considerable lengths to conceal their disposable wealth as this relieves social pressure. One informant claimed to have deliberately moved house into a smaller dwelling to avoid having to look after distant relatives, as they were draining his business finances (Comment 6.36). Comment 6.37 from the banking sector described clients who dressed down to look poor yet stockpiled savings. Such behaviour makes it very difficult to research the liquid capital situation of enterprises.

6.4.5 Planning

Business planning amongst the enterprises researched was found to be virtually non-existent. The Baganda phrase "mere ya leero", or "working for today's food"

summarises the common attitude to planning. Comments such as "*we do not know if, or how many jobs will come so we cannot plan"*, were common (Ssebalu, Danert & Kakooza, 2000). Tactics involved taking on as many jobs as possible, and simply trying to complete them. Companies feared arranging to delay the commencement of a contract due to the "NOW" attitude of customers who may have subsequently looked elsewhere (Ssebalu, 2000b). It was difficult for enterprises to plan when those around them were not. No matter how busy companies were, turning down work was rare, and, if done, likely to result in the accusation of *"you have become very rich"* (Ssebalu, 2000c).

The tendering process did not encourage budgetary planning. District tenders for water source construction usually go out prior to the identification of the sites (Comment 6.38; Danert, 2000b; Mpigi, 2000c) with the result that the contractor usually does not know the location of work and cannot price accordingly. Budgets for the sources contained a ceiling, which was known in advance and tenders tended to be submitted which were fairly close in price (Danida, 2000a; Danert, 2000b), and the final price paid for the work was often not that quoted in the tender, but rather the budget ceiling[26]. One enterprise's reason for lack of financial planning was the huge margins made on his contracts (Ssebalu, 2000a).

This apparent lack of planning was not unique to the watsan contractors in Uganda. The best time to purchase goods from the informal sector was when the school fees were due, as enterprises were so desperate for cash that the prices dropped. Despite the fact that school fees had to be paid regularly, people had not saved. This can be considered as short term thinking, which, given a country ravaged by war until 1986, may be understandable. Lack of planning may be a consequence of recent history, culture, lack of skills, or the immediate needs of poverty and patronage which place high demands on liquid capital.

6.4.6 Fingers in Many Pies

Tactics to cope with the seasonal nature of contract work were found. For example, one watsan contractor also ran a hardware shop in Kampala[27]. The activities

[26] Discussion with several contractors, district staff and DWD in 2000 and 2001.

[27] Visits made to shop in 1999 and 2000.

which enterprises claimed to undertake proved to be extremely wide in scope, as illustrated in Table 6.3. The information has been obtained from the profiles supplied to the research by 15 enterprises. The activities have been categorised according to whether they claim to have experience (letter E), or if they say that they could undertake such work (letter S).

Although the type of activities vary considerably, in-depth interviews with several companies indicated that the enterprises tend to claim expertise in more activities than they actually do. Should they obtain such work they would sub-contract within their network. Although the breadth of work companies claim to undertake may include some wishful thinking, the prevalent attitude of individuals in both private business and Government is to spread the risk of lack of income by undertaking multiple, diverse activities.

In discussion with Ugandans, I found that as I talked of undertaking additional business to my job of LCDP team leader, that it would generally excite people considerably and they would foster comments such as: "*You are becoming a real Ugandan"*, indicating the norm of having fingers in several pies in Uganda.

6.4.7 Record Keeping

The majority of the enterprises were found to keep very few records. One company claimed to have no time for written records while another recorded cash transactions, but not creditors and debtors (Kakooza, 2000b). Others attributed the difficulty in planning to not recording how long previous works had taken. The keeping of written records was not found to be a business tactic.

*Table 6.3: Types of Work the Enterprises Claim to be Able to Undertake (Key: E = Past **Experience**, S = **Say** that they can do it)*

	General Construction					Water Supply And Sanitation Construction											Other								Social				Agric.	
Enterprise/Activity	Building	Bridges	Road Maintenance	Roads	Brick Laying	Spring Protection	Hand Dug Wells	Hand Augered Wells	Water Quality Testing	Concrete Rings	Latrines	Gravity Flow	Valley Tanks	Borehole Drilling	Tank Construction	Siting And Test Pumping	Drainage	Electrical Installation	Painting, Decorating And Plumbing	Renovation	Hardware Shop	Welding And Carpentry	Dam Extension	Landscaping	Community Sensitization	Teacher Training	Training-Health, Mechanics,	Research - Farming & Social	Tree Nursery	Animal Husbandry
1.	E	S	E								E	E	E				E	S												
2.	S																		S	S	S		E							
3.					E																				E	E				
4.	E							E			E																	S		S
5.	E			S							E			E				S	S			S		S						
6.	E										E									E										
7.						S								S	E														S	
8.						E	E	E		E					E															
9.						E	E				E			E				E												
10.						E	E				E				E						E									
11.						S			E																E		E			
12.						E	E							E																
13.																E														
14						E	E				E				E										E		E			
15.						E	E			E																				

6.4.8 Contracts

Businesses were found to not always sign written contracts. This was partly attributed to the networks eg *"if one is your friend, how do you start signing?"* (Ssebalu, Danert & Kakooza, 2000). This was confirmed by Danida (2000b) who stated that often the District staff are friends with the company directors and thus think that everything will be alright. All of the companies had encountered problems of payment default at some stage. At least two companies had experience of undertaking work for councillors who refused to pay (Ssebalu et al, 2000). In such cases, even where a contract had been signed, the legal process was perceived as lengthy and corrupt, hence companies were reluctant to take legal action.

6.5 EARLY ADOPTION OF TECHNOLOGY

The LCDP team considered five enterprises as contenders for the early adoption of Pounder Rig prototype II within phase 1. Two enterprises utilised the rig commercially, with one company subsequently drilling 4 successful wells out of 9 attempts. Since the end of phase I in June 2001, this company has gone on to drill a further 2 successful wells out of 3 attempts**.** The other enterprise drilled one unsuccessful well, and did not subsequently utilise the rig. No single factor, but rather a combination of factors was found to be decisive in determining early adoption, as shown in Table 6.4.

Introducing a contractor to a District for work is very political and the contractors selected by the LCDP were not accepted, despite their strong technical backgrounds. This echoes findings from Ruwasa, who attempted to put in outsiders to assist the District in its tendering process, but met with considerable resistance (Danida, 2000a). Linking in to existing company-public networks proved effective for company A, who was also able to penetrate another District with the new technology. Although company D attempted to obtain work in another District, it was not successful. The reasons for this are not known. However, market access in Uganda is influenced by a number of factors (see 6.3), and the technology was still very new and may thus have not been considered acceptable by the District tender board.

The initial attitudes to the technology and early experiences both differ between the two companies who attempted to drill commercially. The failed well discouraged

contractor B, but he also expressed less enthusiasm from the start. It appears that the lack of interest was not improved through experience. On the other hand, contractor A, which subsequently adopted the rig, had a positive attitude and the experience of successful drilling. It is thus not possible to draw conclusions with respect to the relative importance of attitude over experience for these contractors.

The LCDP only had full access to one rig (the other was owned by Government) and during the commercial drilling, the priority for the LCDP team was for the Mukono District wells. The explicit priority of the equipment for these wells may have been interpreted as an outright refusal to hire out the rig to other contractors, particularly given the lack of planning which they generally undertake (see 6.4.4).

The behaviour of the public sector proved to be an important factor in facilitating technology adoption. The fact that Mukono District substituted commercial Pounder drilling for hand digging provided a market for the work. The differences in District attitudes to the conditional grants are discussed further in chapter 7 and highlight the importance of ensuring national acceptance of the method, a point made by company A.

Table 6.4: Factors Influencing Early Adoption of Technology by Contractors

CONTRACTOR	**A**	**B**	**C**	**D**	**E**
Adoption	Yes (Public- and NGO-Funded Community Wells)	No	No	No	No
Adoption Factor					
1. Company selector	District	District	District	LCDP	LCDP
2. Company category	Medium	Medium/Small	Small	Medium	Small
3. Initial attitude towards technology	"we saw the rig and were anxious to try the new technology" (Adopter, 2001).	Researcher perceived them to be hesitant about new technology.	Expressed interest verbally, but did not push LCDP team to pursue a contract to drill.	Expressed that they wanted to see the rig performance before trying.	Expressed interest verbally, but did not push LCDP team to pursue a contract to drill.
4. Direct experience of technology	Successful and unsuccessful wells drilled with prototype II.	one unsuccessful well drilled with prototype II.	None	None	Witnessed successful and unsuccessful wells with prototype I.
5. Attitude wrt unsuccessful wells				Voiced repeated concern.	
6. Behaviour wrt unsuccessful wells	Continued to use rig despite some failed holes.	Expressed no further interest after failed site	N/A	N/A	N/A
7. Attitude towards market	Requested LCDP team to lobby GoU for national acceptance of method.			Wanted a "decent sized contract of say ten wells" (Comment 6.48).	Claimed they could not arrange Pounder contracts themselves (Comment 6.49)
8. Behaviour towards market	Accessed other Districts.		No attempt to access other markets	Tendered for contract with Pounder Rig but did not obtain work.	No attempt to access other markets
9. Rig availability to company	Priority hire from LCDP	Hire from LCDP	Hire/Borrow from District Govt.	Rig available from LCDP if not in use	Hire/Borrow from District Govt.
10. Public sector behaviour	Substituted Pounder Wells for Hand Dug wells in conditional grant	Substituted Pounder Wells for hand dug wells in conditional grant.	Would not substitute Pounder Wells for other methods in conditional grant	N/A	N/A

6.6 SUSTAINABLE UPTAKE OF TECHNOLOGY

6.6.1 Introduction

The key issues identified by the research pertaining to sustainable technology uptake by commercial enterprises are illustrated in Figure 6.4 as spokes of a wheel.

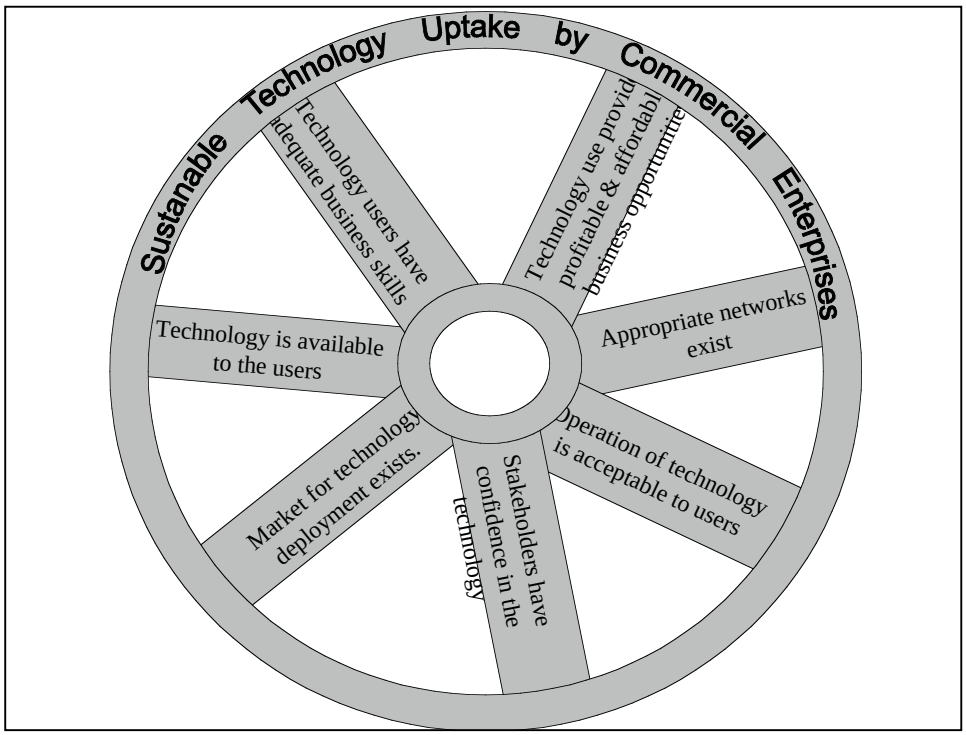

Figure 6.4: The Components of Sustainable Technology Uptake by Commercial Enterprises

The subsequent discussion considers the spokes in Figure 6.4 in further detail. The relationship between the key issues identified during the action research and the principles developed in chapter 3 is discussed in chapter 10.

6.6.2 Technology Deployment as an Affordable and Profitable Business

"First of all on my side I would wish that we should continue with the technology because I have seen it profitable...[and]... it has been very cheap" (Adopter, 2001). Enterprises must be able to make a profit out of Pounder drilling and the business must be affordable if uptake is to be sustained.

Although the Pounder Rig Adopter found that he could make a profit, this was dependent on the well construction cost, its selling price and the conditions of contract.

Figure 6.5 depicts the many factors which influence the well cost. Direct costs refer to the expenditure attributable specifically to the well, whereas indirect costs

concern expenditure associated with running the business, which are spread out between wells and other activities.

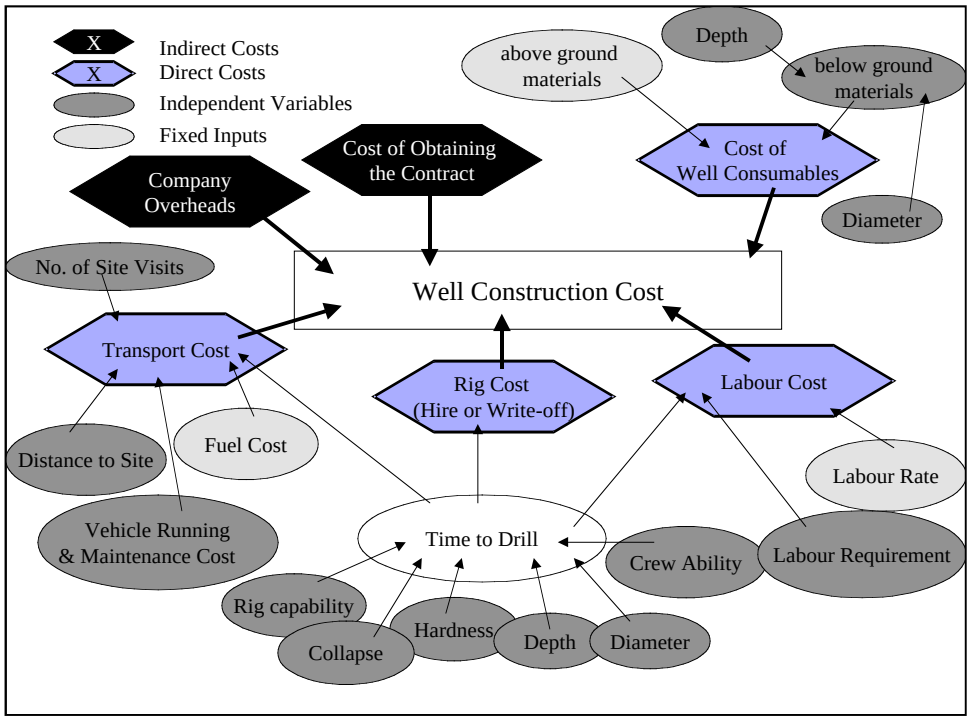

Figure 6.5: Factors which Influence Well Cost

Direct Costs

The direct costs are influenced by the ten discrete and independent variables of well depth, drilled diameter, labour requirement, crew ability, hardness of formation, well collapse, rig capability, vehicle cost, distance to site and number of site visits made. Table 6.5 provides the breakdown of direct costs of a sample well using the unit costs, quantities and Pounder rig hire charge from December 2000. The costs were calculated with the early adopter in November 2000 and are utilised as a base cost from which to explore the sensitivity of direct well cost to variation of input. The reason for this particular well type to be classified as the base well, is that it provides the contractor with sufficient profit under the budget rates prevalent in Uganda in December 2000. Although a per day cost for a pick-up is common in Uganda, hand auger equipment appears to be hired out per well. The LCDP team decided that costing per well was economically unrealistic, given the variation in time to drill a Pounder Well, and thus the LCDP charged rig hire on a daily basis.

Table 6.5: Estimated Direct Cost for a Pounder Well: 6 days drilling, 18m depth 65 km from base

Item	Rate (Us$)	Unit	Quantity	Total (US$)
LABOUR				
Investigative Drilling				
Skilled (including meals and accommodation)	6.11	manday	6	36.66
Unskilled	1.67	manday	12	20.04
Production Drilling and Well Completion				0
Skilled	6.11	manday	6	36.66
Unskilled	1.67	manday	12	20.04
Well Development and Pump Installation				0
Skilled	6.11	manday	2	12.22
Unskilled	1.67	manday	4	6.68
Concrete Construction				0
Skilled	6.11	manday	2	12.22
Unskilled	1.67	manday	2	3.34
Sub-total				147.86
TRANSPORT				
Pickup Hire	16.67	day	2	33.34
Material Collection	0.08	km	100	8
Equipment, materials & crew to and from site	0.08	km	260	20.8
Foreperson visits	0.08	km	260	20.8
Transport at site	0.17	km	10	1.7
Sub-total				84.64
EQUIPMENT				
Rig Hire	41.67	day	8	333.36
Sub-total				333.36
PUMP				
Well Headworks	233.89	piece	1	233.89
75mm uPVC Rising Main/Casing	18.33	piece (3m)	4	73.32
Pump Connecting Rod x 3m	21.45	piece (3m)	4	85.8
Pump Top Rod x 3m	26.00	piece (3m)	1	26
Centralisers	17.22	piece	4	68.88
Pump Cylinder Assembly	58.22	piece	1	58.22
63mm Male Threaded Adapter (MTA)	1.14	piece	1	1.14
75mm MTA Grooved with O-Ring	4.67	piece	1	4.67
Sub-total				551.92
WELL CONSUMABLES				
63mm well screen x 3m	14.39	piece (3m)	2	28.78
63mm End Point	0.83	piece	1	0.83
Gravel Pack	5.56	bag (50kg)	6	33.36
Sand	16.67	tons	1	16.67
Hardcore	11.11	tons	1	11.11
Aggregate	19.44	tons	1	19.44
Cement	9.44	bags	6	56.64
Water for Drilling	0.06	20 l jerry can	200	12
Sub-total				178.83
TOTAL COST				1,296.61

The relatively low pickup hire charge in Table 6.5 can be attributed to the pickup business not fully costing its activities or to informal agreements between the two businesses. If the pickup business were to start charging realistic rates, this would increase the direct well costs. Although unskilled labour and water currently tend to be provided freely by the community, this has actually been costed in Table 6.5, as it is usually included in bills of quantities. Changes to the GoU rural watsan programme guidelines now require communities to pay a cash contribution (rather than in kind) thus legitimising the inclusion of unskilled labour costs. However, communities, when mobilised, still tend to provide free labour and water for drilling.

Chapter 5 provides an indicative cost of $9,078 for the Pounder rig. This figure is currently beyond the means of most Ugandan contractors for outright purchase. Alternatives such as credit, hire purchase, straight hire or a donation are required to render it affordable. With the exception of informal credit, all require the services of an external organisation.

Figure 6.6 plots the daily hire cost against the number of days to write off the rig for a range of prices. The graph shows that even at a price of $14,000 the rig can be written off at $50 per day over 270 days usage, (90 days use per year over three years). The rig becomes affordable to a contractor under various hire scenarios and the LCDP rig hire charge of $42 per day in Table 6.5 is realistic.

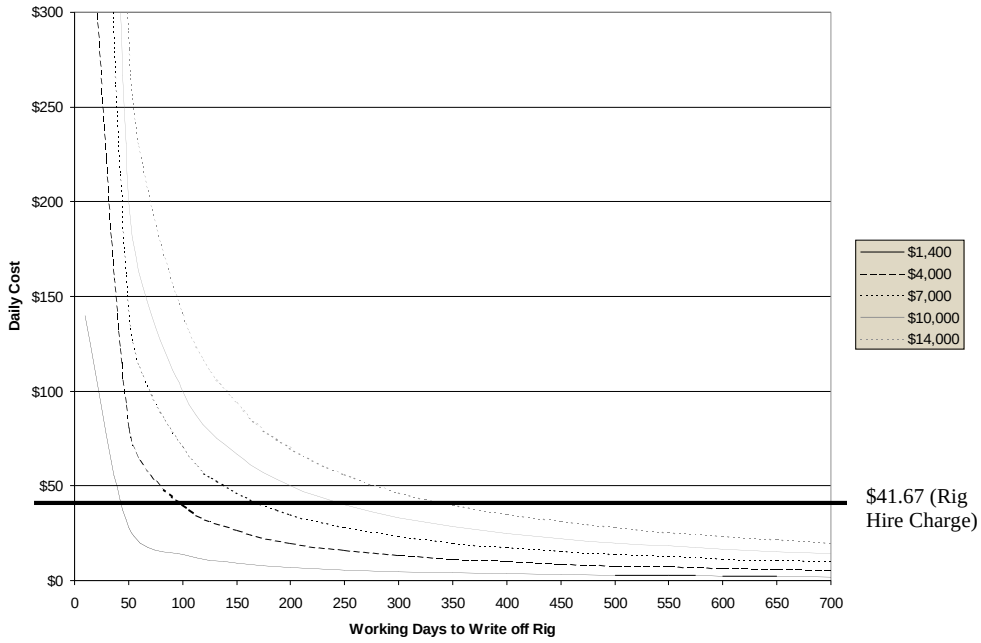

Figure 6.6: Rig Hire Cost

Value Added Tax (VAT)

The high proportion of consumables cost (42% to 72%), which are subject to Value Added Tax (VAT), at 17% suggest that VAT registration may be advantageous. However, VAT was introduced to Uganda in 1996 and the research indicated that (1) very few SMEs understood how VAT worked; (2) the Ugandan Revenue Authority were considered to be corrupt by those not VAT registered; (3) VAT returns were found straightforward by those registered, provided a return was presented each month; (4) not all suppliers of materials issue VAT receipts; (5) enforcement of the regulations for registration of small enterprises for VAT payment are lax; and (6) non VAT registered companies are often competing for the same jobs with the same prices because there is a lack of understanding about VAT from private and Government employers. The last point means that VAT non-registration is an advantage as non-registered companies do not pay 17% of their income to the revenue authority. Consideration of whether VAT registration is advantageous is thus dependent on whether the client will differentiate between companies who pay VAT and those who do not as well as the proportion of material inputs.

Indirect Costs

Indirect costs include the cost of obtaining work, and company overheads. These vary between districts, and among the different enterprises, according to the turnover and type of business. District staff and contractors were explicit in informing the LCDP that the price ceiling for Pounder wells would have to include a sufficient component for bribes, otherwise the construction of the wells would not be viable for the contractor[28].

The contractors were generally found not to know their expenditure on overheads, as observed by the discussions during and after the business training courses (Ssebalu & Danert, 2001). Most of them were found to spend as they needed to and kept no records. Kakooza and Danert (2001) estimated regular monthly expenses of $460 for a company based in a small office in a district capital, with two directors, employing one permanent staff member in the office and hiring labour for construction when required. The breakdown of the estimate is shown in Table 6.6. The figures are

[28] Discussion with District staff and contractors on several occasions towards the end of phase 1.

based on information obtained from discussion with participants during the business training. They were generally very surprised to see how high their total indirect costs could be, but expressed delight at realising where their margins are actually spent.

It was found that enterprises generally only paid skilled labour for the duration of the construction work. Artisans thus spend some parts of the year without income, while at other times there are shortages of skilled labour as the artisans often work for several enterprises.

Table 6.6: Breakdown of Estimated Monthly Indirect Costs for a Small to Medium Water Sector Enterprise in Uganda, 2000.

Item	Monthly Expense ($)
Rent	55.56
Utilities	13.89
Telephone	22.22
Security	13.89
Office Staff	111.11
Directors' Allowances	55.56
Subsistence	16.67
Publicity, Entertainment & Meetings	66.68
Printing and stationery	10.00
Repairs and General Maintenance	27.78
Newspapers and Journals	11.67
Rent	27.78
Medical and First Aid Kit	11.11
Loose Tools	2.78
Interest on loans	2.78
Bank Charges	5.56
Bank Commitment Fees	5.56
Grand Total	460.60

Variation in Cost for Successful and Non-Successful Wells

Well cost is a function of the drilling time, well depth, distance between site and company base and transport requirements. The sensitivity of the well cost to these is examined by considering six scenarios for successful wells as presented in Table 6.7 . In each case the company director is assumed to visit the site every three days as was observed in the field.

Figure 6.5 illustrates the differences between these scenarios and the cost breakdown into transport, labour, drilling equipment, pump and well consumables. The variation in total direct cost ranges from 0.68 to 1.73 of the reference well cost, while the pump constitutes the largest cost component in all cases except scenario D, where

the drilling equipment forms a higher proportion of the cost. Labour comprises no more than 25% of the cost, with transport varying from 4% to 15% (note earlier comments about unrealistic costing by transport providers).

Due to the difficult and unpredictable hydrogeology, not all wells meet with success. Figure 6.8 illustrates the variation in direct costs for five unsuccessful wells scenarios given in Table 6.8. These scenarios have been selected in order to illustrate the sensitivity of the cost to the key variables of drilling time, well depth, distance between site and company base and transport requirements. Site visits are as for the successful wells.

The variation in total direct cost ranges from as little as 10% to as much as 100% of the base cost. Wells which take many days to drill and which are mistakenly installed with below ground components can be as expensive as successful wells. A bad run of dry wells can thus be expensive. This highlights the importance of developing operator skills in the identification of productive aquifers and developing appropriate payment mechanisms for private contractors in order to reduce their risk of incurring financial losses.

Table 6.7: Six Successful Pounder Well Scenarios in Uganda, 2000.

Variable/Well	**A** - reference well (Table 6.5) - moderate drilling time and depth and close to base	**B** - quick to drill, very close to company base and shallow**;**	**C** moderate drilling time, shallow to medium depth and far from company base**;**	**D** slow to drill, shallow and close to company base;	**E** - moderate drilling time, shallow to medium depth and medium distance;	**F** - slow to drill, very deep and very far from company base.
Days Drilling Investigative Hole(s)	3	1	3	10	5	10
Days Drilling Production Hole	3	1	3	5	1	5
Pounder Well Depth (m)	18	10	15	10	15	30
Distance from base to site (km)	65	20	300	65	130	300
No. of days rig in transport	2	1	3	2	2	2
No. of days pickup required	2	1	3	2	2	2

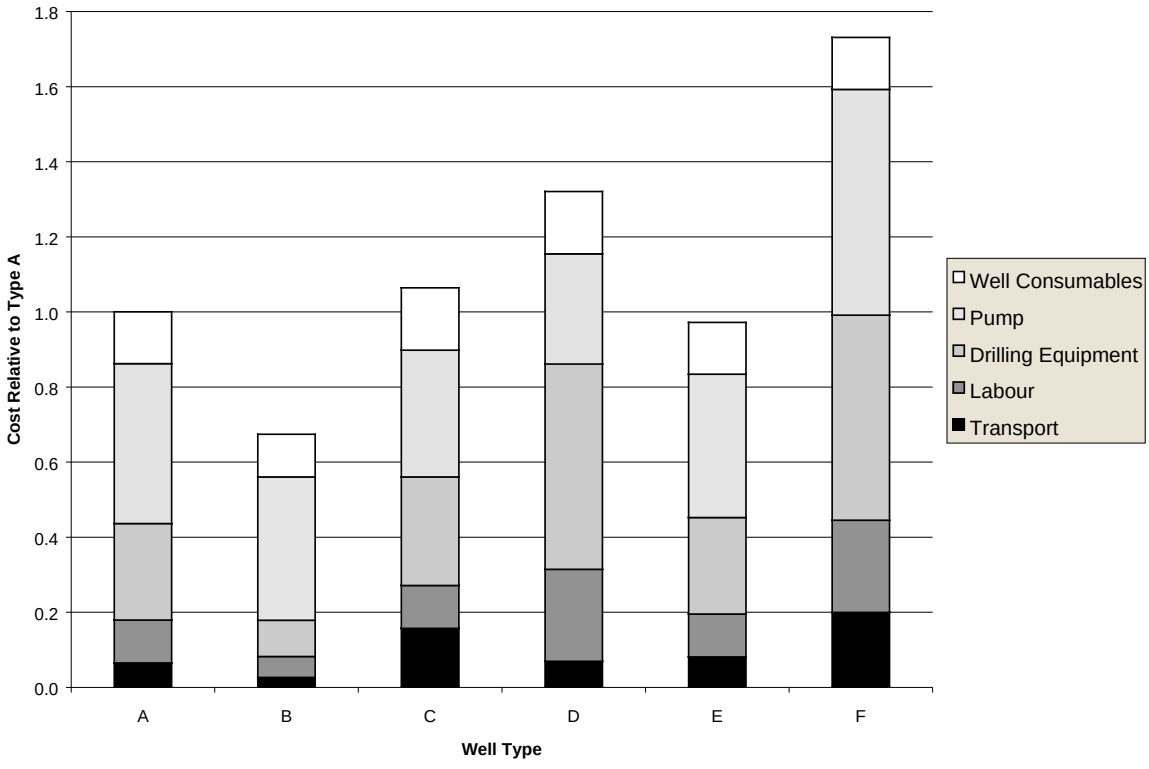

Figure 6.7: Comparison of the Direct Cost for 6 Successful Pounder Well Scenarios (described in Table 6.7) in Uganda, 2000

Table 6.8: One Successful and Five Unsuccessful Pounder Well Scenarios in Uganda, 2000.

Variable/Well	**A** - sample well (Table 6.5) - moderate drilling time and depth and close to base	**G** - quick drilling, no well consumables installed, close to base;	**H** - very quick drilling, no well consumables installed, very close to base;	**I** - moderate drilling time, well consumables installed to mmoderate depth, medium distance to base;	**J** - long drilling time, well consumables installed to shallow depth, far from company base;	**K** - medium drilling time, no well consumables installed, close to company base.
Days Drilling Investigative Hole(s)	3	3	1	3	10	5
Days Drilling Production Hole	3	0	0	3	5	1
Successful Water Source?	Y	N	N	N	N	N
Below ground parts installed	N	N	N	Y	Y	N
Pounder Well Depth (m)	18	0	0	15	10	0
Distance from base to site (km)	65	65	20	130	300	65
No. of days rig in transport	2	2	1	2	2	2
No. of days pickup required	2	2	1	2	2	2

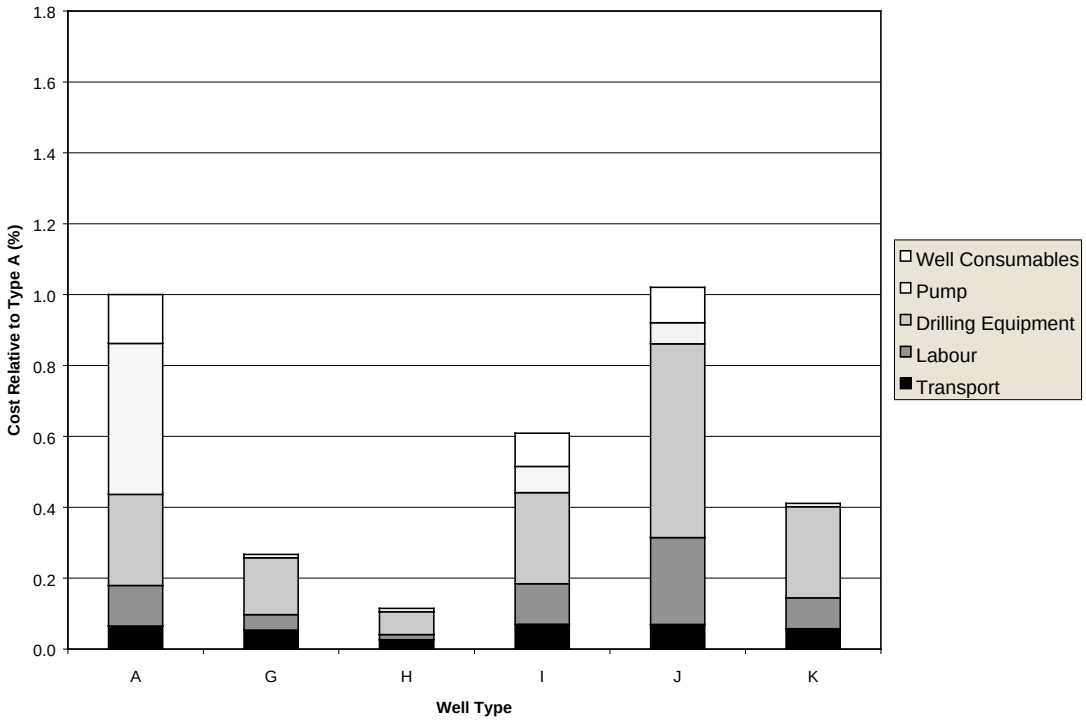

Figure 6.8: Comparison of the Direct Cost for One Successful (A) and Five Unsuccessful (G to K) Pounder Well Scenarios (described in Table 6.8) in Uganda, 2000

Conditions of Contract

The Government funding conditions only enable District Government to pay a set rate for successful wells, apart from exceptional circumstances, such as drilling on the islands. As there is a variation in direct cost, which is not known until the well is completed or the hole abandoned, a prearranged fixed price raises challenges for the contractors. The contractor must absorb losses by making a sufficient margin on the cheaper wells.

One implication of the fixed price system is that difficult sites may be abandoned, despite the fact that they may be viable. For example, the water table may be particularly deep, or lie below a hard layer which takes a long time to penetrate. This has implications for (i) individual communities, which may be left without shallow wells unnecessarily, and (ii) the cost of national coverage, as more challenging locations are left to expensive deep drilling. Alternatively, paying a variable rate, and paying for unsuccessful wells would guarantee a margin for the contractor on each hole drilled by passing the cost variation, and hence risk on to the client.

Discussions with contractors and District and central Government on several occasions reiterated that contractors would not be paid for unsuccessful wells. *"[With] the dry wells, what happens is 'thank you for trying, good bye' "* (Rwamwanja, 2001a); *"the District officials are not free with those funds. Because it is difficult for them to pay for dry wells yet those risks are there in drilling"* (Adopter, 2001). However, observation of District behaviour when encouraged to pay for dry sources after the event, and the fact that contractors and District officials can be networked led the author to question whether there may be unofficial means which are used to solve such problems.

Official variable pricing would require contractors to price their works properly and clients to understand costs. These skills appear to be lacking in both cases. It would also make GoU budgeting less straightforward and, in the absence of competent supervision, provide greater opportunity for corrupt practices. A fixed payment for only a successful source is the end of a chain of conditions from the donors.

Non-payment for dry wells is not only a problem for publicly funded wells, *"...people won't pay for dry wells"* (Comment 6.39), as it is difficult for individuals, institutions and communities to comprehend that they should pay for drilling if they end

up with no finished product. Most people in Uganda are generally not knowledgeable of the intricacies of hydrogeology and require education on this matter.

Fixed payment for successful wells results in considerable risk being borne by the contractor. *"If people are drilling a well and find it is dry, and they are not paid for it they get discouraged"* (Comment 6.40). The Pounder Rig Adopter (2001) pointed out that non-payment for a failed hole inhibits technology uptake, and is likely to cause people to conclude that the technology is inadequate. In contrast he found the case where he was paid for exploration work very encouraging.

If the technology is to be adopted widely, the risk to the contractor must be reduced. This can be at institutional level and through education. Siting methods which consider failed holes as exploratory drilling (outlined in chapter 5) provide a possible step towards reducing the risk. Without such measures, attitudes such as: *"I don't think people will refuse until [the technology] fails. Where it fails they have their reason not to take it up"* (Mukono, 2001a) are likely to undermine technology uptake, despite the fact that it has considerable potential for application in Uganda.

Cash Flow and Profit

The Ugandan Government and commercial enterprises were very inquisitive regarding capital cost of the rig and the price of the well, but rarely questioned the business running costs. This may indicate a lack of appreciation of its importance, reflecting the informal manner by which company finances are handled.

Estimates of the requisite working capital and pre-tax profit for the Pounder business are presented in Table 6.9. The figures have been taken from the LCDP project report (Kakooza, Ball & Danert, 2001) which undertook a cash flow forecast for three scenarios: in the first scenario, it was assumed that the contractor purchases a Pounder Rig and pickup truck, and drills 75 wells in one year. These wells are spread throughout the year, and the contractor waits three months for payment. The contractor is VAT registered; the second scenario assumes that the contractor hires the rig and a pickup and drills 30 wells in one year. It takes one month for the contractor to be paid, and (s)he is VAT registered; the third scenario comprises rig and pickup purchase and assumes 30 wells drilled in one year. The contractor waits one month for payment and is VAT registered. The indirect costs used in the calculations are those shown in Table

6.6, the direct well cost used is $1029 and the price paid for the well is $1741. It has been assumed that all wells are successful.

Table 6.9: Initial Capital and pre-tax Profit for 3 Contractor Scenarios

Scenario	Initial Capital Requirement ($)	Annual Profit Before Tax ($)
Contractor purchases Pounder Rig and pickup; drills 75 wells per annum; waits 3 months for payment; is VAT registered.	40,648	67,294
Contractor hires Pounder Rig and pickup; drills 30 wells per annum; waits 1 month for payment; is VAT registered.	5,642	18,071
Contractor purchases Pounder Rig and pickup; drills 30 wells per annum; waits 1 month for payment; is not VAT registered.	18,564	19,346

Table 6.9 suggests that a working capital of approximately $6,000 - $41,000 is required for a contractor to drill between 30 and 75 wells per annum. Hiring, rather than purchasing the rig and pick-up considerably reduce the initial capital requirements. The pre-tax profits are estimated to range from $18,000 to $67,000. These figures assume that the business only undertakes Pounder Well drilling. This is unlikely, given the that Ugandan entrepreneurs tend to undertake multiple activities. Additional different work may reduce or increase cash flow requirements depending on the spread of work throughout the year and payment times and conditions. The assumption that all wells drilled are successful and cost the same evens out the margins on each well. Both the capital requirements and pre-tax profit can vary up or down according to the variation in drilling requirements and success rates.

6.6.3 Appropriate Networks

Given the existence of company-government and inter-company networks in Uganda (described in 6.3.3), even if a company has skills in Pounder well provision, it is likely to be difficult for them to obtain work from District Government unless they are well networked. It may thus be advantageous to train and support key members of a network rather than undertake more widespread training. Such targeted intervention may enable the technology to spread more rapidly through Uganda.

However, such an approach does raise issues of equitable access and poverty reduction, for the companies which are already well established and well networked would benefit from greater access to the new technology.

6.6.4 Operation of the Technology is Acceptable

Key issues with respect to the acceptability of the technology operation comprise siting, well design concerns, skills required to operate the technology, water requirements and well development. These are discussed below.

Siting and Hole Failure

The main concern expressed by the Pounder rig adopter regarding operation is the siting difficulty and how it is detrimental to the image of the technology: *"Poor siting [is preventing the rig from being taken up]. If we fail at a particular site people will blame the technology and say [it] can't manage."* (Adopter, 2001). The fact that contractors are currently not paid for unsuccessful wells renders an improved siting method attractive if it can reduce or eliminate the risk of drilling a hole which is not paid for.

Siting methods and payment varies between Districts. One case was observed in which a contractor paid for a geo-electrical survey by a hydrogeologist as an insurance policy. He claimed that by having this work undertaken he would be able to claim payment from the District if the well was not successful. In other cases, site location is entirely the responsibility of the contractor, who also bears the financial cost of a failed hole, and in some cases the District sites the well or pays for siting but the contractor still bears the financial cost of failure. Some of these approaches are more acceptable to a contractor than others.

In order to eliminate any risk to the contractor, he would require to be fully paid for his endeavours to determine the optimum water source at each site. This could include groundwater exploration with the Pounder technology as discussed in 5.5.4. However, this requires a considerable change in Government and donor policy as considered in chapter 7.

Well Design Concerns

The operators required considerable training in the unfamiliar pump installation method (described in 5.3.3) and continued to express reservations about the well design. Requests were frequently made to the LCDP team to design a larger diameter drill bit which would allow for a conventional pump installation (Box 5.3). Although these

reservations may reflect a resistance to change rather than actual problems with the Pounder well design there are several valid reasons for the well design to be rejected.

The Pounder well design meant that drilling could not take place unless there was a supply of pump cylinders. Lack of cylinders was cited as one of the reasons for not deploying the Pounder rig in Mpigi district. In contrast, both hand augered and hand dug wells can be completed with the pump installation taking place later.

The ingress of fine material into the well was blamed by the rig operators on an insufficient gravel envelope between the wall of the well and the well screen. The operators also raised concerns about corrosion of the pump cylinders. Both of these issues have been noted as requiring further research (5.7). In addition, the contractor did not want to risk wasting cylinders by installing them into holes which might not be able to provide sufficient yield. Given the potential cost of such an installation (scenarios I and J in Table 6.8 and Figure 6.8) and lack of payment, this concern can be justified in financial terms.

Skill Requirements

The policy makers and contractors who had no direct experience of rig deployment considered it easy to operate: (Comment 6.41) *"you can get someone using it in three months"; "it does not need a degree man"* (Comment 6.42). Although making a hole in the ground with the Pounder rig may appear relatively straightforward, ensuring that the drilling fluid hole is not lost, the hole does not collapse and determining whether the hole will provide a productive water source requires considerable skill.

For 26 of the 29 holes drilled between August 1999 and June 2001, either the drilling trainer was on site, or I was available on call in case of difficulties. In the words of the Adopter *"Every site comes with its own problems, so if you are trained and left alone, you wouldn't know how to handle some of those problems encountered on site: to decide if this depth is enough; if the recovery is enough. We would not reach a final decision alone...the decision making requires an experienced person"* (Adopter, 2001). If the Pounder rig uptake is to be sustained, ideally there should be a simple methodology to aid the decision making process. The danger is that this would probably be over-simplistic, failing to consider the individuality of each site.

The apparent simplicity of the Pounder Rig operation is likely to make it attractive to contractors. Potential Pounder drillers vary in terms of adsorptive potential and existing skills. One driller trained by the project had several years experience of large drilling equipment, others were experienced well diggers and one was an English teacher by training. Observations[29] of artisans while hand augering revealed that they had an extremely limited understanding of hydrogeological principles. If the initial lure of the technology's apparent simplicity is not followed up with adequate training and support, there is a lot to go wrong, affecting the profits of the contractors and ultimately the appropriateness of the rig.

An in-country training mechanism, which is not dependent on foreign experts, is necessary if new contractors are to be enabled to take on the technology. However, the difficult decision making which needs to be undertaken for each site suggests that costly on-site trainers are necessary for a considerable duration. If the need for such training is accepted, the question arises of who should undertake it. *"[Training] is something that you cannot expect the private sector to undertake, as they are competitive. [It] needs to be undertaken by the Government, and thus this knowledge needs to be in the Government"* (DWD, 2001d). However, the Government is already stretched, and it is unclear if it will be able to take on board such an activity. Enabling a fledgling Pounder drilling industry to develop is a task which may have to be undertaken by external agents, until there is sufficient skill within Uganda. Reaching sustainability requires the investment of considerable resources.

Water

Although the cost of water for drilling is a small fraction of the total well construction cost, or none at all, insufficient water can result in collapse of the hole. Water for drilling is thus essential. Current practice involves community members collecting water free of charge. Lack of community participation in this activity has proved to be a hurdle for the Pounder drilling as it has resulted in insufficient water for the drilling. On more than one occasion, the contractor has moved site because of this. Community labour is discussed further in 8.4.2.

[29] Field observations on 23rd August 2000.

Well Development

Well development after the below ground parts have been installed is essential in order to provide a clean water source, as otherwise, fine material will tend to ingress into the well, discolouring the water, and wearing the below ground parts. If the water is very dirty, the community may even abandon the source because of this. Well development did not appear to be a priority by the constructors observed, who would leave the site with turbid water. This problem may be a consequence of inadequate emphasis on quality by the client, which is considered in chapters 7 and 8.

6.6.5 Confidence in the Technology

The Pounder Rig increases the scope of work which small enterprises involved in shallow well construction can undertake, as it can penetrate formations which existing methods cannot. This has improved confidence in shallow well drilling (see 5.2.2).

It has also been suggested that the Pounder rig success has boosted confidence in private sector drilling*: " [you] involved the private [sector in low cost drilling] which many people did not think could be done...the feeling was that something technical needs a very sophisticated [company]...but now you are having the local contractors...so it has built confidence in the private sector for the shallow well construction"* (DWD, 2001b).

However, Ugandan stakeholder perception of the Pounder rig at the end of the LCDP phase I in June 2001 was that it was still a test machine (see 5.7). There was not full confidence in the equipment in the eyes of the private or public sector. Several companies did not want to tender for work with the Pounder equipment until they had operated the rig (personal communication[30]).

The LCDP was considered to be a project which did not complete by the end of phase I. The fact that the LCDP team would not release a commercial price for the rig and that all the requisite rig spares were not made available reinforced this view. Despite promises to the stakeholders, the LCDP did not field a finished product which won the full confidence of the Ugandan stakeholder in its three year duration. Although

[30] Informal discussion in 2000 and 2001 with several enterprises regarding their likely adoption of the technology.

the LCDP was on its way to that target, funding expired and no additional finances were forthcoming from donors or Government. The work was thus suspended at the end of phase I in June 2001.

Research in general does not have a good name in Uganda and research organisations are reputed to undertake studies and then leave. Although the LCDP overcame many of the prejudices towards research, during the project duration, it ultimately fell into the same trap and left behind hollow promises.

If Pounder rig uptake is to be sustained in Uganda, a follow on project is required which picks up those pieces and builds further confidence in the technology. Discussions reveal that this should include further testing of the equipment and that in terms of design modifications a definite period of no further change should be adhered to, during which the technology is utilised, *"otherwise you will have a problem with the private sector thinking that [the technology] is not certain. It is important that there are steps and that the gaps are well defined"* (DWD, 2001b).

Thus a subsequent phase is required to build confidence that the technology is more than a piece of research. This issue is discussed further in chapter 9.

6.6.6 Market for the Technology Deployment

Given the private sector focus in Uganda, the policy emphasis on low cost technology and availability of funds in Uganda for water source construction, there is considerable latent demand for technology deployment by the private sector.

However, by end of phase 1, the market for Pounder wells was not considered to be sufficient *"People may want to buy [the rig] but there is no market"* (Mpigi, 2001a). *"The buying [of the Pounder Rig] would mostly depend on the policy makers because it requires sensitisation...if our clients first of all get used to it so that we can get the jobs. ... I would recommend that first of all...go and negotiate with possible donors and the Government of Uganda, because we can miss the new technology...we shall leave it out due to lack of commitment"* (Adoptor, 2001).

Despite the large amounts of money available for water and sanitation in Uganda, if the contractors are to tap into the rural public-funded community water supply market with the Pounder Rig, the Districts must be able to legitimately contract out Pounder well construction. *"The problem is funds are not there to allow us to drill as many Pounder Wells as we would wish"* (Adoptor, 2001). Given the varied

interpretation of the guidelines of the conditional grants, this requires institutionalisation of Pounder Wells, thus placing them on a par with other accepted methods. Institutionalisation is discussed further in 7.

The LCDP focused on the rural-public funded community well installed with a handpump to the exclusion of alternatives (eg schools, irrigation wells, private household wells) for a number of reasons:

i) domestic community water supply commitment - the research was committed to this in view of the GoU's commitment to poverty alleviation;
ii) lack of resources - the team was stretched to full capacity dealing with the public-private sector issues, that there remained few resources to explore alternatives;
iii) small hole diameter - the maximum drilled diameter of 100 mm excludes submersible pumps from use in Pounder wells. Submersibles are the preferred pump type for many institutions and wealthy individuals;
iv) availability of equipment - the first Pounder Rig was the property of Mpigi District council, and the LCDP did not have the right to remove the rig, while the second rig only arrived in November 2000, seven months before the end of the phase I;
v) attitudes to failed wells - persuading private clients to pay for dry wells was deemed to be extremely difficult.

The public funded rural community market is but part of a larger potential market in Uganda. Other public markets could include peri-urban wells: *"I would like to think that [the Pounder Rig] is appropriate for ...point sources in rural towns in... fringe parts of the town which is outside the core areas...really those point sources will need developing... A lot of money will be coming into the urban water sector in the next ten years"* (DWD, 2001f).

Private markets could include NGOs, individuals, institutions and agriculture. The adopter did drill for an international NGO. This involved exploratory well drilling for hand dug wells in difficult hydrogeology. Although both the NGO and the contractor were keen to continue to collaborate, the contractor submitted a pro-forma invoice for this work which was excessively high, and the NGO was put off. The author speculates that the problem was a combination of short term thinking on behalf of the

contractor (trying to maximise profits), and the NGO being unwilling to bargain. It may be difficult for commercial enterprises to provide services to NGOs because of the cultural differences between the organisations.

The LCDP was approached several times by individuals and institutions interested in boreholes. The perception amongst District officers, civil servants in the Ministry of Agriculture and DWD, as well as commercial enterprises, was that there is a considerable market for agricultural wells. However, AT Uganda (1999) have found that the use of irrigation in Uganda is very limited. The beneficiaries of this market may thus require considerable education if this is to be actualised. These markets require further research if the Pounder Rig is to extend beyond its existing target market.

6.6.7 Availability of the Technology

As outlined in section 5.1, the technology includes the Pounder Rig and installed pump which must be available to the contractors.

Rig Availability

Early on in the LCDP, the decision was taken to include high specification components to provide the requisite capability and ensure their *availability*, in preference to lower specification components *manufactured in country*. Rig availability in Uganda is therefore dependent on (i) the transfer of foreign exchange and (ii) the overseas supplier. The former is currently not a problem if the buyer can pay, given relatively low inflation in Uganda (3.9% in 1997; 3.3% in 2000; 3.1% in 2001 (World Bank, 2001a)and the free movement of foreign exchange. Dependency on the overseas supplier was problematic during the research duration. Towards the end of phase 1 the technology was not perceived complete by the entire LCDP team. Consequently the sole UK supplier would not supply rigs or spares. This monopoly meant that alternatives could not be readily procured. Two rigs were left in Uganda, one with Mpigi District Government and the other with a Ugandan independent engineer. With the exception of leather flap valves (manufactured in Kampala) no alternative mechanisms had been set up to supply spare parts for these rigs. Ensuring sustainable availability of the rig and parts will only be realised if agents (Ugandan or external) dedicate resources to it.

A full analysis of long term availability to the Ugandan private sector was not undertaken within phase I of the research and there is insufficient information to enable long term availability options to be considered fully. However, experience of the short term situation sheds considerable light on several issues which are likely to prove important when developing a strategy for sustained availability.

Given the dependence of the design on imported parts (drill pipe and drill bits), the first step in ensuring availability *within* Uganda, is bringing the constituent components, or indeed the rig *to* Uganda. The options for this are given in Table 6.10.

In light of the limited engineering capacity in Uganda, and high material specification, importing all raw materials for complete local manufacture was not considered to be a viable option by the LCDP UK team. Purchasing off-the-shelf components to import into Uganda was considered cheaper, resulting in higher quality. On the other hand, the greater the importation requirements, the greater the Ugandan dependency on foreign organisations.

Opinions with respect to how much local manufacture should take place in Uganda varied within the UK team. The key issue of concern lay with manufacturing capability and motivation. Although there were several well set up manufacturing workshops in Uganda (such as Uganda Railways), who take in piecemeal work, these were considered unsuitable due to the priority which they place on their in-house manufacture and repair. This concern was confirmed by AT Uganda (1999) who had experienced problems with large manufacturers not delivering small orders on time. They preferred working with the smaller workshops. No single suitable existing workshop for part local manufacture of the Pounder Rig was identified which was considered to have the motivation and requisite quality standards. However, towards the end of phase 1, the engineering assistant expressed an interest in undertaking part manufacture by liaising between several workshops. This option requires further exploration.

Table 6.10: Rig and Spares Availability in Uganda Options and Implications

Options	**Precedents**	**Preference**[31]		**Perceived Cost**				
		Ugandan Stakeholders	UK Team	Ugandan Stakeholders	UK Team	Issues wrt Materials	Issues wrt Manufacturing	OTHER ISSUES
Complete local manufacture	Gate manufacture (Uganda)[32]	Most	Least to medium (variation within team)	Low	Very high (without design mods.)	All requisite raw materials are not readily available in Uganda.	Very high level of skill and equipment required in Uganda	Difficult to find the skills, equipment, motivation and investment by Ugandan manufacturers.
Mix of importation/ local manufacture	U3 handpumps (Uganda)[33]		Most		Medium	Could manufacture components which comprise raw materials available in Uganda, and import remainder.	Medium level of skill and equipment required in Uganda	Builds on existent capability in Uganda and overseas. Provides Ugandan control over the availability of some, but not all components.
Import in kit form	Nira handpump (Ghana)[34]		Most		Medium	Consideration of the availability of local materials not necessary.	Low Ugandan level of skill and equipment required	Does not build upon existing Ugandan capacity. Provides very little Ugandan control over availability.
Import complete machine	mobile phones (Uganda)[35]	Least	Medium	Very High	High	Consideration of the availability of local materials not necessary.	Low Ugandan level of skill and equipment required	Does not build upon existing Ugandan capacity. Provides no Ugandan control over availability.

[31] Preferences expressed in interviews and informal discussions.

[32] Iron gates are manufactured by small enterprises in Uganda from a mix of scrap and readily available materials.

[33] The below ground parts of the U3 handpump are imported into Uganda from India while the above ground parts are manufactured locally, using imported materials.

[34] All the pump components are imported from Finland and minor work is undertaken in Ghana.

[35] Mobile phones are imported into Uganda as finished products and sold on to the end user. No adjustment is undertaken. Small, local enterprises undertake repairs.

The public and private sector Ugandan stakeholders were particularly concerned about the availability and cost of imported components. *"The problem is the [drill] bits, which may not be available in the country, which may increase the cost. But still, we can maybe have a solution"* (DWD, 2001d). One such solution would be for a subsequent project phase to guarantee covering the costs of drill bits to local suppliers until the market is sufficient. The risks in the early days of uptake are likely to be higher than subsequently. Quality assurance in manufacture is another key concern for the future and has been raised by DWD, donors and the LCDP team. Although the LCDP started liasing with the Ugandan Bureau of Standards, the design needs to be finalised before this work can be taken further. In addition, this organisation is not equiped to police poor quality product. Maintaining quality thus remains a major concern in terms of long term availability in the absence of external monitoring.

Supplying the complete rig in kit form from overseas for assembly in Uganda is no guarantee of quality. This method also places considerable control in the hands of the overseas agent. If he should no longer be willing or able to supply the kits, contractors would face difficulties.

Even given rig availability in-country, the key issue is that of availability to contractors. This comprises a number of options including hire, hire purchase or outright purchase from different types of individuals and organisations. As discussed in 6.6.2 , outright purchase is difficult for all but a minority of contractors. Given this, hire options and their pros and cons are listed in Table 6.11. None of the options listed provided an ideal solution. Involvement of the LCDP cannot continue indefinitely, while Government, although able to provide continuity has a poor track record of hiring out equipment and civil servants in the respective institutions are not keen to undertake equipment hire. Although NGOs may be suitable agents, and may be able to hire out at reasonable rates, they may have priorities which favour local NGOs over commercial enterprises. The UK LCDP team perceived the main difficulty with hire by the commercial sector to be the fact that they may drill as well as hire, which was considered to be a conflict of interest, as they would be hiring to their competitors. However, given the networks of companies which have been found to exist, this concern may be ill founded.

Table 6.11: Options for Long Term Pounder Rig Availability in Uganda

Options	Agents	Pros	Cons
Hire or Hire Purchase from:	Research Project	hire, training , monitoring and modifications can be undertaken by dedicated staff	non-Ugandan agent, longevity of which is dependent on securing funds.
	Uganda Leasing[36]	continuity	organisation not familiar with drill equipment
	Government of Uganda: Directorate of Water Development (DWD)	continuity	track record in hiring out large drilling rigs is poor (lack of maintenance and nepotism), so there would be concern about small equipment; policy favours private sector involvement
	Government of Uganda: Technical Support Unit (TSU)	proximity to District Government	uncertain if policy will allow; unsure about continuity as TSUs are considered temporary by GoU and Danida
	Government of Uganda: District Government	continuity and proximity to District based contractors	not favoured by central govt. policy makers; not favoured by District staff due to potential political interference; unlikely to have capacity to hire out or repair
	Technology Mobilisation and Business Access (TEMBA)[37]	recognised by DWD; known to contractors	lacking technical skills; motivation unclear; longevity is dependent on securing funds.
	Non-profit organisations	may take a more benevolent view to profit making than a commercial enterprise	question of continuity; capacity to run a hire business; may favour use by local partner organisations over commercial enterprises
	Large commercial enterprise	continuity; capacity to repair	unlikely to be motivated for small financial returns; may prefer to drill rather than hire out equipment
	Small commercial enterprise	financially interesting for them	question of continuity; many sharks exist; may not have sufficient capital; positioned weakly to deal with non-payment or damage; may prefer to drill rather than hire out equipment

[36] organisation specialising in hire purchase of equipment

[37] TEMBA is an NGO set up by the Ugandan members of the LCDP in order to continue with the work started by the LCDP, in particular capacity building of small and medium enterprises in the water sector and local Government, as well as strengthening the links between them.

Although the second rig has been left in Uganda for hire, continuation of use in the market will ultimately be hampered by availability of spares - there are no spare button bits accessible in Uganda, or the UK. Thus the life of the equipment left in Uganda will be limited by wear.

Pump and Well Consumables Availability

The potential demand for Pounder Rigs is a fraction of the potential demand for Pounder Well consumables. Assuming that one rig drills 30 wells per year over its three year lifetime gives a ratio of 1:90 of Rig:Wells. In financial terms, utilising the reference cost in Table 6.5 of $1297, and a cost of $10,000 for a rig, the ratio of rig to well turnover is 1:11.7 This formed part of the justification for less focus on local manufacture of rigs, compared to local manufacture of pumps and other well consumables. U3 pumps were available in Uganda, and the LCDP negotiated with a local manufacturer to produce a special run of well screen.

6.6.8 Business Development

Background

This section reflects upon the value of the business development undertaken, and its importance to the technology uptake.

Although the businesses researched generally had some technical skills, and business tactics (see 6.4), they were found to be lacking in knowledge of modern (western style) business management (Ssebalu, 1998; Snell, 1999d; Ssebalu, Danert & Kakooza, 2000; Ssebalu & Danert, 2001). Such findings were not limited to the LCDP. The staff of the Accord[38] project, for example, found that individuals entered into contracts with communities and would sometimes agree on unrealistically low prices in order to secure contracts, with the result that work was often left unfinished once it was realised that it could not be completed without making a loss (Snell, 1999a).

The LCDP team believed that the success of the Pounder rig depended, among other things, on the capacity of small contractors to function as effective profitable businesses (Ssebalu, Danert and Kakooza, 2000) and thus undertook a series of business

[38] Run by Conciliation Resources, London.

training courses, based upon the findings of brief training needs assessments (TNAs), to build the capacity of potential technology adopters. Despite the new private sector focus in watsan, there was no national business development of the sector. DANIDA and DFID talked of funding a study into the water and sanitation private sector before March 2000, (DFID, 2000b) but it had not been undertaken by the end of October 2002. DFID (2000b) speculated that getting such a study off the ground was difficult due to DWD's contentment at the status quo and them not wishing to expose skeletons.

Business Training Content and Observations

The topics covered by the training are summarised in Table 6.12, together with a number of observations from the training.

Table 6.12: Topics and Observations of Business Training (Ssebalu, Danert & Kakooza, 2000)

TOPIC	OBSERVATION
Business Communication	Companies would mix up documents, eg delivery notes and invoices.
Business Planning	Companies generally do not plan their activities and time.
Costing and Pricing	Companies tend to cost raw materials only, and not include transport, feasibility studies or overheads.
Entrepreneurship	Companies tend to stick with the work that they know very well, despite other capabilities that they may have.
Financial management	Generally no line is drawn between personal and company funds. There tends to be little contingency for overhead expenses.
Record keeping	No records of which directors take money from the company as income. No record of contract duration.
Office Management	Some companies file documents, while others do not.
Management	Some companies meet when necessary, while others meet on a regular basis. Directors who are also still in Government are very busy and often absent.
Marketing	The employees rely on the director for company contracts. One company runs after jobs for which it often cannot raise the capital. Sometimes staff skim off company work for themselves.
Salesmanship	Some companies follow up their sales afterwards while others do not.
Tendering	The tender documents are found to be very difficult to complete. In addition, companies must be familiar with many different types of documents. Tender boards may not always be sufficiently skilled or qualified to undertake their job properly.
Trust	Directors are afraid to provide too much training to staff in case they leave and float their own companies.

Attitudes to the Business Training

The LCDP business training came to be seen as a pilot for future small business training in Uganda (DWD, 2000f). The business development was extremely well received by the contractors eg *"they were very grateful that they received a tremendous amount of training, across a broad range of activities..."* (DWD, 2001f); *"[i]n a nutshell, a bottle of thanks to the facilitators...and [we] still request that such training*

be carried out since they show light to a competitive world" (Comment 6.43) and "*I attended the business development training, of course a number of these lectures I had always been taking for granted. So that one I appreciate very much"* (Comment 6.44).

However, one observer, (Comment 6.45) severely criticised the business training: *"...the business training aspects...I think that I would have taken a more sink and swim [attitude], rather than spend all the time trying to make contractors out of foot in foot outs, that are always going to be flawed. Some [companies] may nurture and grow and will be a success, but there is a clear difference...[like that between] a Muslim or a Christian....nobody can train the difference in an entrepreneurs attitude".* This attitude is particularly fatalistic with respect to businesses success and does not recognise the role of education in trying to improve the skills of existing entrepreneurs. The training was not trying to create entrepreneurs, but rather provide existing businesses with knowledge which could improve their success.

Reflections on the Business Analysis and Training

The Pounder technology provided an entry point to the contractors, and a means to overcome their suspicion of the LCDP team members as competitors. Promises were made of a new technology which would be available to them: *"we have raised the expectations of the contractors and have built their capacity. They have relied on us, and the trust ...the bait was the rig"* (Ssebalu, 2001a). These promises were not fulfilled but not deliberately. It was in good faith. Through understanding the businesses and undertaking the training, the LCDP raised expectation which, despite its good intentions, it subsequently failed to meet when the funding ceased in June 2001.

Although the SWOT analysis provided considerable insight into the world of the watsan contractors, it was not without contradictions. One company was criticised for not diversifying into other activities, despite the fact that it was acknowledged that the director was already overworked and facing extreme time pressures (Snell, 1999d).

Initially, the business trainer lacked knowledge of the water sector and experience of water sector businesses. One company was advised to tender for large drilling contracts and subcontract the work to competitors despite the fact the company had absolutely no skills or knowledge of deep drilling and its pitfalls. However, this advice is consistent with the Ugandan company culture of building and using networks and accepting any work, even if it is well beyond one's expertise.

Impact of the Business Training

Measuring the impact of the training on behaviour is methodologically problematic as one can not always distinguish between the impact of the training and what would have happened anyway. However, a number of observations were made:

- two companies were observed to move offices following the training: one company to improve their image and for potential expansion, the other to reduce costs;
- one company calculated the cost of having an office in Kampala, including the travel to the office, and thus moved closer to their primary clients and directors homes;
- one company approached the trainer to help him register the company and open a bank account;
- one company moved the computer to the front office and started to undertake commercial typing during slack times;
- one company started to rent his car out as a taxi, rather than leaving it parked all day and
- AWASCO (Association of Water and Sanitation Contractors) was formed during the training course and met regularly in the ante-room of the TEMBA office.

A questionnaire was used as the basis for collecting information from the contractors six months to a year after the training. Twelve companies were interviewed by the business trainer while three filled in the questionnaire themselves. This survey may be accused of being more illustrative of what are considered desirable responses, rather than true, as the participants may tend to tell the trainer what he wished to hear. However, given resource constraints the research was not able to observe the participant behaviour, and had no baseline data with which to compare this. Although it was anticipated that the participants would respond favourably to the questions, given the cultural tendency for politeness, the trainer was posed many questions regarding aspects of business practice. This suggested a propensity for criticism, rather than simply positive response to the questions about the training and a belief in the expertise of the trainer. It also indicated that either the training was insufficient, or had considerably raised an awareness amongst the participants. The latter is certainly a desirable outcome of business development. Table 6.13 summarises the topics the companies enjoyed most, and which were new to them. Marketing and advertising, tendering and

management and organisation were cited most frequently by the participants followed by costing and pricing.

Table 6.14 lists the issues implemented and changes to the businesses since the training, as identified by the businesses themselves. Issues are grouped together according to the way in which the participants responded rather than according to the subject titles. Record keeping and book keeping featured very highly, with eleven out of fifteen companies stating that they had implemented some form. Changes to financial management practice, including costing and pricing of activities were identified by nine of the fifteen companies. Changes to marketing, by which some companies actually meant advertising was cited by seven enterprises, while six companies identified changes to the way in which they obtained work, particularly applying for more tenders. Table 6.14 suggests that the enterprises tried to implement a considerable number of skills obtained from the training. Unfortunately the level of detailed narration from the survey is not enough to determine what the mention of implementation or change means to each company.

Table 6.15 lists the stated problems of the businesses, solutions suggested and the assistance which they perceive TEMBA to be able to offer for each of the 15 companies surveyed. The responses are grouped to enable the reader to cross check the solutions proposed with the problems and how this related to their perception of assistance from TEMBA. Blank cells in the table indicate that the company did not express a problem which related to a solution or vice versa.

Insufficient capital was perceived as a problem by 8 companies, of which 4 were looking to TEMBA for finance or equipment supply. Six companies wanted TEMBA to find work for them. The fact that several companies are looking to TEMBA for credit and work highlights the perceived importance of personal contacts and networks in Uganda and illustrates the ease with which a training organisation such as TEMBA could be drawn into the role of agent.

Eleven companies stated that they would like some type of additional business training suggesting that they felt some benefit from the training.

Table 6.13: Results of Follow-up of Business Training (Ssebalu and Danert, 2001)[39]

	Marketing & advertising	Tendering	Management and Organisation	Costing and Pricing	Entrepreneur Skills	Record Keeping	Pounder Rig	Business Planning	Office Management	Book Keeping	Financial Management
Training aspect most enjoyed	5	5	4	4	1	4	1	2	2	1	1
New training aspects	5	5	6	3	4	1	2	0	0	0	0
Total	10	10	10	7	5	5	3	2	2	1	1
Sample Comments (all from Ssebalu & Danert, 2001)											
General	*"The training itself is something new and we would want to pay for more."*										
Marketing	*"The most interesting topic was advertising because we did not know a thing."*										
Costing and Pricing	Costing, especially depreciation was new to the company; Costing and pricing was a new topic especially company overheads; Company did not used to cost the transport in the price of the work. *"We did not know a thing [about budgeting]"*										

[39] Topics covered by the business training and summary of the responses of 15 companies surveyed six months to one year after the training. A point is given to each topic if it was mentioned by the participant due to its enjoyment, novelty and implementation in order to rank the topics.

Table 6.14: Aspects implemented and Identified changes to business from training (Ssebalu et al, 2001)

Issue	Description Of Implementation Or Alteration By The Company[40]	Frequency [41]
Record & Book keeping	- company have implemented record keeping - book keeping skills implemented. - record keeping and book keeping practices changed;	8 1 2
Financial management including costing and pricing	- company have started saving - company have reduced financial losses; - business activities are costed and financial management has improved; - negotiation with clients has changed;	3 2 3 1
Marketing	- company have has made a profile and started advertising - company are now marketing themselves; - new marketing skills implemented.	2 1 4
Business Management	- changed delegation of work; - company tried to restructure its top management to deliver faster; - company have implemented management and administrative skills training resulting in increased worker efficiency; - improvements in co-ordination and communication.	2 1 2 1
Obtaining Work	- company has started/increased tender application for tenders; - customer relations altered; - implementation of tendering skills and lobbying.	4 1 1
Change of location	- relocation to improved premises; - company have moved closer to main client and have thus cut transportation costs.	2 1
Time Management	- implementation of improved time management;	3
Business Planning	- implementation of improved to business planning;	3
Contract Law	- application of contract law; - now making agreements with clients.	1 1
Other	- changes to office management; - better customer handling;	1 2

[40] Mentioned or observed.
[41] Number of companies who mentioned each implementation or alteration.

Table 6.15:Perceived Business Problems, Solutions and Assistance from Temba (Ssebalu and Danert, 2001)

Company	Current Problems	Company Suggestions to Solve Problems	Company Suggestions regarding areas where TEMBA could assist
A	Company faces too much competition.	Company should increase its range of work and thus obtain a wider market.	Identification of other business opportunities.
	Company faces high taxation.	Government should crop down briefcase companies	
			Advising company on the type of employees.
B	Company finds it difficult to meet deadlines.	Company should work out programmes or progress charts and schedules to help the implementers work accordingly.	
	Company has problems with acquiring new works.	Company should approach consultants and clients for work.	Companies with which the company can associate should be identified.
	Company finds it difficult to settling outstanding bills, especially taxes.	Company should try to save as much as possible.	TEMBA should identify projects from which the company can benefit financially.
			More training should be availed.
C	The staff have limited skills.	The company needs to seek assistance for skills development.	TEMBA could develop the skills of the company staff
	The company finds it difficult to promote the business.	The company needs to seek assistance for assistance as regards promotion.	
D (NGO)	Volunteers do not give sufficient time to the organisation as they work elsewhere.		
		The organisation should attend training workshops.	TEMBA should provide training in organisational skills.
		Organisation should consult with resource agencies (donors).	
E	Company has insufficient capital.		
	Company does not have enough assets.	They are trying to improvise, especially with tools.	
	Company has no transport to travel to sites and monitor workers.		TEMBA could assist with the transport problem.
	There are no uniforms for the workers	Company is trying to solicit funds from donors and people of good will.	.
			Training the workers in Pounder Drilling

Company	Current Problems	Company Suggestions to Solve Problems	Company Suggestions regarding areas where TEMBA could assist
F	The directors and staff find it difficult to delegate work and administer the company.	The workers require training.	TEMBA could organise training workshops.
			They could help to find funds and be the trustee of the company.
G			TEMBA could provide further training.
			They could find jobs in water well construction for the company.
			They could help to promote the company.
H	The company had insufficient capital to tender for large works.		TEMBA could provide a loan to the company or access us to loan agencies.
	The company lack access to customers and contacts.		TEMBA could help to access customers.
			TEMBA could improve the company skills.
			They could help mobilise technology for the company.
I	The company lacks financial capital.	The company is saving to purchase a new car which can carry equipment.	TEMBA could help the company increase their financial capital.
	The company lacks equipment.		
	The company has problems with record keeping.		
			TEMBA could help the company to obtain work.
			TEMBA could provide more business skills training, with more emphasis on marketing, advertising and tendering.
J (NGO)	The organisation has inadequate capital.	The organisation should solicit funds from its members.	
			TEMBA could become the trustee.
			TEMBA could assist in marketing.

Company	Current Problems	Company Suggestions to Solve Problems	Company Suggestions regarding areas where TEMBA could assist
K	The company does not have sufficient capital.		
	The staff require more business skills.	More training is required.	TEMBA could provide more assistance and training in business.
L	The company has inadequate financial capital.	The company could try to obtain a bank loan.	
	The company does not own enough equipment.		TEMBA could become the company trustee.
			TEMBA could assist in marketing.
M	The company would like to take out loans but considers the interest to be too high with respect to the profits which can be made from the capital.		TEMBA could find finances for the company and provide training in credit management.
	The company is poor in the area of book keeping.		TEMBA could provide additional detailed training in book keeping.
			TEMBA could assist in providing work for the company.
			TEMBA could provide general business training.
N	The company has insufficient capital and the operation costs are high.	The company could acquire a loan.	TEMBA could assist the company to acquire more capital.
	The company requires more staff.		
			TEMBA could provide further training in business and technical skills.
O	Some equipment is too expensive to buy, or is not readily available (eg concrete mixers).		TEMBA should arrange the supply of tools for drilling and construction.
	The company has problems with the costing and billing of works in advance.		
			TEMBA should prepare more training courses.

Business development services have been criticised due to their limited impact, the fact that they are supply driven, and their expense (Dawson, 1997). In response to this, the LCDP undertook business training for 21 companies over three years. Although the idea of training came from the LCDP team, the participants responded very positively to the training, and attendance at courses was consistent once the imagination had been captured. It is difficult for businesses to demand training if they do not know how they could benefit from it. Table 6.16 shows the total cost to the LCDP of undertaking the business training was $12,360, which works out at $589 per company. Financial viability of this business development from fees paid by these enterprises is highly unlikely. The contractors paid a $20 fee for the courses, ie less than 3.4% of the cost. This fee was far less than commercial organisations charge for such training ($1110 trainer fee for a three day financial management training course[42]), but was considered by the LCDP to be an acceptable fee for the MSEs, and able to provide an expression of demand. For most of the artisans, a fee of $20 would not be affordable. Other business development organisations in Uganda subsidise business training. In one case, officially, 50% of the fees are paid for by the support organisation and 50% by the participants. In reality, the participants do not pay, and the courses are fully subsidised.

Table 6.16: Direct cost of Business Training

Item	Unit	Quantity	Rate ($)	Amount ($)
Baseline study	days	10	140	1400
SWOT Analysis	days	12	140	1680
Team Discussions	days	10	140	1400
Preparation	days	5	140	700
Training Needs Assessment I	days	2	140	280
In house training of two companies in Aug. 2000	days	15	140	1680
Training Needs Assessment II	days	10	140	1400
Facilities and materials for 5 day course in Nov. 2000		1	1360	1360
Trainers for Nov. 2000	days	7	140	980
Facilities and materials for 5 day course in Feb. 2001		1	500	500
Trainers for Feb. 2000	days	7	140	980
Total				12,360

Although the cost of the training is high, such activities, if done well have considerable potential to benefit the companies as illustrated by the response of the participants. The issue which is of concern is rather a question of whether such ventures

[42] Low Cost Drilling Project Expenditure Breakdown

should continue to be donor supported or self sufficient - a political issue for the donor community.

The training resulted in the setting up of AWASCO, illustrating the value to the sector in bringing the contractors together. They found that they faced similar problems, including all facing competition from rogue contractors who tender for jobs but are not technically competent to undertake them. Perhaps this association can enable the contractors to form a stronger lobby which can try to take on some of their concerns with the Government, including the risk of drilling dry wells. Although such action is dependent on the contractors themselves, the business training at least provided a starting point.

When considering these enterprises, it is questionable whether the purpose of these businesses in Uganda is to serve and provide for the family, or to grow in size and turnover. It was unclear if businesses really wanted to improve in terms of growth, or were comfortable with the status quo. In some cases, the business training may have been attempting to inject western values into Ugandan business. Notwithstanding this, if Ugandan businesses are to survive and grow they require business skills, and the research indicated that companies were excited by the new knowledge offered by the business training, and were attempting to make improvements. In order to understand the impact of such training, longer term follow-up is needed, in an atmosphere of trust between the researcher and researched.

Business development provides no guarantees that an enterprise will grow or become more profitable. One must question the value of training if companies do not have market access, suitable technologies and access to finance. A case in point is provided by an example from another training programme: *"having had [the artisans] trained, the project had not freed them to engage in private work. As a result [they] have not been able to market themselves and find contract work"* (Rwamwanja, 1999b).

Ironically, the sole technology adopter did not attend any of the formal business training. *"[They are]...going places by hook or by crook, but there is no...business school approach....if you were to look at a similar business in this area it would be equally true. The ducking and diving of little civil contractor would be equally structured in the UK... Out of every one of these ducking and diving contractors you get the odd creation of George Wimpey"* (Comment 6.47).

6.7 CONCLUSIONS

The key issues which the research identified as capable of affecting sustainable technology uptake are summarised in Figure 6.9. The issues are wide ranging in scope.

Four of the principles developed in chapter 3 (Table 3.1) relate to the findings presented in this chapter as follows:

Private Sector

Principle 2: *An analysis of the strengths, weaknesses and dynamics of the potential private sector technology operators must be undertaken to understand (a) target markets and (b) bottlenecks, and (c) determine requisite training and support and (d) an effective regulatory framework.*

Access to public funded markets for rural domestic water supplies depends on the ability of enterprises to navigate the Government tendering process. This requires not only the submission of adequate tender documents but also the use of appropriate networks, the steerage through corruption and sufficient finance. These market access requirements pose potential bottlenecks to the uptake of the Pounder technology in Uganda.

Private enterprises in the water and sanitation sector have been found to have a wide range of business management skills and training needs. If deployment of the new technology is to provide a multitude of private enterprises with profitable business opportuntites, further skills need to be developed and training needs must be met. Although some enterprises are likely to continue to flourish without such training and support many companies are likely to struggle to compete for want of skills such as costing and pricing. Ongoing support in business development has the potential to contribute to the enhancement of the private water and sanitation sector as a whole. However, such training and support requires considerable resource inputs.
An extremely challenging aspect of the *private sector* principle to address is that of effective regulatory frameworks. Lack of regulation threatens to undermine the technology uptake as it leaves the door open for poor quality construction. Formal regulation of the rural Ugandan water sector had significant weaknesses at the time of the LCDP. Knowledge about how informal mechnisms currently provide quality

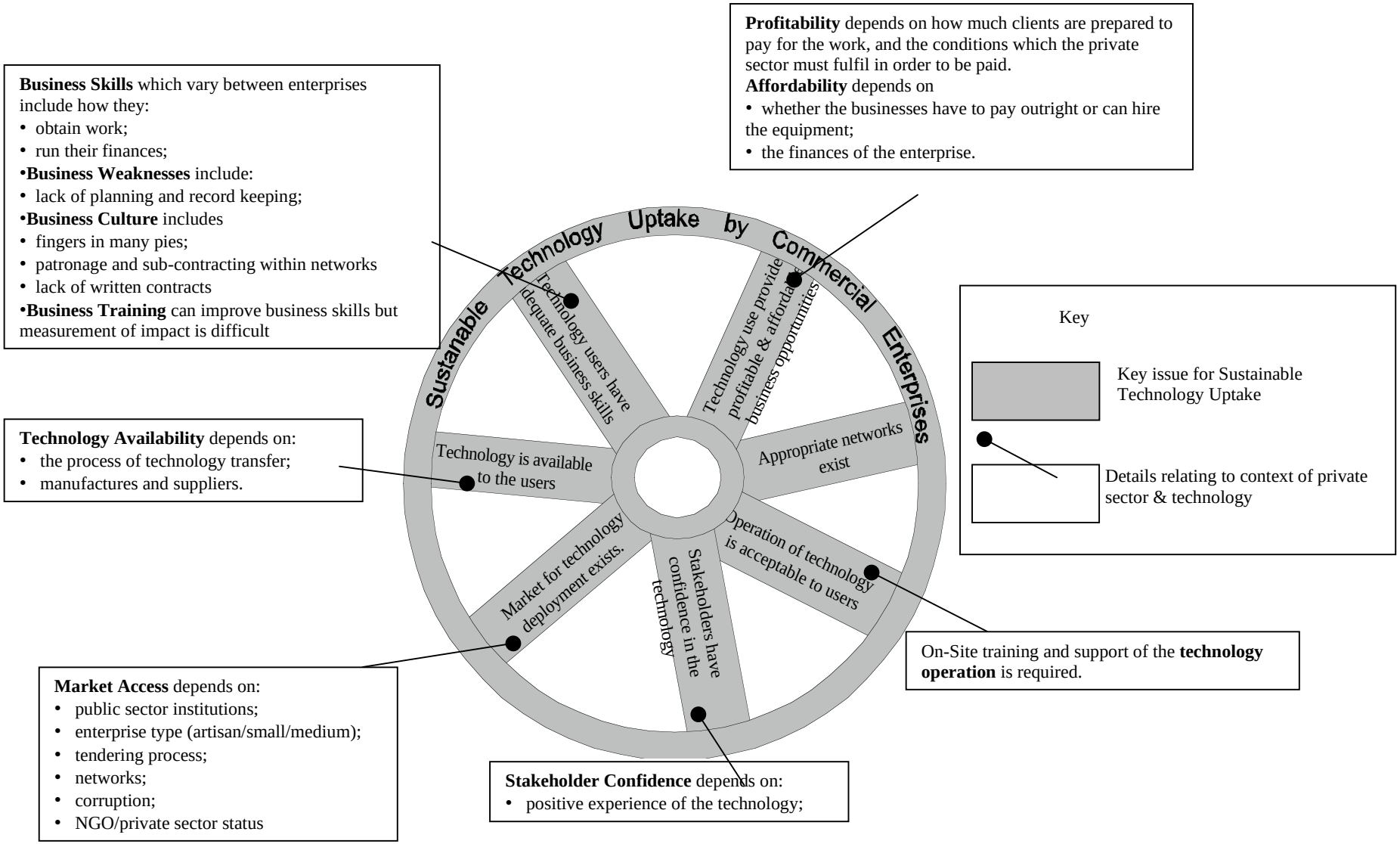

Figure 6.9: Summary of Key Issues for Sustainable Technology Uptake

assurance is lacking. Further research is much needed in order to investiage, develop and test formal and informal regulatary mechanisms for the the sector for their viability

Operation

Principle 8: *The users of the technology must be able to acquire the skills and organisation required for operation of the technology.*

The technical operation of the Pounder technology was found to be acceptable to the operators. Although the Pounder rig can be operated by semi-skilled labour, on site training and support is required in order to provide the necessary technical skills. Thus, widespread technology uptake is unlikely without some form of ongoing training and support. The wording *"must be able to acquire"* is particularly important for the onus can be on the user or a support agency. If no further funding can be obtained for the LCDP, this principle cannot be met. However, if a longer term view of the technology uptake and support can be taken, which includes resources for the longer term, this principle can be met.

Affordability

Principle 14: *The capital and running costs of the technology must be within the means of the potential operators and clients.*

The capital cost of the current design of the Pounder technology is outwith the means of all but a minority of enterprises if they are expected to purchase the equipment outright. However, when a longer term view is taken (ie two or more years), and hire or hire purchase options are considered, the Pounder rig is affordable for some of the enterprises currently operating within the water supply sector. If the commercial technology deployment is to be brought within the means of artisans, provisions must be made to ensure that the pump and well consumables are paid for by the public sector. Artisans do not have the requisite cash flow for the running costs of these components. However, many of the larger enterprises can afford the running costs.

The abilty of the new technology to provide a profitable and affordable business is paramount for its uptake. However, the scope of technical capability of the Pounder rig coupled with current payment conditions within the public sector and the way in which siting is conceptualised render the uptake of the technology a risky venture for private enterprise. Risk is discussed further in chapter 8.

Availability

Principle 11: *Any supporting materials or consumables required to operate the technology package must be available.*

This principle is fundamental to the technology uptake. Despite its obviousness, the LCDP did not manage to achieve it. Availability should have been either addressed fully from the early stages of the LCDP or in follow-on work. Lack of availability of the Pounder rig spares has aborted any further organic uptake of the technology.

Technology Tranfer for Development

As indicated at the start of this chapter (Rogerson, 2001), the Ugandan private sector faces a diverse array of constraints. The uptake of the new technology could provide additional opportunities for small and medium Ugandan enterprises. The new technology increases breadth of ground conditions which can be tackled using shallow well drilling technology. However, there are many contextual constraints which still need to be addressed in order to turn the potential of the technology providing a profitable business into a reality.

The research has also revealed some insights into the business culture and constraints faced by water sector enterprises. Building on these findings will help the development of additional mechanisms which can enable Ugandan private enterprise to reach its potential.

7 Public Sector Analysis

This chapter provides the reader with insights into the environment of the Ugandan public sector organisations responsible for the provision of rural, domestic water supplies through public-private-partnerships. It analyses the Sub-County and District Government influence on early technology adoption and determines the impact of this on sustainable uptake.

7.1 INTRODUCTION

The Government of Uganda (GoU) is committed to both poverty alleviation, including the improvement of rural domestic water supplies, and public sector reform which includes decentralisation and privatisation. Five distinct types of public sector organisations are involved in facilitating the provision of water services to rural communities in Uganda. **Error! Reference source not found.** shows the organisations involved and the flow of funding for the public-funded rural domestic water sector.

In 1996, the private sector started to undertake water source construction activities in a small number of Districts. Most of the finance originates from International Finance Institutions, bilateral donors and, more recently, the Highly Indebted Poor Country (HIPC) funds. Although contributions from the tax payer comprise a small percentage of the total, they play an important role in the process, particularly at Sub-County level. Most of the funding to the sector flows down through central Government to District Government, which liaises with the private sector.

The early adoption of the Pounder technology by private contractors for use in the public-funded market was affected by the policies, attitudes and behaviour of the public sector organisations shown in **Error! Reference source not found.**. The following organisations were researched:

- Directorate of Water Development (DWD) in Kampala;
- the Water, Health and Community Development offices of Mpigi and Mukono District Government; and
- several Sub-County Councils within the above districts.

DWD and Mpigi District were partners in the Low Cost Drilling Project (LCDP) from year one while Mukono District were drawn in at the start of the third year. The introduction of the technology to Government and subsequent collaboration enabled the

researchers to observe these organisations and develop an understanding of their world, including their skills, attitudes and behaviour and draw out implications for sustainable technology uptake.

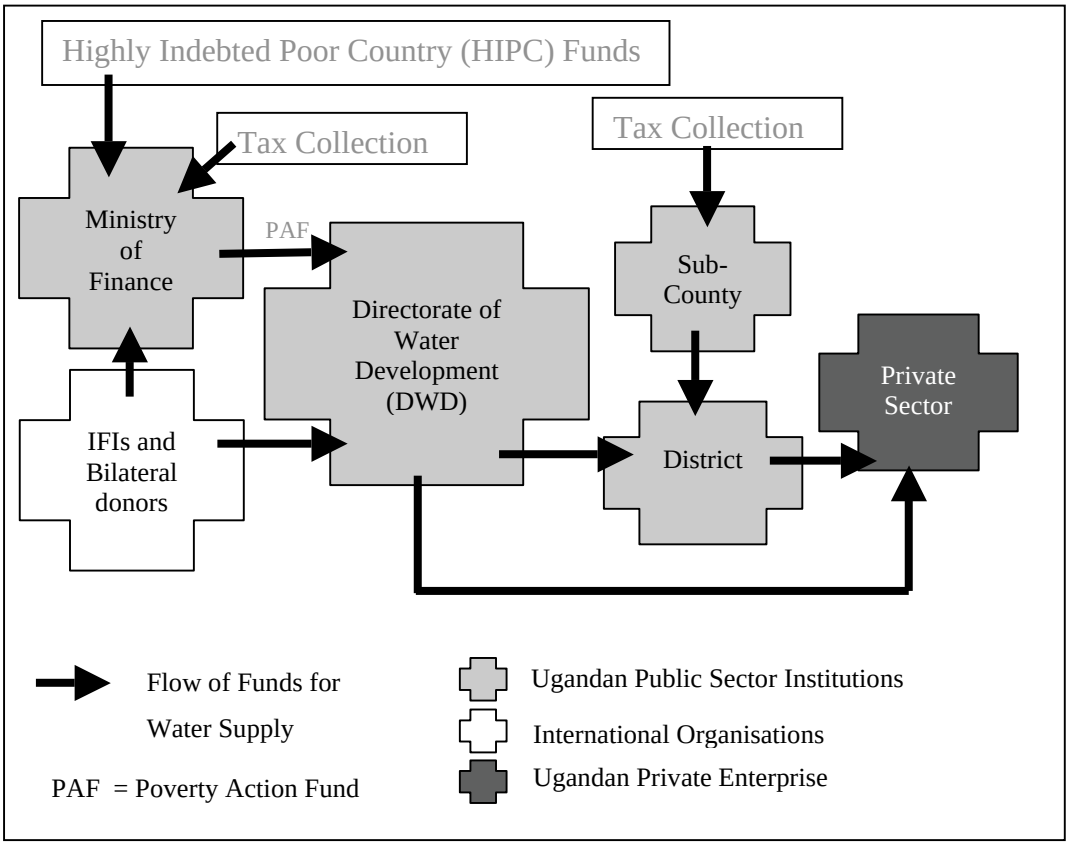

Figure 7.1: Rural Domestic Water Supply in Uganda - Organisations and Funding

This chapter analyses the role of the public sector, in particular Sub-County and District Government, as facilitators of water source construction activities and their role in the provision of a market for the technology.

7.2 INFORMATION SOURCES

Participant observation was undertaken while liaising with the public sector organisations in order to plan, facilitate and observe Pounder Well drilling and contract management. Semi-structured interviews with civil servants, politicians and contractors were also held. In total 84 individuals, working for public sector institutions were consulted during the research period. The type of contact is summarised in Table 7.1. In order to preserve confidentiality, no individuals have been named.

Table 7.1: Summary of Type of Contact with the Public Sector in Uganda

Institution (No of Individuals)	Contact Period	Description of Contact
Ministry of Finance (2)	July 1999 - Sept 1999	Semi-structured interviews; informal discussions.
Directorate of Water Development (18)	Nov 1998 - June 2001	Participant observation in planning and debriefing meetings and workshops; group discussions; informal discussions, semi-structured interviews.
Mpigi District Council (7)	Nov 1998 - June 2001	Participant observation in planning and debriefing meetings, workshops and field visita; group discussions; informal discussions, semi-structured interviews.
Sub-Counties in Mpigi (12)	June 1999 - June 2001	Participant observation in planning and debriefing meetings, workshops and field visits; group discussions; informal discussions, semi-structured interviews.
Mukono District Council (8)	July 2000 - June 2001	Participant observation in planning and debriefing meetings and field visits; group discussions; informal discussions, semi-structured interviews.
Sub-Counties in Mukono (4)	Sept. 2000 - June 2001	Participant observation in planning and debriefing meetings and field visits; group discussions; informal discussions, semi-structured interviews.
Luwero District Council (4)	Jan 1999 - Feb 1999	Semi Structured interviews; focus group discussions.
Sub-Counties in Luwero (3)	Jan 1999 - Feb 1999	Semi Structured interviews; focus group discussions.
Kampala District (4)	Jan 1999 - Feb 1999	Semi Structured interviews; focus group discussions.
Sub-Counties in Kampala (3)	Jan 1999 - Feb 1999	Semi Structured interviews; focus group discussions.
RUWASA (8)	Jan 1999 - July 1999	Semi Structured interviews; focus group discussions.
United Nations International Children's Fund (UNICEF) (3)	Nov 1998 - June 2001	Participant observation in planning and debriefing meetings and workshops; group discussions; informal discussions.
Danish International Development Assistance (DANIDA) in Uganda (3)	March 1999 - June 2001	Participant observation in planning and debriefing meetings and workshops; group discussions; informal discussions.
Department for International Development (DFID) in Uganda (5)	March 2000 - June 2001	Semi-structured interviews and group discussions.

7.3 ANALYSIS OF THE RURAL WATER SUPPLY CONTEXT

7.3.1 Demand for the Technology

The Ugandan National Water Policy (GoU, 1999a), Government practice and the commercial involvement of Government employees in the water sector provided considerable demand for the Pounder technology as outlined below.

The National Water Policy (GoU, 1999a) states that *"...appropriate low-cost technologies should be selected, offering good possibilities for community participation in decision making and in physical implementation*" and that "*for rural and sparsely populated peri-urban communities, preference should be given to point sources".* The high demand for reliable water sources, including shallow wells, largely from Districts on behalf of the end users, was considered to provide a considerable opportunity for the new technology by DWD (2001c; 1999b).

The fact that Ugandan civil servants were not paid a living wage (eg $25/month for a Sub-County Health Assistant; $66/month for Senior District Staff) coupled with previous retrenchment and more planned for the future, meant that they had to find ways of supplementing their income. Many senior DWD and District staff also have their own companies. It was found that the activities which these enterprises undertook included water supply construction, groundwater investigation, building construction, supply of materials to the water and sanitation and construction sectors and hardware supplies.

Given the links between Government and businesses, it was sometimes difficult to distinguish business interest in the new technology from that due to their role in Government. Individuals expressed an interest in the technology from the Government perspective but the business interest of individuals contributed to its appeal. *"Along the way I am concerned about the financial gain, especially [to] the private sector ... I thought [that] I, among others could have some equipment to construct shallow wells, privately"* (Comment 7.1). In fact, several Government contacts were initially made by the research team through commercial enterprises. *"I came on board when you had actually contacted [my company] ... I was really looking at ... my involvement as being important for further utilisation of the technology. I knew that what I was doing ... was not just to be thrown out. The company can use it"* (Comment 7.2).

One contractor (Comment 7.17) was reluctant to try and deploy the Pounder technology as it had not been specified as an approved technology by Government. A concern about uncertainty with respect to Government acceptance was also raised by the Pounder Rig Adopter. Although the National Water Policy (GoU, 1999a) states a preference for appropriate technologies which provide point sources, public funds are spent from budget lines which specify the technology to be deployed. The shallow

groundwater technologies currently included are hand augered, hand dug and motor drilled wells. As District Governments vary in how flexible they are with respect to following these line items (see 7.5.3), the development of a market for the Pounder Technology requires it to be included as a budgetary line item. This would demonstrate institutional demand for the technology by the public sector.

7.3.2 Responsibilities and Control

Water supply for approximately 89% of the population of Uganda is the responsibility of the rural sub-sector of DWD. DWD, under the Ministry of Lands, Water and Environment is mandated with resource management, co-ordination and regulation of water resources as well as overseeing their development and exploitation. As well as the Central Government Line Ministries, the Ugandan Government also comprises Local Councils (LCs) which form a hierarchical structure that stretches from village to District level as shown in Box 4.1.

According to the policy of a demand driven approach, District plans for water and sanitation services are derived from Sub-County plans. However, DWD and the Ministry of Finance, in collaboration with the donors are responsible for budgeting. Rwamwanja (1999a) found that District plans were considerably influenced by the allocation of funds from Central Government, and found no evidence of Sub-County plans being derived from village plans.

The conditions under which these funds are to be spent also flow from central Government to the Districts (**Error! Reference source not found.**). Thus, although the rural water supply facilitation is co-ordinated by the District Water Office, they are mandated to undertake this according to the rules set from higher levels of Government and the donors.

During the LCDP duration, contractors operating in rural water source construction were only paid for successful wells (Mukono, 2000a; personal communication[43]; Mpigi, 2000). The amount paid was a fixed quantity, which was set by central Government in 2001/2. Although DWD were providing more flexibility to Districts with respect to pricing in FY 2001/2, failed wells were still not paid for.

[43] Personal Communication during a focus group discussion with District Staff and DWD Gravity supply team on 4th July 2000.

7.3.3 Finance

After little investment in the water sector in the 1970s, the main aim of work in the 80s was to restore facilities to the standards of the early 1970s. The mid 80s saw an average investment of $14 m per annum, of which 25% was designated for rural areas (GoU, 1990). Of the total investment, only 5% was provided from Government sources (GoU, 1990). Since 1990, rural water and sanitation sector activities have been primarily in the form of Donor-funded projects, with limited counterpart funding from the Government. The Danish International Development Agency (DANIDA), UNICEF, with Swedish International Development Agency (SIDA), the Japan International Co-operation Agency (JICA) and the European Union have been the main donors.

Table 7.2 shows the budgets for rural water and sanitation from the mid 1980s to 2002. The inconsistencies found between GoU documents have been included. Table 7.2 illustrates an increase in spending from the mid 1980s to 2001 as well as a high dependency on donor funds. The high budget for 2001/2 is due to the overlap between the last phases of the Ruwasa and WES funding overlapping with the phasing in of the Conditional Grants.

Table 7.2: Budget Allocations for Rural Water and Sanitation in Uganda

Financial Year	Budget ($m)				Percentage of Total		
	GoU	Donor	CG [a]	Total	GoU	Donor	CG[a]
Mid 1980's Average[b]	0.7	13.3	0	14.0	5	95	
1997/98[c]	2.5	18.4	0	20.9	12	88	
1997/98[d]	2.4	16.7	0	19.1	13	87	
1998/99[c]	7.3	31.8	0	39.1	19	81	
1998/99[d]	7.0	23.2	0	30.2	23	77	
1999/2000[d]	5.6	24.2	0	29.8	19	81	
2000/01[d]	2.7	28.2	14.4	45.3	6	62	34
2001/02[d]	2.1	16.8	15.2	34.1	6	49	45

[a] Poverty Action Fund (PAF) Conditional Grants (described in 4.5.1)
[b] Government of Uganda, 1990
[c] Boumokama, 1998
[d] MoFPED, 1999

The potential implications of the increased funding on the provision of a market for the new technology are disputed. It has been suggested that this provides an opportunity, as there is more money to be spent (DWD, 2001f). On the other hand, this increase may marginalise shallow well drilling in favour of techniques which enable money to be spent more quickly (DANIDA, 2001a). Funds for the rural water sector have been consistently under-spent, for example, only 50% of the budget was spent in FY 1997/98 (MoFPED, 1999) and 81% in 1998/99 (MoFPED, 2000).

Table 7.2 also shows that the proportion of funding for rural water and sanitation activities provided by the donors has consistently been much higher than that of Government. As a result, the donors have been able to exert considerable influence on the way in which the sector was run as echoed by DWD (2001b) *" Because water supply is so donor driven here that we need to get them convinced about some of these things early".* DWD has also been criticised for failing to communicate its requirements to the donors (Danida, 2001a).

The information which Table 7.2 does not reveal is the way in which the budget is to be spent. The donors emphasise expenditure on water source construction rather than training or support. This has implications for the provision of a market for the new technology as training and support of District supervisory staff would be required, yet current funding for this is inadequate.

7.3.4 Changing Policies, Roles and Finance

Due to alterations in Government policy and funding mechanisms in domestic rural water supply, the roles of the Government institutions involved were in a state of transition before and during the research period with more changes planned in the future. The changes included:

- privatisation, ie private sector undertaking service provision rather than Government direct labour;
- further decentralisation;
- a national approach to rural water supply rather than several projects and
- increased public-funding through HIPC funds.

Decentralisation and privatisation meant that central Government were no longer directly implementing watsan activities. Rather they were *"... responsible for policy formulation and creation of an enabling environment, while implementation and operation of water and sanitation facilities are the responsibilities of local Governments, communities and the private sector"* (MoFPED, 1999). In line with decentralisation, both WES and Ruwasa had phased in a decentralised approach to their activities prior to 1998. In line with the privatisation policy, the utilisation of the private sector was phased in under Ruwasa in 1996 and WES in 2000.

Prior to Financial Year (FY) 2000/1, GoU rural water supply activities were undertaken on a project basis with Ruwasa and WES comprising the most recent rural

community water supply projects. However, during the research period, the separate projects were being phased out and a single integrated approach, the Sector-Wide Approach was introduced with one common framework based on decentralisation, privatisation, response to demand and community participation (GoU, 1999d).

The new Sector-Wide Approach was a radical change for the rural water sub-sector and included the allocation of funds directly to the Districts from June 2000. 15 Districts were brought on board in the first year, another 15 planned for FY 2001/2 and the remainder in the following year. Initially, the funds were allocated through the Conditional Grants (described in 4.5.1) although this was viewed as a temporary measure until all the funds could be channelled through a consolidated fund. The channelling of local and external revenue through one consolidated fund was considered part of the Sector-Wide Approach. As confidence in this approach grew, it was the desire of Government that few external support agencies would by-pass this agreement when providing assistance to the rural sub-sector.

More changes to the public water sector were also being brought in at the end of the research duration. The Government was setting up five "*Technical Support Units (TSUs) in Uganda to provide assistance to District Government and approve budgets and work-plans on behalf of the Ministry of Finance"* (Danida, 2001a). However, the TSUs were considered as temporary, suggesting that the sector will undergo further changes in the future. Further retrenchment of DWD technical staff was also anticipated followed by a recruitment of social scientists (DWD, 2001f).

In addition, several districts were being sub-divided into two or three. When the research commenced in 1998, Uganda comprised 44 districts, which had risen to 58 by 2001. Both of the Districts partnering the LCDP were being split in 2001(Figure 4.1).

The changes taking place in the Ugandan water sector impacted upon the provision of a market for the technology deployment in a number of ways:

1. partners to the LCDP in DWD were distracted by other activities. *"The transition, of DWD ... affected the project. The research and the technology development became second priority"* (DWD, 2001c). The formation of the

TSUs meant that some staff were *"split between doing regular DWD work and the TSU"* (DANIDA, 2001a; observation[44]);

2. the individuals considered as key decision makers changed during the research: *"I think you need to involve very much the...overall TSU co-ordinator [now]* (DANIDA, 2001a);
3. the District which was new to privatisation was learning about the process in 2000 and thus found it difficult to include the new technology;
4. Districts were learning about the conditions and flexibility of the conditional grants;
5. there was uncertainty at the District with respect to future capacity and funding: *"[New staff] are being recruited on contracts [of two to three years]. People feel that donors will not give us more money [in the future]"* (Mpigi, 2001a).

7.4 THE SUB-COUNTIES

7.4.1 Monetary Contribution to Water Supply Infrastructure

Although Sub-Counties have a certain degree of autonomy, the procurement of goods and services exceeding $556[45] have to be channelled through the District Tender Board. This regulation generally frustrates the Sub-Counties as it creates an unwanted dependency on the Districts (Rwamwanja, 1999a). As the cost of spring protection and shallow wells is higher than this limit they are facilitated by the Districts. Although DWD (2000c) suggested that they wished to pass the facilitation of activities straight to the Sub-Counties, rather than the Districts, there was no evidence of this within the research duration.

Ruwasa phase II, WES and the Conditional Grants demanded that communities and/or Sub-Counties contributed to the capital cost of public-funded water sources and paid for their ongoing maintenance. In reality, sometimes the Sub-County would pay the community contribution (Mpigi, 2000d; Rwamwanja, 1999a; Rwamwanja & Carter, 2001). Ruwasa phase II demanded a community contribution of $100[46] for all hand

[44] Personal observation of the increased difficulty in co-ordinating with staff who started to undertake a role in the TSUs as well as that for DWD.

[45] 1m USh at 1800 USh = $1

[46] 180,000 USh at 1800 USh = $1

pump sources. WES initially demanded a contribution of locally available materials, and then switched over to a cash contribution of $83[47] for a hand augered well. The conditional grants, introduced in June 2000 demanded cash contributions of $56[48] from the Sub-County and $56 from the community. As a result of this increase compared to the WES contribution, at least one Sub-County, which had previously paid the required WES contribution to the District for ten augered wells was requested to raise more funds to qualify for sources under the new scheme (Mpigi, 2000e). This illustrates the difficulties for local Government in adjusting to policy changes.

Sub-County contributions are generally made out of their revenues from graduated tax, which is a tiered individual tax. 65% of this revenue was retained by the LC 3, 5% remitted to the LC 4, 5% distributed among the LC 2s and 25% distributed among the LC 1s (Government of Uganda, 1997). Urbanised Sub-Counties around Kampala may have incomes and budgets of more than $83,000[49] whereas an average Sub-County operates on $11,000[50] - $28,000 (Rwamwanja, 1999a).

Mpigi (2000f) stated that Sub-Counties had not applied for water sources due to the limited flow of graduated tax. Water source construction competes with primary education, health care, feeder roads and environmental protection for the revenues outlined above. Unless water source construction is a priority activity, only small contributions are made. Thus, the contribution system does not always run smoothly due to difficulties in accessing funds. Cases were observed in which District funds were available but Sub-County contributions were not forthcoming, thus preventing targets from being met and frustrating Districts (observation[51]). However, there were also cases where the reverse was true. Sub-County and community contributions were made for water sources but District funds were not forthcoming (Rwamwanja, 1999a).

The Districts were found to deal differently with respect to Sub-County contributions. One District was observed to insist on constructing only once the contribution had been made. However, faced with the possibility of seriously

[47] 150,000 USh at 1800 USh = $1 ;
[48] 100,000 USh at 1800 USh = $1
[49] 150,000,000 USh at 1800 USh = $1
[50] 20,000,000 USh at 1800 USh = $1
[51] Personal observation of District Government delaying activities due to lack of contributions from the Sub-county.

underachieving their targets they abandoned this rigidity and undertook construction anyway. Another District sought contributions following the construction activities.

7.4.2 Staff - Responsibilities, Knowledge, Skills and Involvement

Sub-County employees responsible for water and sanitation activities comprise Community Development Assistants and Health Assistants. They have been cited as being responsible for well siting in collaboration with the community (Rwamwanja & Carter, 2001; Rwamwanja, 2001b; observation[43]) and community sensitisation and mobilisation. Mukono District (2000a) were considering training these personnel to also undertake the supervision of construction work. In terms of involvement in Pounder Well construction or supervision, other than courtesy calls to the Sub-County headquarters, no Sub-County staff were involved during the Pounder well construction in Mukono. The experience in Mpigi varied, including a very active Health Assistant in one Sub-County who regularly visited the construction sites.

In terms of knowledge, Ssebalu (2000a) suggested that Sub-County staff sometimes do not know the difference between deep and shallow wells. Rwamwanja (1999a), found that Sub-Counties often lack basic information upon which to base planning decisions. On the other hand, group discussions with several Health Assistants in one District revealed individuals with considerable know-how with respect to shallow wells.

In terms of mobilisation and siting, one contractor (Comment 7.3) described a Sub-County which had left them to undertake the selection of the village, the community mobilisation and the siting. The research team also found site selection undertaken by Sub-County staff (observation[52]; Rwamwanja & Carter, 2001) and LCDP team members, and community mobilisation undertaken by District staff (observation[53]), Sub-County staff (Rwamwanja & Carter, 2001) as well as none undertaken at all. This illustrates the wide variation in knowledge at Sub-County level and also in mobilisation and siting practices.

One stakeholder explained that some Sub-Counties understood little of the Poverty Elimination Action Plan (PEAP), the Poverty Action Fund (PAF) and access to

[52] Site selection for trial Pounder Wells was undertaken by Sub-County Health Assistants in Mpigi.
[53] Mobilisation in Mukono District.

water through Government funding (Comment 7.4). Although the Conditional Grants came into effect in July 2000, preparation of the Sub-Counties did not commence until after October 2000 in Mpigi (Mpigi, 2000f). A budget of $1333[54] was available for this activity, less than the price paid for one shallow well. Such limited resources are unlikely to enable the knowledge base of the Sub-County staff to be improved.

7.4.3 Pounder Technology Experience

The actions taken at Sub-County level can affect community ownership of, and responsibility for a new water source as illustrated by Box 7.1.

> The elected LC 3 chairperson who was also the LC 1 chairperson in his village had promised improved water sources as part of his campaign for office. The Pounder Rig was taken to the village to be tested in laterite formation, and was successful. Although no community mobilisation had been undertaken, the site was completed and installed with a handpump. Upon seeing the success of the endeavour, the LCDP team and District were keen to repeat the success in this area. The LC 3 chairperson also saw this as an opportunity to fulfill his election promise. He used the 25% tax revenue from the LC 1 to pay the community contribution for the sources, which was in fact common practice in this Sub-County. Subsequently another 4 wells were drilled.
>
> However, the 25% had been used without consultation with the LC 1 commitee, who were not aware of the developments. There was no community mobilisation or participation up to the time the crew left the area. To the community, the chairperson was merely fulfilling his electoral promises. Of the five wells drilled, only one had a water source committee at the time of pump installation. Having completed well construction, it was an uphill task to form a sense of ownership by the community and institute a maintenance system (Rwamwanja & Carter, 2001).

Box 7.1: History of Pounder Wells

Although the actions undertaken by the Sub-County chairperson in Box 7.1 were in good faith for the community, this story provides an example of insufficient community involvement from the planning stage. It also illustrates that the monetary "community contribution" is no guarantee of community demand as it can be paid from community funds held by the Sub-County without community involvement.

Box 7.2 describes the experiences of two villages with improved water sources. Unlike Box 7.1, the communities expressed their interest to the Sub-County. In these cases, these were no contributions made by the Sub-County or community, but there remains a sense of responsibility for the maintenance. These histories illustrate two

[54] 2.4m USh at 1800 USh = $1

different types of LC 3 involvement in the construction of improved water sources, and two different outcomes.

> The villages of Lubiri and Namalesa in Jinja District had discussed the lack of safe water sources at their LC1 meetings. They communicated this to their respective LC3s, and following improvements to sanitation they qualified for the allocation of new water sources under the Ruwasa project. At this stage in the project, neither communities nor sub-counties were expected to pay any contribution. Although there is no maintenance fund, money is collected when there is a breakdown and the community contacts the pump mechanics (Rwamwanja & Carter, 2001).

Box 7.2: History of Water Sources in Jinja

Differences in the Sub-Counties exist:

- between districts: eg one has working hand-pump mechanics while another has not (Rwamwanja & Carter, 2001);
- within the same district: *"one Sub-County may be OK, while the next may not even seem to be in this District"* (Comment 7.5);

The LC 3 has an important role to play with respect to facilitating or inhibiting the construction of sustainable water sources. Consequently, it is a key player in developing a market for the new technology. If sources provided by the new technology are not maintained, it may be considered as a poor reflection of the water source construction method rather than due to the intricacies of Sub-County politics or skills.

Given the high profile which the sources of the early days of the technology transfer have, the skills and behaviour of the LC 3 need to be understood and appropriate collaborative mechanisms found or support measures taken. This relates to the technology transfer process, and is discussed further in chapter 9. However, for future sustainable community supplies, any support must not only be a short term solution, but leave the requisite skills, capacity and resources at Sub-County level.

7.5 THE DISTRICTS

The Districts researched for this thesis were Mukono and Mpigi (Figure 4.1), with which the research team collaborated in order to test the equipment and develop a market for it. In addition, the Pounder Rig Adopter secured work for the equipment with Jinja District. This section provides the reader with an understanding of the

District responsibilities and experience of the private sector and subsequently analyses the factors which influenced the early provision of a market for the technology.

7.5.1 Responsibilities

Ugandan District Government plays a key role in the facilitation of the public-funded local development process, including rural water supplies. Districts are responsible for facilitating community mobilisation, undertaking the construction work or contracting out and undertaking supervision.

Although the locally elected politicians, councils and committees have been officially given extended political powers to oversee the District civil service and guide the local development process, targets and budgets for water source construction are set by central Government. These targets are not being fulfilled. Of the 1183 shallow wells targeted nationally in financial year 1998/99, 210 were achieved, a shortfall of 82% (MoFPED, 2001). The WES third quarter budget for 2000/01 was under spent by an average of 42.5% (DWD, 2001e), illustrating the inconsistency between the centrally set targets and the implementation realities.

Lack of capacity at the District level coupled with the difficulties of raising District, Sub-County and Community contributions, as well as the problems associated with hand augering had inhibited water source construction activities in the districts. Many Districts in Uganda lacked the capacity to undertake the administrative work which was expected of them.

Some Districts had considerably more capacity than others, while some barely had functional District water offices (Obitre-Gama, 1999) and thus had little hope of meeting their targets. The research found considerable differences in the staffing of the Water, Health and Community Development offices between Mpigi and Mukono. The few active staff in Mpigi were extremely stretched, while there were considerably more active staff members in Mukono (observation & Comment 7.6). Observations of the Mpigi WES co-ordinator revealed a highly dedicated individual who had to run to keep still. Queues of individuals would line the corridor to his office, and he was continuously interrupted by telephone calls. Many meetings had to be delayed due to what he referred to as "hijacking", (ie someone catching him as he was leaving office), or cancelled due to the sudden demands of workshops, planning meetings or politicians. Discussions with DWD regarding other Districts included a statement that the Water

Officer in a particular District was very good, but had to work alone due lack of capacity of other staff members in the District (Comment 7.7).

In 2001, the District water offices were recruiting five junior staff each, who were expected to relieve the pressure on senior officers. In addition, the recent formation of regional Technical Support Units may provide more accessible support to the Districts than that which currently exists.

Comments and observations of DWD indicated that it was accepted that decentralisation was difficult for the Districts. One stakeholder (Comment 7.8) stated that the centralised system had caused these problems for the Districts, but that the Districts would have to learn the reality and difficulties of facilitating implementation. He added that he expected them to flounder in the first year of the conditional grants and thus learn for the future. Another stakeholder (Comment 7.9) remarked that decentralisation could not be done slowly otherwise central Government would tend to retain power.

Despite decentralisation, some District staff still felt at the mercy of the central Government and not free to take decisions. I was often requested to lobby to DWD on behalf of the Districts, for more equipment, additional funds and to raise awareness of difficulties.

7.5.2 Public Private Partnerships

Private sector water source construction was introduced under Ruwasa in 1996, under WES in 2000 and in the Conditional Grants in 2001. As a former Ruwasa District, Mukono had four years experience of contracting to the private sector, while Mpigi was just starting in the final year of this research. DWD provided the Districts new to privatisation with one day of training on the use of tender documents in 1999 (Snell, 1999c) followed by two days orientation in 2000 (DWD, 2000f). Familiarity with the tendering process, contractual agreements and supervision of commercial enterprises was thus in its infancy in Mpigi District.

Attitudes with respect to the private sector and the skills required varied between Districts. Mukono staff expressed an acceptance of privatisation, while Mpigi were still coming to terms with the changes. One District officer (Comment 7.18) explained that they had been doing very well with direct labour and that they needed help in getting through the transitional period to privatisation. DWD (2000g) described one District

which was facing problems understanding the bill of quantities on the contract agreement while one District (observation[55]) lacked an understanding of the implications of VAT registration for payment.

The District Tender Boards were responsible for the procurement of goods and services required by the Districts. They were criticised for sharing work out amongst the councillors rather than evaluating tenders (Danida, 2000c) and for the fact that the board could be dissolved by the District chairperson at any time, leading to huge delays in the tendering process (Danida, 2000b).

Although many companies were tendering for water source construction work to the Districts**,** (eg 37 to Mpigi in 2000 (Mpigi, 2000f)) there was a consensus that district based private companies in the field were few and that their skills varied widely (Mpigi, 2000g; Mukono, 2000c). However, DWD (2000h) took the line that it was necessary to firstly create a demand for private sector work in water supply by showing that work was available rather than firstly trying to build up the sector.

Despite the fact that the District owned equipment for the construction of water sources, and in many cases private companies did not, formal arrangements for the equipment hire to the private sector were not made. Discussions in Mpigi (2000h) revealed that the Water Office was against the idea of hiring out equipment, including the Pounder Rig, due to the difficulty of actually administering such an endeavour and the likely political interference. The latter was considered as a potential threat to continued employment. Although Danida (2000c) was not keen to see Districts hiring out equipment, DWD (2000d) staff wanted the equipment to be hired out to private contractors by the Districts. This is illustrative of the different opinions between the stakeholders with respect to the way in which equipment could be made available to private contractors.

Quality assurance is also a key issue in rural water source construction and is discussed in 8.3.2.

[55] Participant observation during discussions with District staff with respect to contract payment in July 2000.

7.5.3 Early Provision of Market for Technology Use

Table 7.3 sets out the differences between Mpigi, Mukono and Jinja with respect to the provision of a market for the new technology and the factors which appear to have influenced this.

Although Mpigi participated in the early days of the research during which the first rig was utilised under direct labour, they did not contract Pounder Wells out to the private sector. In fact, the rig lay unused in the District stores for 9 months. In contrast, following discussions with the LCDP team and DWD, Mukono reallocated five planned hand dug well sites for Pounder Wells. Four Pounder well sources were completed in FY 2000/1. However, the only District to continue to provide a market for the Pounder Wells after phase 1 of the LCDP finished in June 2001 was Jinja, where the Adopter had a firm base for obtaining contracts. Jinja District only had one meeting with the LCDP drilling consultant. Well drilling for Jinja District was not anticipated as this was outside the focus areas of the LCDP. This indicates the complex influence of social, economic and institutional factors on the provision of a market for the technology by District Government.

Despite the foundation built with Mpigi District during the test drilling, the stretched staff, the interpretation of the lack of flexibility of the funding conditions and dealing with the private sector in source construction for the first time proved to be obstacles which could not be fully overcome while carrying forward the new technology.

Although Mukono contracted out the private sector drilling of the Pounder Wells following the planning undertaken with the LCDP team, no further sites were contracted out following the completion of this work. It was found that Mukono District were under pressure from central Government to fulfil their targets, and the Pounder had not performed as quickly as they would have liked.

Jinja District continued to deploy the Pounder Rig. In order to observe what would happen in a District which had virtually no contact with the LCDP research team, I deliberately kept away from Jinja and tried to observe at a distance. However, this, coupled with the fact that I have not returned to Uganda since leaving in July 2001 has resulted in a lack of information regarding why this District continued to request for Pounder Wells, despite the fact that not all of the sources were successful.

However, Jinja is a very small District, in comparison to Mpigi and Mukono and thus easier to manage and access communities. The staff were also observed to be highly skilled and motivated (Ball, 2000). A further factor in the development of a market in Jinja, which may be key, was that the contractor introduced the technology to them rather than the LCDP team. Given the networks (discussed in chapter 6) which exist between the public and private sector, this method of introduction may provide a better entry point to District Government than by the external agents. This concurs with Rogers (1995) who cites change agent homophiliy with the target group and one to one communication as crucial factors for successful technology adoption.

Table 7.3: Experiences of Three Districts with Pounder Drilling from June 1999 to June 2001

Factor	Mpigi	Mukono	Jinja
Technology Deployment			
Rig prototype used [defined on pp X]	Pounder Rig I & II	Pounder Rig II	Pounder Rig II
Operator	Direct Labour	Commercial Enterprise	Commercial Enterprise
Successful Sources	5	2	2
Non- Successful (incl. Test) Sources	10	3	2
Relationship with LCDP team	Collaboration from June 1999.	Collaborated from October 2000.	No contact after brief meeting in Feb. 2000.
Size of District (km^2)	6,222*	14,242*	734*
Water Supply Projects			
WES	✓		
Ruwasa		✓	✓
District Development Grants	✓	✓	✓
Active Officers in Water Supply			
Water Officer	1	2	2
Health Inspector	1	1	Not Known
Community Development Officer	0	1	Not Known
First Private Sector Experience	June 2000	1996	1996
Shallow well technologies			
Hand Dug Wells	✓	✓	✓
Hand Augered Wells	✓	✗	
Motorized Drilling	✓		
Use of Conditional Grant for Pounder Wells	None	Substituted five out of 28 hand dug sites for Pounder sites.	Substituted hand dug sites for Pounder sites.
Attitude to substituting non-Pounder for Pounder sources under the Conditional Grant	Staff did not believe they had the mandate (C 7.10) Complex and difficult to manage (C 7.11) Fear of corruption allegations (C 7.12; C7.13) *"Conditional Grants have been signed. It is a long process to have them changed"* (C 7.14) Prefer to use conditional grant once rig performance is known (C 7.15). *"Our limitation was just [additional] fund."* (C 7.16)**;**	District had no problem to reallocate funds from hand dug to Pounder wells	
District, DWD & LCDP Discussions	District, DWD, LCDP; District, LCDP	District, DWD, LCDP; District, LCDP	One meeting between District & LCDP

* Rwabwoogo, 1997

7.6 CONCLUSIONS

Overall, the Pounder technology was considered desirable by individuals in private and public sector organisations. It also fits in with Government policy regarding appropriate technology. However, further confidence in the technology needs to be built in order to overcome concerns raised about shallow drilling and presented in Figure 5.7. McCormick (1999) advocates the underwriting of technology development as a suitable area to help technology clusters. The findings of this research suggest that further deployment of the technology with support mechanisms as well as feedback to the public and private sector could contribute to wider uptake of the technology.

Principle 7, regarding desirability (*"the technology must be desirable to the members of the social system in which it is to be operated*") fails to encapsulate the need for institutionalisation in the case of the Pounder technology in the Ugandan public-private sector context. In order to move from being desirable to being accepted and utilised by private enterprises, it needs to be institutionalised. This requires the endorsement of the technology by the organisations which control and run rural water provision in Uganda.

Principle 6 which relates to *culture* is particularly relevant to the *culture* of the water sector organisations: *"The technology must be fit for the culture in which it is to be utilised such that (a) it must not diminish the social status of the users; (b) the collective or individual use of the technology must be compatible with local culture; (c) it must not alter the power distribution, status and reward mechanisms in place".*

The Pounder rig does not diminish the social status of private sector organisations which are aspiring to move into shallow water well drilling from other hand operated water provision technologies, or indeed from other related activities such as construction. However, for those organisation which have set their eyes on deep drilling, the Pounder technology is unlikely to prove attractive.

The Pounder technology requires considerable unskilled labour input. Although this ties in neatly with the desire for community participation in water well construction, this requirement also creates barriers to the deployment of the technology when such participation is lacking. This issue is considered further in chapter 8.

The third aspect of the culture principle is highly contentious. Adoption of the technology may be greater if the existing power distribution, status and reward

mechanisms are not affected by the technology. However, if this is the case, the uptake of the technology, may exacerbate inequality within society and even increase poverty. Mainstream development thinking advocates the reduction of poverty. However, technology introduced as part of the development process does not always lead to this desired outcome.

The tendering process and capital requirements for public-funded rural water source provision in Uganda excludes most locally based artisans from taking on contracts directly from Government. Instead, they depend on small and medium enterprises which secure the contracts and pay the artisans minimum wages. Local artisans thus stand to benefit little from current privatisation strategies and funding increases in the sector in terms of remuneration. In the case of the Pounder technology, if it is primarily adopted by the well networked and financially secure enterprises, its transfer will do little to improve the wellbeing of the less skilled, less well networked and poorer enterprises and artisans.

8 Community Analysis

This chapter considers key issues at the interface between the community and the technology, local government and the private sector. These key issues affect the Pounder technology uptake and well sustainability.

8.1 INTRODUCTION

The purpose of the Low Cost Drilling Project (LCDP) was to develop and transfer new drilling technology which would provide low cost water wells for rural communities in Uganda. At the LCDP outset, the technology was considered to be the Pounder rig and the users were considered to be the private sector rig operators. The power to decide which technologies can be deployed and paid for from public funds is in the hands of the public sector. Thus, the research focused primarily on the private sector (rig operators) and public sector (well funders) stakeholder groups.

As the LCDP progressed, it became apparent that the rig could not be considered independently from the well (see chapter 5). The Pounder well became regarded as an integral part of the Pounder technology. In theory, the Pounder technology can be adopted by private enterprise and institutionalised by Government without taking community issues into account. However, it was observed that the events which take place (or are absent) at community level affect the likelihood of well completion and source longevity. As an analysis of the Pounder technology would not be complete without consideration of these issues, research into community issues also became an important aspect of the LCDP.

The limitations within the LCDP in terms of resource availability and the flexibility of their use meant that the amount of research undertaken into communities was less than for the other stakeholder groups. This explains the relatively short length of this chapter. Despite these resource constraints, the research and subsequent analysis provides key insights into the technology (rig *and* well) uptake.

This chapter draws on data from several tasks undertaken in central Uganda during the LCDP as shown in Table 8.1 as well as Government of Uganda policy and project documents. The tasks were undertaken by the LCDP team under my supervision. Most of the data was collected by the LCDP community development specialist.

Table 8.1: Research Tasks undertaken during the LCDP into Communities in Central Uganda

Task	Methodology	Informants	Date
to determine attitudes to different groundwater sources; to investigate interaction between civil society and the public sector. (Rwamwanja, 1999a)	literature review; interviews; focus group discussions.	key informants in Central Government, NGOs; in two sub-counties in each Mukono, Mpigi and Luwero Districts: • district water and health offices; • sub-county water and health staff; • sub-county leaders; • parish chiefs and councillors	Jan - Feb '99
to determine community knowledge and perceptions of shallow well technologies (Rwamwanja, 1999c)	focus group discussions; interviews	in 2 Sub-Counties in Mpigi District • 2 communities with shallow wells; • 2 communities without shallow wells • district water sector official; • sub-county health assistant	July - Aug '99
to gather the narrative histories of community water source improvements and investigate issues affecting the sustainability of shallow wells. (Rwamwanja, & Carter 2001)	focus group discussions; interviews	in Mpigi: • 5 communities with Pounder wells; • 5 communities with non-Pounder wells; • district drill crew in Mukono: • 2 communities with Pounder wells; • 2 communities with non-Pounder wells; in Jinja: • 2 communities with Pounder wells; • 2 communities with non-Pounder wells; in Mpigi, Jinja and Mukono: • district water and health offices; • sub-county water and health staff; • LCDP research team	Oct. '99 - Jun. '01
to obtain insights into community issues relating to technology uptake and sustainability (Ssebalu, 2001b; Rwamwanja, 2001b; Danert, 2001a; Ball, 2001)	observations and informal discussions during Pounder well drilling	in Mpigi, Jinja and Mukono: • drill crew members; • community members; • District health, water and mobilisation office staff;	Sept '99 - June '01
to obtain insights into community issues relating to technology uptake and sustainability (various field notes and transcribed interviews)	observations, informal discussions and semi-structured interviews during LCDP implementation	• DWD staff; • District staff involved in rural water supplies; • Sub-County staff and politicians; • commercial enterprises; • NGOs; • drill crew members.	June '99 - June '01

The insights presented in this chapter centre around community participation. Participation of the poor in development intervention is now part of mainstream development thinking, including rural water supply provision.

Community participation in infrastructure provision is considered as being able to contribute to an understanding of the context in order to steer development activities. It is believed that through participation greater results can be achieved at a reduced cost than non participative approaches. Participation in development intervention activities is also considered to be able to foster long term sustainability by developing a sense of local ownership. As community members are increasingly responsible for ongoing maintenance once a water source has been completed, this sense of ownership is important in order to facilitate source sustainability (refer to section 3.2.2 for literature review on participation).

Community participation is firmly embedded in Government of Uganda (GoU) policy (GoU, 1999a). Theoretically, community participation in water source construction in Uganda comprises the participation in the planning, decision making, implementation, operation and maintenance of new and rehabilitated water and sanitation facilities and a contribution towards the source construction costs (GoU, 1999b). Through the research undertaken within the LCDP, several difficulties in realising community participation were observed. These difficulties present barriers to the successful uptake of the technology.

This chapter provides several insights with respect to community participation, technology deployment and well longevity. These issues relate to the interface between communities and: (i) local Government; (ii) private contractors and (iii) the technology (rig and well) (Figure 8.1). Analysis of these issues is followed by a brief discussion on the relevant technology transfer principle developed in chapter 3 (risk).

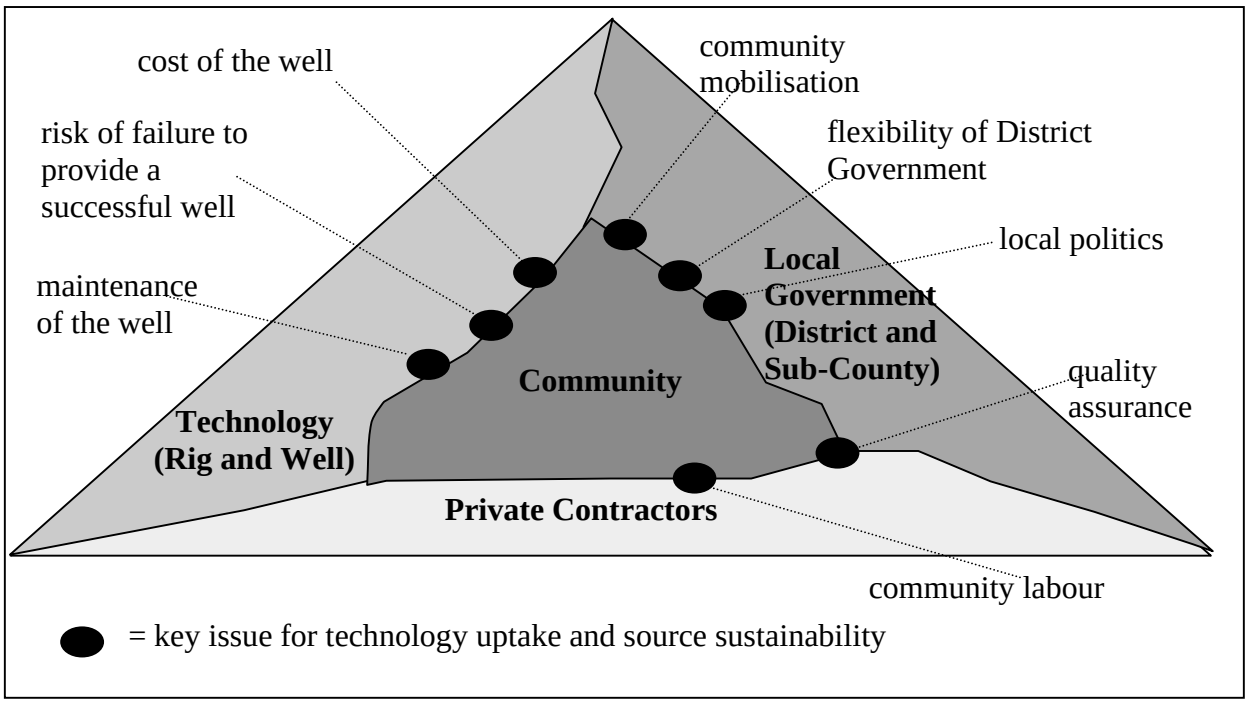

Figure 8.1: Key Community Related Issues for Successful Technology Uptake

8.2 COMMUNUIY – LOCAL GOVERNMENT INTERFACE

8.2.1 Community Mobilisation

The *"demand driven"* planning approach whereby households should be provided with services they want and for which they are willing to pay is becoming accepted in water supply and sanitation in many Third World countries (Whittington et al, 1998). The consensus agreed at Dublin in 1992 was that water should be seen as an economic good (Black, 1998). According to this principle, the need for improved water supplies *"should be expressed in terms of demand or willingness to pay"(*Black, 1998). The Ugandan Water Policy (GoU, 1999a) adheres to the principle of the *"provision of services through demand driven approaches in which users are fully involved and contribute to the cost of facilities and services to promote ownership and sustainability"*.

The ability of communities to demand for service improvements depends on their knowledge of the possibilities afforded to them and their awareness of how to express their demand. Traditional water sources in Uganda are often unprotected, comprising waterholes or ponds near swamps. The situation of lack of safe water, often at some distance from the home is one which communities live with and often come to accept (Rwamwanja and Carter, 2001). Thus, in order to support the demand driven

approach, resources are required to sensitise communities to the opportunities available to them for water source improvements.

District and Sub-County staff in Uganda have been trying to sensitise communities to water source improvement possibilities and how to demand them (GoU, 2001c). Katabi Sub-County in Mpigi District, for example, held meetings to educate communities about safe water and sanitation and raise awareness about opportunities for improvements. The meetings would culminate in community requests for improved water sources (Rwamwanja and Carter, 2001). This provides a successful working example of community sensitisation which results in community members expressing their demand.

The women in a community may be aware of a need for water source improvements. However, the men, elders and councillors may be the individuals who express demand beyond the community to local Government. Community demand for a particular type of water source improvement, eg spring, shallow well or deep borehole is influenced the exposure of community members to the different options and sensitisation activities. Communities without an improved water source expressed demand for a *"Naikondo"*, ie a well fitted with handpump (Rwamwanja, 1999b; Rwamwanja, 2001b). In general they were more aware of deep drilling than shallow drilling or hand digging (Rwamwanja, 1999b). Communities which had their own working shallow wells were generally satisfied with their facilities and were requesting more of these point sources (Rwamwanja, 1999b). Rwamwanja (1999b) found that the focus of promotional activities undertaken in Uganda for groundwater was on deep drilling. This, coupled with the above field observations suggests that communities do not prefer deep wells per se but are just more aware of them. The preference for deep wells by some Government officials (Table 5.1), may be driving the community preference for this technology. This indicates that in order to raise community demand for the Pounder technology, Government staff, in particular community mobilisers, need to be aware of the technology and believe in its suitability.

Sensitisation to different technologies is one aspect of community mobilisation in rural water supply. Mobilisation also includes the activities undertaken to ensure that

communities contribute in cash or kind towards the new water source (discussions[56]; GoU, 1999b), and the preparation of communities to maintain their water sources in the long term.

Adequate community mobilisation is crucial to provide a foundation for Pounder well (as with any other wells) sustainability. Insufficient mobilisation can result in lack of community ownership of the water source and thus lack of responsibility for ongoing maintenance. The narrative in Box 7.1 provides a prime example of a scenario in which there was inadequate mobilisation and thus no sense of community ownership.

Community mobilisation varies considerably in terms of whether it is undertaken, who does the work and how it is carried out (see 7.4.2). I have spoken with community members who believed that the well was being donated by the aspiring presidential candidate. In this particular case, mobilisation had been hurried. The community members in another village thought the public funded well was a private well which belonged to the landowner (Rwamwanja, 2001b).

At the other extreme, there are cases of mobilisation without follow-up in terms of resource provision. Communities, although mobilised and having expressed a demand to their local authority (including the payment of a community cash contribution) had yet to benefit from water source improvements (Rwamwanja & Carter, 2001; GoU, 2001a).

Community mobilisation prior to, during and after construction is affected by limited financial and human resources at local Government level[57], lack of knowledge within the public sector (Rwamwanja, 1999a) and pressure to meet construction targets rather than prepare communities[58].

The demand driven approach, where communities apply for water sources is an attempt to reduce mobilisation time (GoU, 2001c). Although this approach may overcome some of the resource constraints faced by Government, it is likely to favour known technologies, communities with better access to information about improvements and communities which are better networked over the less well informed

[56] Discussion with central and District Government about mobilisation activities.

[57] MWLE, (2001) stipulates that *"2% of the water grant should be used by the water office to enable it to effectively plan, supervise and monitor the ... activities, report and account for resources in a timely manner"*. 2% of a well price of $1667 is a mere $33.;

and isolated. Networks between stakeholders and obligation to local leaders affect decisions regarding the selection of communities for new water sources. The LCDP was requested to drill in the home village of politicians on various occasions.

8.2.2 Local Politics

In additions to the problems associated with inadequate mobilisation, local politics also affects community perceptions of their ownership of a new water source. Community members in two villages were observed[59] to perceive a connection between the Pounder well drilling and national politics. In both cases the drilling was taking place during the run up to presidential elections. Community members were observed to utilise the concept of this connection in order to try and undermine community participation in water source construction activities. In one case these allegations were successful and in another they were not.

Another political issue which can undermine community participation is the lack of trust by communities of local Government (Rwamwanja, 1999a). Rwamwanja, (1999a) attributes this to a lack of transparency and accountability of budgeting and expenditure and an increasing number of reported cases of financial mismanagement by Government.

The effects of local politics on access to water source improvements and community participation is an area which deserves further research.

8.2.3 Flexibility

Prior to 2000, Mpigi District had trained local private artisans in the construction of hand dug wells. Communities were able to deal directly with them in well construction, while the District would provide a pump (Rwamwanja, 1999a). It has been suggested that if community leaders were more aware of lower cost options, the Sub-County could part fund sources with some assistance from the Districts, such as through the supply of handpumps (Rwamwanja, 1999b).

However, current water sector public funding conditions (MWLE, 2001) do not allow for this. The contractor is only paid for a completed well, which includes the

[58] Mpigi District had a target of 183 sources to be constructed in 12 months (Mpigi, 2000i) while Mukono were expected to construct 90 (Mukono, 2000d).

[59] Personal observation during Pounder Well drilling in Jinja and Mukono Districts.

pump. This condition restricts the involvement of the private sector to enterprises which are better equipped to raise the requisite capital.

Although private sector participation in water and sanitation in Uganda is under way, little is known of village level artisans, water vendors and local traders (Rwamwanja, 1999a). Due to the conditions placed upon the release of public funds and the limited funds available at Sub-County and community level, the flexibility afforded to local artisans within communities regarding water source improvements is limited. This lack of flexibility limits the operators and the ways in which the Pounder technology can be deployed in public-funded programmes.

8.3 COMMUNITY-PRIVATE SECTOR INTERFACE

8.3.1 Community Labour

Section 5.2.1 discusses the perception among key stakeholders that insufficient community participation was a barrier to successful shallow well provision in Uganda. The provision of free community labour during water well construction is one component of community participation in rural water supply provision. Both Pounder and hand auger well construction require considerable unskilled labour input[60]. The research found that insufficient free community labour, coupled with the expectation by private enterprises that it should be provided, prevented the full deployment of the Pounder technology.

In general, the Pounder rig operator adopter would not persevere to drill a source to completion if the drill crew did not have the assistance of free community labour. The issue of free community labour provision consequently has major implications for successful technology uptake.

Under former WES and RUWASA projects[61], communities contributed towards water source construction in kind (materials, food and labour). Under the new strategy, communities are now expected to a pay cash contributions (GoU, 2001b). However, the strategy document (GoU, 2001b) does not specify if communities are still expected to

[60] For hand augering, community members sit on and turn the auger handles, while for Pounder drilling, they fetch water for drilling and aid with drill pipe reciprocation.

[61] Described in 4.5.

provide free labour or not. The public sector expectation of this is consequently unclear. Some local Government officials expect communities to provide labour and others do not (observation[62]; Rwamwanja, 2001b). However, the private sector still tends to expect a free community labour contribution. A consistent expectation for community labour provision between communities, contractors and local Government is much needed.

The willingness of community members to participate in the construction work for the Pounder wells varied. One community participated in construction and did not feel that the contractors had made any undue demands on them (Rwamwanja, 2001b). In another community, a gang of more than a dozen boys and teenagers congregated at the drilling site and formed a very effective team with high morale and no demands for payment (Ball, 2001b).

However, in one community, individuals were paid in order to keep up their morale of collecting water for the Pounder drilling (Rwamwanja, 2001b). $0.55 would be paid for seven 20 l jerry cans. Following the well completion, one community member was still demanding $2.61 for his services (Rwamwanja, 2001b). This community gave the impression that they were aware of a contractor obligation to pay for services and the community members were only willing to offer labour and services at a cost. In two other communities, the Pounder drilling was abandoned due to lack of community participation in construction (Okwi, 2002).

The provision of free community labour during construction may be instrumental in fostering community ownership, particularly in cases where Sub-Counties have paid the *"community"* cash contribution (7.4.1). The abandonment of a site for want of free labour may thus be considered as a method of not drilling where there is insufficient community interest. However, due to variation in mobilisation, community members are not always aware of what is expected of them in terms of their participation in construction. Construction work is not always planned around the community's ability to participate. Further, as communities become more aware that the profit making private enterprises are constructing their wells, they may start to resent the fact that contractors benefit financially from the community efforts.

[62] Discussion with officials from several Districts

In order to ensure that shallow well construction methods such as hand augering and Pounder drilling, which require considerable unskilled labour are not abandoned for want of free community labour, community members could be paid (as in the example described above). However, there is an inconsistency between the community paying a cash contribution, and subsequently being paid to construct their water source. There seems to be an inherent conflict between rural private sector water source construction and free community participation in construction. This conflict deserves urgent attention as it may undermine the realisation of the consensus built up over the past 20 years regarding community participation as a means of fostering ownership and source sustainability.

8.3.2 Construction Quality

Poorly constructed, low quality water sources place undue demands on community members in terms of maintenance and at worst can cause rejection of the facility. Even if the Pounder technology has the potential to provide low cost, improved water sources, the benefits to the community will be limited unless quality of the construction can be assured. The limited research undertaken suggests that quality assurance of private sector construction is problematic and requires considerable attention in order to improve the situation.

The quality of rural water source construction in Uganda prior to privatisation and the effects of privatisation on quality are not known. However, the LCDP observed poorly constructed works provided by private contractors being handed over to the community (Rwamwanja & Carter, 2001). One contractor moved on to a new site before developing the well into a clean water source (observation). One company (Ssebalu, Danert and Kakooza, 2000) stated that a District for whom they worked did not care about the state of works, as long as they were completed.

The RUWASA Technical Review (Government of Uganda, 2001c) states that the condition of sources may be poor: *"the review team only made a brief inspection of a few newly installed water and sanitation facilities. Although it is impossible to conclude much from the limited sample of installations visited, the findings were rather alarming"*. Given the fact that these facilities were *newly installed*, it is likely that they were poorly constructed when they were handed over to communities.

Local Government, particularly in the Districts most new to privatisation, is still learning about the private sector approach to rural water provision and quality related issues. Quality assurance requires supervision of the construction (in conjunction with appropriate sanctions and rewards). However, the research revealed that nepotism, corruption, lack of capacity and an emphasis on achieving target numbers of sources undermined supervision. These barriers are discussed below.

The company-government networks in Uganda, as discussed in chapter 6 affect supervision. One observer stated that as District staff have friends in the companies undertaking the construction work, they assume that there will be no problems with quality (Comment 8.1).

In terms of corruption, if a contractor is linked to a powerful politician, it can be very difficult for Government officials to apply sanctions. Where *"brown envelopes"* are passing from the private sector back to individuals in Government, it may not be in the interest of supervisors to report shoddy workmanship.

Insufficient financial resources and lack of public sector capacity in terms of staff and skills undermines supervision. Typical payments for the supervision of gravity schemes are 1.5% of the construction price (DWD, 2000i). UNICEF (2001) claimed that the Ministry of Finance would only pay up to 5% of the cost of works for supervision for rural water sources. Out of a $1667 well, this yields a sum of $83. If a well takes four days to construct this results in $20 per day, not allowing for transport costs. Given the low basic salaries afforded to civil servants, research is required in order to determine suitable remuneration for supervision.

In situations where supervisors of deep drilling were supposed to be on site full time, they would often be supervising 2-3 sites simultaneously, which was insufficient (Danida, 2000b). Given the large target number of sources to be constructed by District Government, it remains to be seen if staff will be able to keep up with the supervision of their construction.

Supervision and quality control could be undertaken at Sub-County rather than District level. Mukono District (2000a) were considering training Sub-County staff to supervise construction, while Mpigi have already undertaken some (Mpigi, 2000i). In one case, Sub-County staff were expected to undertake 3 days of supervision of water source construction for $3 (Mpigi, 2000i). This is an unrealistically low payment.

Another problem is that as long as the payment for the wells remains under District control, the Sub-County has no power to apply sanctions. Sub-Counties claim that if they were able to work independently then they would be more accountable to the communities than the Districts (Rwamwanja, 1999a).

Alternatively, supervision and quality control could be undertaken at community level. Mpigi (2000i) related experiences where supervision of latrine construction in a school was undertaken by parents and teachers. However, communities rarely have the know-how to determine whether poor quality materials are being used and, like the Sub-County currently have no power to apply sanctions to the private sector.

The pressure on Districts to achieve their targets rather than provide quality sources, is supported by the indicators which measure water and sanitation facilities which are based on their *existence* rather their *condition* (Rwamwanja, 1999a).

8.4 COMMUNITY-TECHNOLOGY INTERFACE

8.4.1 Cost

Community leaders wishing to develop new water supplies have been inhibited by the huge capital costs involved (Rwamwanja, 1999b). Rwamwanja (1999b) attributes this to the perception that deep drilling is the only possibility for water source improvements. However, the outright purchase of a completed well which has been constructed using existing shallow well technologies is also beyond most rural communities.

The amount which communities can and will pay for water source improvements in rural Uganda varies considerably. Many rural families rely on subsistence agriculture and have no monetary income while others earn very little. One informant (Comment 8.2) claims that communities generally expect water supplies to be improved by the Government free of charge, however this is not always the case.

As part of the *"demand driven"* approach, communities are expected to contribute towards the capital cost of public funded improved water sources. In the case of shallow wells, this contribution is currently \$56[63] (6.25% of the capital cost as paid to a contractor). The contribution for deep wells is currently the same amount, although

[63] 100,000 USh at 1800 USh = \$1

the capital costs range from $7,000 to $10,000. Consequently, communities and Sub-Counties are not able to experience the difference in capital cost between deep and shallow wells and there are no cost incentives to bias them in favour of shallow wells.

Some communities have paid their *"community contribution"* towards water source improvements from their tax remittance. However, the 25% tax remitted to the community from the Sub-County can range from as little as $27[64] per financial year in relatively poor, sparsely populated areas to $333[65] in richer, peri urban Sub-Counties (Rwamwanja, 1999a). In comparison, a Pounder or hand augered well costs over $1300 (Table 6.5). The total annual tax remittance could only cover a fraction of this figure.

Some communities have raised their contribution for improved water supplies independently from their tax remittance. In one community, $0.27[66] per household collected for water source improvements (Rwamwanja & Carter), and another collected $2.70[67] per household (Ssebalu, 2001b). In one village, some relatively well off individuals offered to pay the entire community contribution ($100) but the village leaders refused to accept this for fear of repercussions if the well was not forthcoming (Ssebalu, 2001b).

The initial vision of the LCDP was for the full cost of a completed Pounder well to be financially viable for communities. The concept was that the community would be able to link directly to the contractor. However, due to the difficult hydrogeology, handpump standardisation and Pounder rig design (as discussed in chapter 5), and poverty in the community, it was soon realised by the LCDP team that this vision would not be fulfilled. The Pounder technology as it currently stands thus does not provide a water source which communities can readily afford independent of donor, NGO or Government financial assistance.

Reducing the Pounder well costs to affordable levels would require limiting the technical capability of the equipment and using *very* low cost handpumps. If communities are to pay private enterprises in full for water source improvements then the application of *very* low cost technologies such as rainwater harvesting or Asian sludging of soft formations needs to be further researched, promoted and supported.

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[64] 50,000 USh at 1800 USh = $1
[65] 600,000 USh at 1800 USh = $1
[66] 500 USh at 1800 USh = $1
[67] 5000 USh at 1800 USh = $1

8.4.2 Risk

The Pounder technology is able to penetrate ground which existing hand operated shallow well technologies cannot. However, the unpredictable hydrogeology of Uganda means that there is the risk that the Pounder technology will not provide a successful water source.

There may be cases in which the permeability of the formation is too low. At such sites the well may have to be abandoned completely or converted to a hand dug well. This shallow groundwater option is able to provide significantly more water storage than the Pounder well due to its much larger diameter (1m diameter provides 100 times as much storage volume as a 100 mm diameter well). This provides a strong argument for not considering the Pounder technology in isolation from other water supply improvement technologies.

In other situations, the Pounder rig will not be able to penetrate the formation and the site will be abandoned. If the contractor and community are willing to make subsequent attempts, drilling will recommence at another location within the community. The number of drilling attempts which can realistically be undertaken in a community will depend on contractor and community morale.

In well mobilised communities, as soon as the construction work commences, community expectation rises. In order to keep up morale and avoid disappointment, particularly given community participation(in the form of payment or free labour), communities need to be well sensitised to the inherent risks associated with shallow well drilling operations.

If communities cannot be provided with alternative technologies when shallow well drilling fails and they are not adequately sensitised to the risks of drilling, mistrust of Government and development may grow, leading to an erosion of willingness to participate in future development efforts.

8.4.3 Maintenance

In terms of maintenance, the National Water Policy (GoU, 1999a) adheres to the principle of community management of services. The guiding principles for Ruwasa from June 1999 to Dec 2001 were that "*communities own and are responsible for operation, maintenance and repair of the sanitation and water facilities"* (GoU, 2001c).

The Community Based Maintenance Strategy (CBMS) intends that preventative maintenance and simple repairs are undertaken by the community while more difficult repairs are undertaken by trained hand pump mechanics. All repairs are to be paid for by the community and spares are to be purchased from local private dealers.

Ruwasa (2001) states that this operation and maintenance system has not been fully internalised in certain districts. One criticism was that the operation and maintenance criteria should be more clearly defined (Ruwasa, 2001). The LCDP research investigated shallow well maintenance of 18 sources in central Uganda. A range of maintenance practices was found, as presented in Table 8.2.

Rwamwanja and Carter (2001) express concerns over the lack of ongoing training for water source caretakers. However, it is not only lack of training which is an issue, but also lack of remuneration for trained hand pump mechanics. In one Sub-County, although two hand pump mechanics had been trained, they were no longer active as they were not paid a regular wage and could not make a living from preventative maintenance of handpumps. In this particular case the Sub-County Health Assistant had, to a certain extent, filled the gap left by the handpump mechanics. He would procure spares and undertake simple repair work for the community.

If water sources are not adequately maintained, the benefits of increasing the range of locations in which low cost water wells can be constructed will only be for the short to medium term. The research into Pounder well maintenance was taken at a maximum of 18 months after well completion, and in some cases after two months. This is still too early to draw firm conclusions about well longevity. Ruwasa (2001) recognised that it is necessary to undertake a national operation and maintenance study of rural water sources in Uganda. Such a study is fundamental in order to understand maintenance issues and thus develop workable (and testable) solutions to maintenance problems. If operation and maintenance of the Pounder well cannot be undertaken, the Pounder technology development, transfer and uptake will not serve the poor communities with improved water sources as envisaged by the LCDP.

	Access to skills and equipment				Access to spares		Funds		Structures	Maintenance		Key
	Community Caretakers[68]	Trained Pump Mechanics[69]	District Mechanics[70]	Sub-County Health Assistant[69]	Local private sector dealers	Local Government	Operation & Maintenance Account	Contribution after breakdown	Elected Water user Committee Established	Preventative	After breakdown	
Field Realities												
Mpigi District												✓ = yes
5 Non-Pounder Wells	×[71]	×	✓	✓	✓	×	×	✓	×	×	✓	× = no
5 Pounder Wells	×	×	*N/A*	✓	✓	×	×	*N/A*	×	×	×	*N/A* = *data not available*
Mukono District												
2 Non-Pounder Wells	×	✓	*N/A*	×	✓	×	✓	✓	✓	×	✓	
2 Pounder Wells	×	✓	*N/A*	×	✓	×	***planned***	*N/A*	✓	×	*N/A*	
Jinja District												
2 Non-Pounder Wells	×	✓	*N/A*	×	✓	×	×	✓	✓	×	✓	
1 Pounder Well	✓	✓	*N/A*	✓	*N/A*	*N/A*	×	✓	✓	*N/A*	*N/A*	
1 Pounder Well	***COMMUNITY CONSIDERS DISTRICT GOVERNMENT RESPONSIBLE FOR MAINTENANCE***								×	×	*N/A*	

Table 8.2: Community Based Maintenance - Observations from Three Districts, Uganda 1999 to 2001 (collated from Rwamwanja & Carter, 2001).

[68] for preventative maintenance
[69] for simple repairs
[70] for complicated repairs
[71] caretaker has skills but no tools for maintenance

8.5 CONCLUSIONS

The preceding discussion provides a number of insights into aspects of community participation in practice. The research found that in some cases, community participation was undermined by restraints on Government in terms of resources and flexibility as well as local politics.

The definition and practice of community participation varied between key stakeholders. This range of understanding of community participation echoes Chambers et al (2000) and Catley and Leyland (2001) (see 3.2.1). Definitions and expectation of community participation need to be clearly defined and agreed on by all stakeholders in order to provide support to technology deployment.

Adequate resources (human, financial and time) must be provided to enable key stakeholders to provide sufficient mobilisation to communities before, during and after their participation in water source improvement decision making, construction activities and maintenance. Community participation should cease to be considered as a cost saving exercise. The true cost of bringing about different types of community participation should be examined in detail in order to ensure that key stakeholders can demand adequate resources for the requisite activities. This, coupled with a clearer understanding of maintenance issues could contribute to improving source longevity.

The conflict between community participation and private sector participation in water source construction has not been adequately addressed. This tension would benefit from the clear articulation of detailed expectations of Government, private contractors and communities regarding community participation.

Principle 10: "*The risks associated with the utilisation of the technology package must be acceptable to the users"* is highly pertinent to all three stakeholder groups examined in this thesis. Given the nature of the hydrogeology, there is an inherent risk of the technology failing to provide a productive water source.

Currently, this risk is carried primarily by the private enterprise, who are currently not paid if the well fails. These shallow water well payment conditions (ie fixed price for successful water sources) are formed out of a requirement to avoid corruption in the public and private sector (ie contractors may claim for work not done). Thus, the culture of trying to find ways to mitigate the opportunity for corruption

clashes with the inherent risks associated with the Pounder technology. This clash has the potential to undermine successful technology adoption.

The risk of financial loss borne out by the private sector should not overshadow the risk that the community faces of working for nothing when it participates in shallow well construction. It is ironic, that the labour requirements of the Pounder technology, considered vital for a country with such underemployment, and key in providing the opportunity for community participation may also undermine the deployment of the Pounder technology through private sector participation.

9 Analysis of the Project Process

This chapter considers the technology development and transfer process of the Low Cost Drilling Project. Tensions between the desire for high quality technology and outputs on one hand and on the desire for participation on the other are illuminated.

9.1 INTRODUCTION

The preceding four chapters of this thesis consider the Pounder technology and the three stakeholder groups of private sector organisations, public sector organisations and communities. Through the analysis in these four chapters, issues pertaining to the stakeholders, the technology and its uptake have been identified. What has not been fully considered so far is how the Low Cost Drilling Project (LCDP) process affected the technology uptake. The emphasis of this chapter is on aspects of the *process* as opposed to the *outcomes*, the *'how'* rather than the *'what'*.

The fact that the LCDP process has affected the technology uptake has been alluded to in chapters 5 and 6, which highlight the fact that lack of rig spares in Uganda by the end of the LCDP has inhibited further deployment of the technology. Chapter 7 highlights the difficulties faced by the Government institutions in participating in the LCDP due to changes to Government water supply mechanisms and structures.

Within the LCDP, key stakeholders were exposed to the Pounder technology and were adopting it commercially before it was considered to be a finished product (Box 9.1).

The LCDP innovation diffusion approach involved the following steps:

1. generation of a technology idea by LCDP team;
2. introduction of this idea to key stakeholders in Uganda;
3. design of the technology by the LCDP team;
4. deployment of prototype equipment within ongoing programmes run by key stakeholders;
5. feedback from stakeholders;
6. design of improved technology by the LCDP design team;
7. the deployment of improved equipment within ongoing programmes run by key stakeholders;
8. end of funding period (further technology development requires more funding).

These eight steps in combination with the issues identified in chapters 5 to 8 led to the adoption of the technology by one contractor beyond the LCDP three year duration.

Box 9.1: Pounder Technology Development and Diffusion

Douthwaite (2002) advocates the "*learning selection method*" in order to catalyse diffusion of innovation. In this method, the external R&D team, generate the innovation idea (in isolation) and develop the technology to a point where it is good enough to be adopted by key stakeholders. At this point, the R & D team enter a period of equal partnership with key stakeholders in terms of further technology development, before gradually relinquishing control of the technology design. Early adopters begin adopting and modifying the technology during this period of equal partnership. These changes to the technology, and the selection of those they find beneficial is analagous to Darwinian natural selection, hence the phrase *"learning selection"*. Once key stakeholders have modified the technology to a point where it is good enough for wider adoption, it is taken up by the late majority. Although the R&D team may act as consultants to the key stakeholders by this point, the ownership of the technology is now fully in the hands of key stakeholders.

Although Douthwaite's model provides a useful way of conceptualising the innovation-diffusion process, the LCDP process does not fit this model. The early adoption of the Pounder technology took place without the LCDP team handing over ownership of its development to key stakeholders.

Figure 9.1 provides a conceptual model which is much simpler than Douthwaite's *"learning selection model*" but aids the conceptualisation of the process of technology development and stakeholder uptake within the LCDP. It also provides a useful basis from which to critique these processes. The *x*- and *y*- axes of the graph represent the status of technology uptake and the status of technology development respectively. Different paths can be followed in order to reach the goal of widespread uptake of a fully tested and operational technology. However, different scenarios, stakeholders and technologies may lend themselves to some paths more than others.

Path A illustrates a method whereby the technology is fully developed and then diffused (Douthwaite's (2002) *"over the wall method"*). The diffusion of mobile telephones falls into this category. The technology is developed to completion and then passed *"over the wall"* to consumers. Uptake is encouraged through promotion.

Path B illustrates a process in which there is some stakeholder adoption of the technology in the early stages of its development (more than for path A). The technology is further developed while it is being taken up more widely.

Path C depicts a scenario in which the stakeholders are taking up technology during the early stages of design and test. The development of the Linux software provides an example of this. Since 1991 when Linus Torvalds began to develop the software, it was made freely available to potential adopters, who were able to modify and improve it. By the time Linux 1.0 was released in March 1994 more than 100 people had contributed to the code (Douthwaite, 2002).

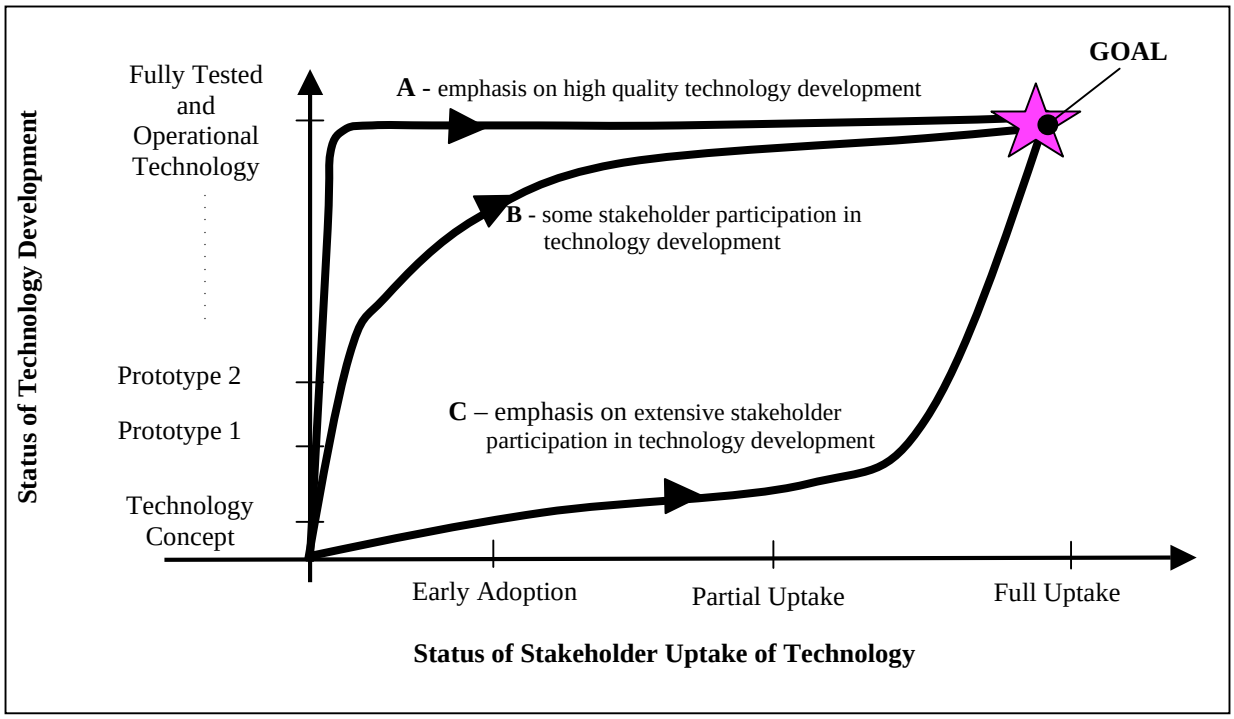

Figure 9.1 : The Process of Technology Development and Uptake by Stakholders

This chapter utilises the conceptual model in Figure 9.1 to assist the analysis of the LCDP process. In the LCDP a participative research and promotion process accompanied the development of technology. The value and need for stakeholder participation in technology development is disputed in the literature (as discussed in chapter 3). A school of thought at one extreme highly values the technical outputs and quality of the product and does not emphasise stakeholder participation until the technology is complete (akin to path A in Figure 9.1). At the other extreme, stakeholder participation is considered to be paramount, even if it means compromising on technology development. Figure 9.2 expresses these two extremes as forces which try to pull the technology development and uptake process in rival directions. Although these forces may not be mutually exclusve, they do aid in conceptualising some of the tensions experienced during the LCDP.

The LCDP experience of trying to combine stakeholder participation with technology development was not entirely harmonious. Rather the process included conflicts and dilemmas and the degree of participation consequently varied.

The technology design and test process was *"messy"* (as defined in 3.2.1), which conflicted with stakeholder planning and co-ordination. There were unforeseen barriers to stakeholder participation, the extent of which varied between individuals, organisations and with time. There was competition, particularly between an urgency to develop and demonstrate the technology on one hand and the time required to involve stakeholders on the other. There were dilemmas between accepting the status quo in Uganda and pushing for change. Empowering others was difficult if it entailed a loss of power for oneself. Throughout the project the different opinions and motives of different LCDP team members and key stakeholders required recognition and careful navigation.

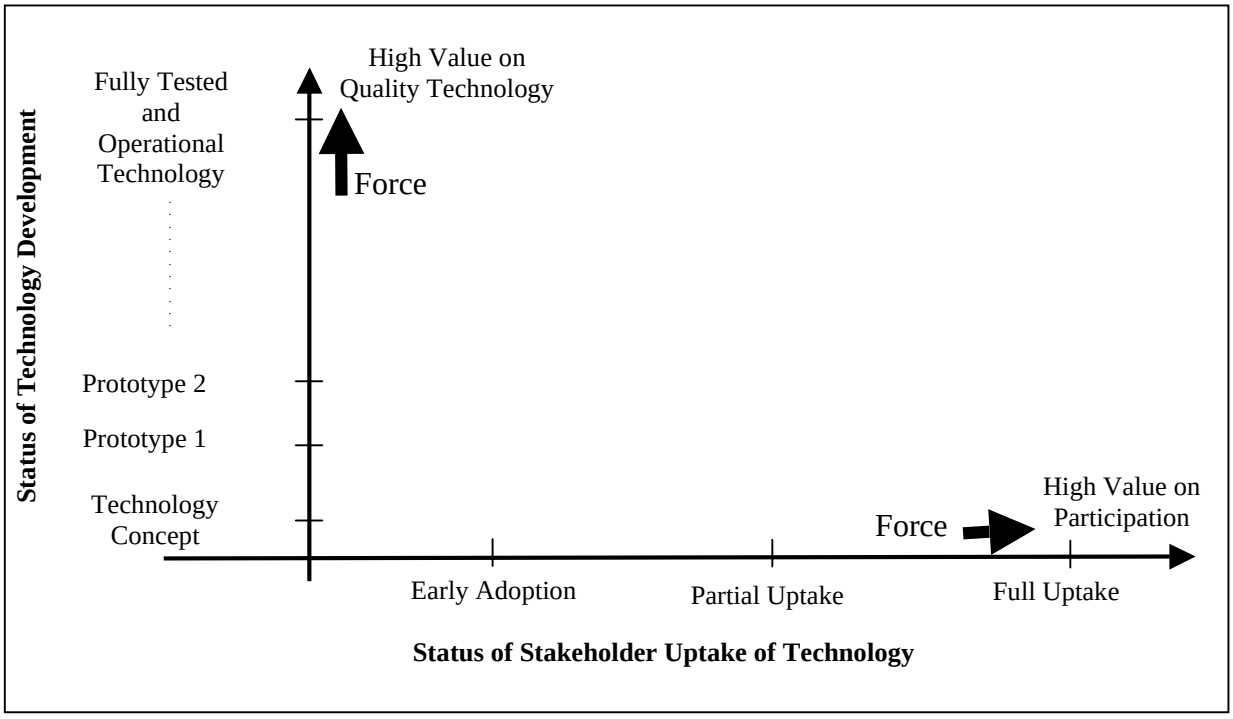

Figure 9.2 : The Forces that Affect Technology Development and Stakeholders Participation

This chapter analyses the LCDP process by drawing on formal and informal discussions and meetings throughout the LCDP as well as internal documents, email correspondance and semi-structured interviews with key stakeholders. The second section of this chapter considers the development and promotion of the technology.

This is followed by two sections which consider stakeholder participation, the first of which considers the way participation was facilitiated by the change agent and the second of which examines how participation was embraced by the key stakeholders.

9.2 TECHNOLOGY DEVELOPMENT

9.2.1 The Design Process

The Pounder technology was developed from a concept into a working product within the three year phase 1 of the LCDP in several stages as shown in Figure 5.4. The design process was *"messy"* (as defined in 3.2.1), in other words untidy, chaotic and confusing and the final outcome was not obvious from the start. Thus, although at the start of the technology development process a goal, as depicted in Figure 9.1 may be perceived as being clear, there are in fact numerous alternative end points as shown in Figure 9.3.

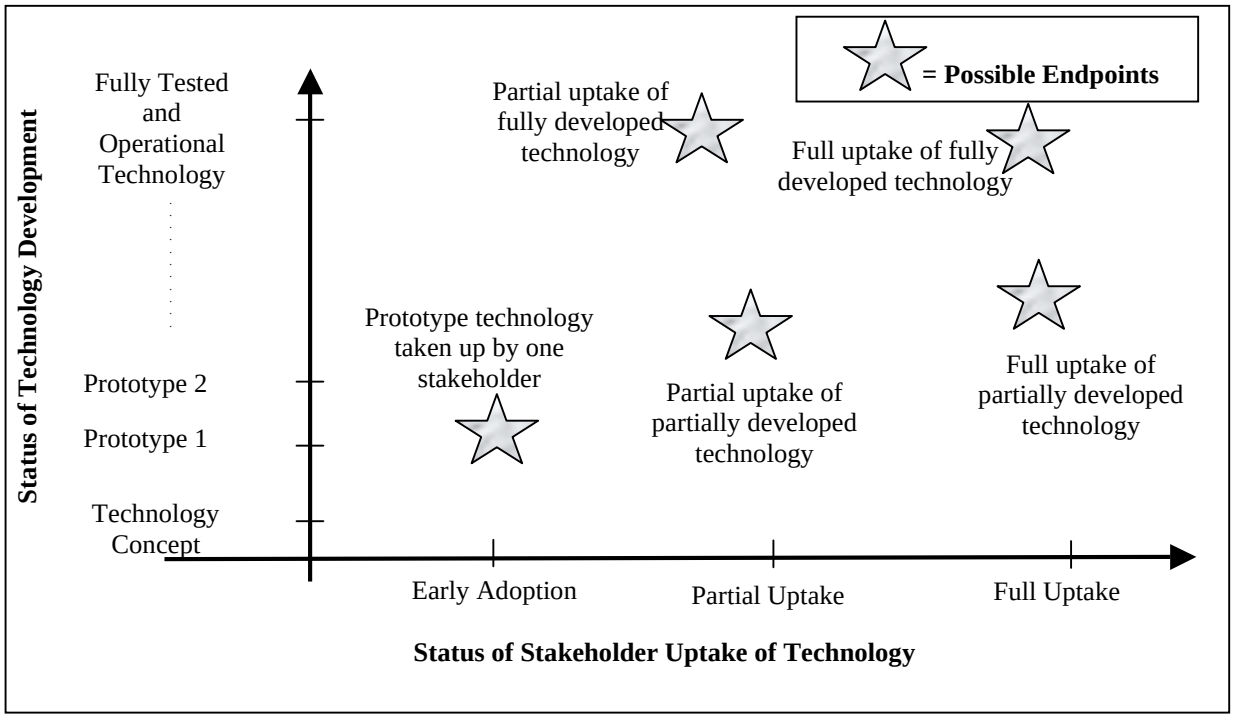

Figure 9.3: Possible End Points of Technology Development and Stakeholder Uptake

Planning and seeing issues through to a conclusion proved difficult during the design of the first rig as priorities were shifting throughout. Finite Element Analysis was undertaken to model drill pipe loading but the work was not concluded. Test beds were made up in the UK to investigate drill bit penetration but were not fully utilised.

The technology design progressed in leaps with decisions taken suddenly, in light of insights from individuals as much as from rigorous technical analysis. However, despite this, the first rig was supplied to Uganda in June 1999 as scheduled, and field trials in Mpigi District commenced almost immediately.

In November 1999 (following the field trials), the second rig (not yet fully designed or built) was scheduled to be shipped to Uganda by the end of March 2000 (Carter, 1999b) with a view to drilling by May. However, by June 2000, the planned import had been shifted to August 2000 with the commencement of drilling scheduled for October (Carter, 2000a). The second rig finally arrived in Uganda in November 2000 and the drilling commenced in the December (Carter, 2000b).

These delays were of little consequence to the Pounder rig design team (working in the UK) who considered them to be a normal aspect of the messiness of the design process. However, the stakeholders in Uganda were not comfortable with the uncertainty. This cultural difference reflects the differences in "*uncertainty avoidance*" between developed and developing countries whereby the latter generally adapt to a lack of certainty by lack of planning for the future (Kanungo and Jaeger, 1990).

The delays were problematic for the planning process with Mukono District, with whom arrangements for commercial Pounder drilling with the second rig were being made. The District started to accuse the LCDP of holding them back from achieving their targets because of delays in the rig supply (Danert, 2001a). As the District was not completely ready for the rig deployment, the design team in the UK did not see urgency in availing the rig to Uganda. However, without the knowledge that the second rig was actually in Uganda, planning was difficult. Given that there is a tendency in Uganda to not believe that something will happen until it actually happens (DWD, 2001d; Mukono, 2001b; DWD, 2001a), it was difficult for the District to plan the deployment of a rig that was not yet in the country. The messiness of the design process proved to be at odds with satisfactory stakeholder participation in Mukono District.

The difficulty in determining whether the Pounder rig should be considered to be a finished product (a production machine) or a test rig by the end of the LCDP phase I in June 2001 was another facet of the *"messiness"* of the design process. Other than the ambition to penetrate the hard formations in the Ugandan regolith, no clear and explicit

design criteria were set down at the start of the LCDP. The goal in Figure 9.1 had not been clearly defined. Following observation of the first Pounder rig and stakeholder consultation several new features were added to the second rig. Although this machine performed better than the first rig, there was dissatisfaction that not all of the additional features were tested (Table 5.4). Towards the end of the LCDP many stakeholders were of the opinion that further rig testing was required (Box 5.7). This, coupled with the fact that the drill bits wore out more quickly than had been hoped nurtured a reluctance on the part of the design team to deem the technology as complete enough for wider release. As the design team were also the sole manufacturers of the rig components, they were able to prevent the supply of rig spares in Uganda. The possibility of joint decision making among stakeholders with respect to spares availability beyond the LCDP funding period was thus undermined.

The unavailability of the Pounder rig for further deployment (once all the drill bits had worn) in Uganda can be attributed to a number of overlapping causes as follows:

1. lack of recognition of the realities of the *"messiness"* design process in the LCDP concept by the project planners combined with lack of willingness from the donors to fund subsequent technology development and the inability of the Government of Uganda to fund such research;
2. a monopoly of power in the hands of the rig design team as they were also the sole rig manufacturer;
3. the sheer difficulty in determining when the technology is "ready" and the danger of being associated with poor equipment performance;
4. insufficient focus on the technology design as too many LCDP resources were utilised to facilitate stakeholder participation in the process.

These themes of messiness are developed through the remainder of this chapter.

Todt (1997) does not expect all design aspects to be agreed upon, but rather that participation should enable designers to be better informed and more conscious of the social aspects of technology. The LCDP experienced tension between innovation and following the status quo with respect to the well design in Uganda. The dependency on stakeholders for rig deployment meant that innovation in the well design had to be compromised. Consequently, the Pounder wells are similar to existing shallow wells in

terms of pump and cost. The Pounder well design challenged the Government status quo to a limited extent by utilising a national standard handpump (U3) with an alternative installation method (Box 5.3). However, the challenge would have been greater if completely different handpumps (not national standard) had been installed. Given that the pump can cost approximately 50% of a Pounder well, introducing a very low cost pump would have reduced the well cost considerably.

This raises the tension between pushing the key stakeholders for change, and the compromises which stakeholder participation brings. This tension could be represented by replacing the two forces in Figure 9.2 with innovation in the top left and status quo in the bottom right. The LCDP found a compromise between these forces but the more innovative stakeholders felt that the status quo had not been sufficiently challenged and those favouring the status quo wanted the well design to resemble existing sources even more. Literature on innovation informs us that the early stages do not occur through consensus but are a direct result of individuals (innovators) challenging the commonly held beliefs and assumptions (Douthwaite, 2002; Rogers, 1995). Consequently, within a participative technology development process, tension is inevitable. An awareness of this inevitability may enable change agents and stakeholders to stand back a little, rather than becoming too emotionally involved in the conflicts which such tension brings.

The path between innovation and the status quo which was followed by the LCDP was influenced by the relative bargaining power of key stakeholders and the design team. Had the LCDP not been so dependent on the Government of Uganda for rig deployment, it could have focused more on trying to develop a well of significantly lower cost. Independence from the Government would have provided scope for considerable innovation. However, such an approach would have brought its own problems. Additional resources would have had to be spent to ensure that the new well design was sustainable at community level (pump and spares supplies and training of caretakers and mechanics). Further, unless the well could be so cheap as to be affordable by individual households, which is highly improbable given the difficult drilling conditions, resources would have been required to gain requisite Government support for the innovation once it had been proven to be technically feasible.

9.2.2 The Test Process

As outlined in 5.4.1, the LCDP was dependent on donors, central and District Government and private enterprises for the deployment of the new technology. Testing within ongoing Government programmes provided the opportunity to experience and observe the field realities of these programmes. Numerous contextual issues, key to long term technology uptake and sustainable community water supplies, as well as linkages between these issues are better understood and documented as a consequence and form much of this thesis. Also, commercial demand for the technology has been shown through adoption by a commercial enterprise.

It has been argued that there was too much time spent on consensus-building with Government during the LCDP (Comment 9.1). However, given the start-stop nature of donor funding for this type of research and development, Government support is vital. The collaboration with local organisations during the technology design and test provided a platform for sharing the ownership of the technology and the LCDP with Ugandan stakeholders.

However, the price for considerable stakeholder involvement has been the limited deployment of the technology, with only 29 holes attempted over a two year period. This limited number of holes, did not provide a suitable basis from which to determine success rates. The success rate of the Pounder technology was cited as key to building trust in the technology among key stakeholders (Comment 9.31, 9.32).

Just how to undertake the technology test within these programmes was perceived differently within the LCDP team. These differences did not become apparent until the first set of field trials were about to commence. The *first faction* subscribed to an approach with an urgency towards testing the capability of the technology. It wanted to access sites with a range of hydrogeological conditions and have the freedom to move between them. This included the ability to start and stop drilling in a number of sites as dictated by the technology, with no obligation to provide the communities with a completed well. *"[We should have the] freedom to come and go in several villages. The villagers can count themselves lucky [if they get a water source]"* (Comment 9.2)

The *second faction* valued the provision of long lasting community wells throughout the test drilling. It preferred to collaborate more closely with the District

programmes regarding site locations, complete all sites which were potential community water sources and hand them over to mobilised communities while learning about the capability of the technology[72].

Box 9.2 and Box 7.1 narrate the experiences of the field trials in Mpigi District.

Mpigi District, in collaboration with Sub-County health assistants, selected 14 test sites in communities for the initial drilling with the first rig. The site selection was undertaken in good faith. However, due to a misunderstanding within the LCDP team regarding how this initial drilling should commence these initial plans were not followed. Rather than drill on the selected sites, there was some preliminary training of the crew close to the District headquarters. Subsequently, drilling attempts were made on sites suggested by the drill crew, including on land belonging to one of the drill crew's family. Out of five drilling attempts, one led to a successful water source. Following this success, another three successful wells were drilled in the sub-county.

Box 9.2: Initial Pounder Rig Field Trials in Mpigi District

As the Pounder technology was completely new and untested in the field, initial operation was bound to be difficult, and there was a risk that the technology would fail completely. Consequently, there was a reluctance from the first faction to allow the initial drilling to be too public or to raise expectations which could not be fulfilled. However, once the rig could be operated and a suitable location was found, the urgency to drill meant that a community was provided with a water source without adequate community mobilisation.

The unpredictable outcomes of the test drilling adds another component to technology development. It is not only the design which was *"messy"*, but also the equipment test. The stakeholders seemed to find it difficult to come to terms with this.

The second rig was brought into Uganda as a production machine. *"We are not talking about trials or testing anymore. We are doing real wells, but still trying to increase our knowledge of equipment performance"* (Carter, 2000c). This rig was initially deployed in Mukono District, as narrated in Box 9.3.

[72] Discussion with individuals throughout the LCDP

In October 2000, Mukono District planned to divert the funds for ten hand dug well sites to Pounder drilling. Four were scheduled in the last quarter of 2000, with another six for the following quarter. The District were initially concerned about the research element of the technology deployment but were assured by the LCDP team that they were equally interested in providing community water supplies with the technology (Danert , 2000c). Following the selection of four Pounder well sites, commercial drilling commenced at Gopali village on 11th December. The first hole, (which also provided the first hands-on training for the contractors) collapsed. The crew moved to a second site in the same village which was completed but not developed or test pumped before the crew moved on to the second of the four selected sites. However the trainer and crew did not think that the completed site would provide a successful water source.

The next site was drilled to 20m but the formation did not look promising. After several days, the drilling was stopped. The LCDP team advised Mukono district that the drilling should be halted while the situation of non-payment was considered by Mukono and DWD. In the mean time, the drill crew took the rig to Jinja district and two unsuccessful drilling attempts were made.

The completed well in Gopali village turned out to be a successful water source after all. However, the break in the Pounder drilling meant that the rig was not utilised to drill the four planned sites. Commercial drilling with the Pounder rig in Mukono resumed on 8th February 2001. Two sites were attempted, one of which became a successful water source.

The commercial enterprise subsequently deployed the rig in Jinja District. Of the ten planned Pounder wells in Mukono District, only five were attempted.

Box 9.3: Commercial Pounder Rig Deployment in Mukono and Jinja Districts

Although plans for the deployment of the second rig were made with Mukono District and private contractors, they were not followed. Once the rig had seemed to have failed twice in succession to provide productive water wells, the drilling was put on hold. The LCDP team were not able to stand back from the drilling in Mukono and ride out the inherent risks associated with the technology deployment. The involvement of the private sector at this stage meant that profit motives had to be contended with, including the issue of non-payment for unsuccessful drilling attempts. As the LCDP also did not have the resources to pay the contractor for these they feared that the contractor would lose too much money.

As with the technology design process, the *"messiness"* of the technology test proved to be at odds with stakeholder participation in it. The LCDP team found it very difficult to stick to the plans which had been made with Mukono District. There was a fear of letting go of the ownership of technology deployment in case it went wrong (ie contractors not paid and not interested anymore). It proved to be very difficult for the LCDP team to hold back from influencing the decision making in Mukono. As Mukono

District staff were seeing the rig used for the first time, it was easy for the LCDP team to influence their decisions regarding the rig use.

It has been suggested (DWD, 2001d, DWD, 2001a, Danida, 2001a) that the private sector was brought on board by the LCDP team too early and that the second rig, like the first, should have been initially utilised by direct labour. However, the LCDP were trying to achieve the project objectives of private sector uptake (Table 4.1) within the LCDP duration and spread the use of the rig to another District (which no longer used direct labour). Further, the second rig was conceived as a production machine rather than another test rig.

Despite the difficulties encountered in Mukono District and lack of further uptake of the Pounder rig in that District, the rig was commercially adopted by one contractor. This enterprise continued to hire out the rig beyond the end of the LCDP in June 2001 to drill more wells in Jinja District. This outcome could not have been predicted by the LCDP team.

Although the adoption of the rig may have grown organically if allowed, there may be limits regarding which Pounder rig features the private sector can be expected to trial using its own resources. Given the profit motives of private enterprises, it seems to be unrealistic to await the test of all Pounder rig features (Table 5.4) as a free by-product of commercial drilling. Although additional funding may be required, much is to be explored in terms of partnerships between external design support and private enterprise in Uganda. Within such partnerships there is the need for clear agreement on who has control as well as who and how stakeholders participate. Douthwaite's (2002) learning selection method may provide a suitable model for future collaboration for technology design as well as test. However, this requires recognition of the *"messiness"* of the design and test process, and less control of the process by the external design team than was exercised during the LCDP.

Box 9.4 depicts the path followed and endpoint reached by the LCDP and shows the forces which pulled the process in different directions. Although there was some stakeholder consultation with respect to the design of the two rigs, the design was primarily undertaken in isolation from the key Ugandan stakeholders. The LCDP reached an endpoint with the early adoption of the rig by one commercial enterprise. As local manufacturers and suppliers were not involved during the LCDP, and there are no

spares available, the uptake reached has been aborted. Although the concept of the Pounder technology was adopted by Government, it cannot continue without additional resources.

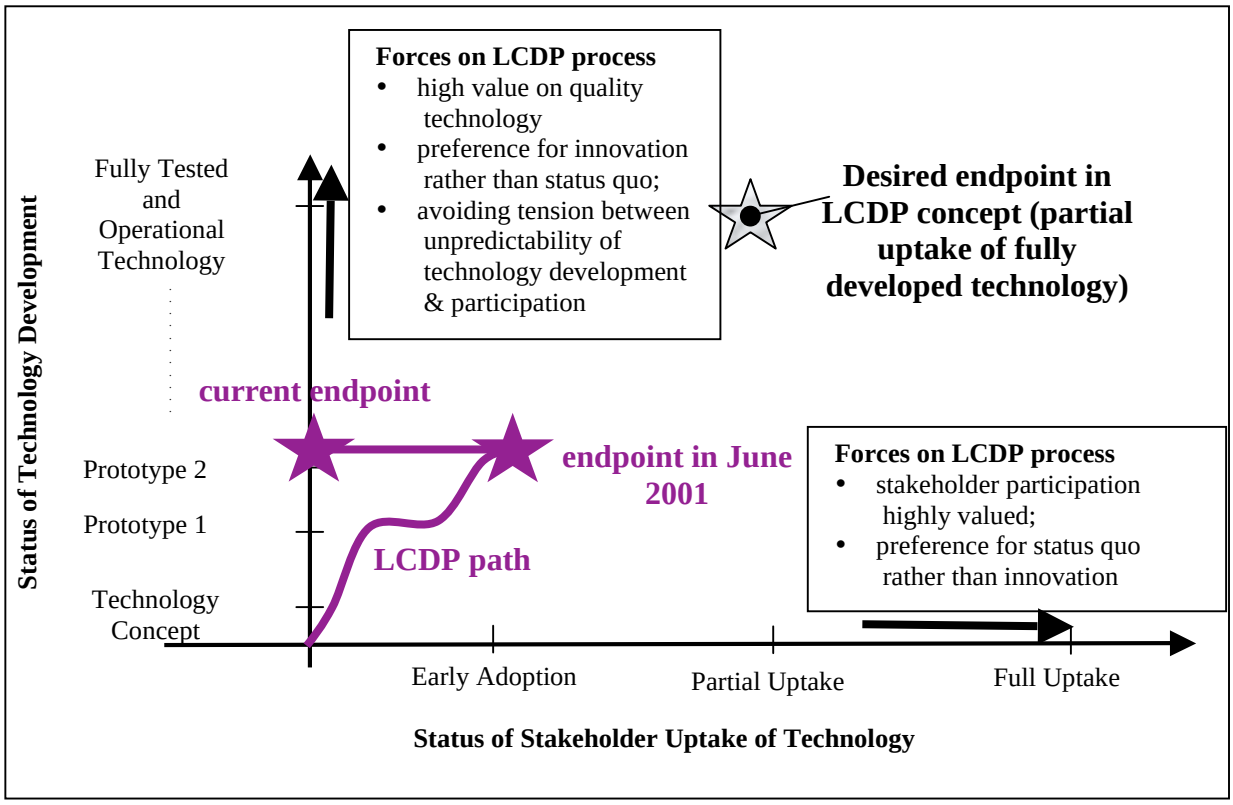

Figure 9.4: Technology Development and Uptake within the Low Cost Drilling Project (LCDP)

9.2.3 Technology Promotion

The deployment of the rig within ongoing public-funded water supply programmes provided a platform for promoting the technology to the stakeholders through demonstration.

The demonstration of live drilling in communities was difficult. Drilling success is highly unpredictable. Successful and fast drilling can provide an unrealistically positive impression of the technology, while well abandonment due to formation collapse or hardness can lead to an unrealistically negative impression. In addition, the nature of the operation meant that the drilling activities were not predictable from one day to the next.

Given these difficulties and limited resources, the LCDP team were not very keen to ensure site visits by stakeholders. Leaflets were circulated to invite people to view the drilling but the telephone number given was that of DWD, who did not always

know what was happening on site from day to day. Instead the rig was demonstrated at workshops (attended by 70 participants in November 1999 and 21 in June 2001) and the business training courses. Informal feedback was also given to key stakeholders regarding the outcomes of the technology deployment.

By the end of the field trials in November 1999, the LCDP team were confident that the project outputs could be met and exceeded during the three year LCDP lifetime (Danert, 1999a). The second Pounder rig was brought in to Uganda as a production machine, and in December 2000 there was the intention of supplying additional rigs in Ugandan through a mix of local manufacture and import (Comment 9.3).

The promotional activities, which were being undertaken in parallel to the technology development reflected this optimism regarding the future availability of the technology. Numerous donors, Government, NGO and private sector stakeholders were informed about the technology during consultation meetings, informal discussions, workshops and training courses. The promotion of the Pounder technology concept was successful and expectation was high.

Expectation was deflated when the LCDP team announced in June 2001 that the rig was not a completed product but still a prototype under design. Stakeholders close to the LCDP who were aware of additional requirements (Box 5.7) for technology development understood the situation to a certain extent. They agreed with the LCDP team that more time was required. However, to the stakeholders further afield, these details were not known. The change of direction was more difficult to comprehend. *"We have raised the expectations of the contractors and have built their capacity. They have relied on us, and the trust ... the bait was the rig. To hire the rig. ...[now there is no rig]"* (Comment 9.4).

Just how ready the technology was for release is highly debatable. Carter (2002b) reflects on the decision to hold back from wider dissemination as follows: *"I think that the lack of wider uptake reflects on us as a team, as a project, and one specific thing …[the judgement] that the technology was not ready for wider dissemination. In retrospect I think that was a misjudgement …which has constrained where we have gone. And I think that had we not come to that conclusion, the project would have [left] on a rising curve [rather] than hanging. ….I think that [this has] limited uptake. It has slowed down the process".*

Determining when a technology is *ready* for wider dissemination, equivalent to Douthwaite's (2002) point at which the technology *is "good enough for widespread adoption"* was extremely contentious within the LCDP. However, had the LCDP team recognised that although this point had not been reached, it was actually *"good enough to be adopted by innovative key stakeholders"*, further rig deployment would have been possible beyond the end of the LCDP.

One of the inhibiting factors to letting go of the technology was the lack of further resources. With no additional funds to follow the progress and the problems so far faced in Pounder rig deployment, the LCDP team were afraid that the technology might fail and that there would be no external support to enable problems to be reconciled. The decline in hand auger use served as a warning for what could go wrong given lack of ongoing support and research into uptake problems.

9.3 CHANGE AGENTS AND PROJECT MANAGEMENT

9.3.1 Change Agent Involvement of Key Stakeholders

Throughout the LCDP, considerable time was spent and energy was channelled to interacting with key stakeholders in order to exchange ideas, seek advice, pass on information, co-ordinate activities and collect data. Both during the LCDP and in the semi-structured interviews key stakeholders informed me that they valued this interaction considerably (Comments: 9.5, 9.6, 9.7, 9.8, 9.9). In several cases, individuals commented that they would have preferred more interaction (Comments: 9.10, 9.11, 9.9). One stakeholder wished that he had been involved more throughout the rig deployment rather than only during the planning (Comment 9.12). Opinions with respect to the extent that the LCDP should have involved politicians varied. Two key stakeholders considered that it was a mistake not to have involved them in the LCDP (Comments: 9.13, 9.14) One considered it to be too early for political involvement (Comment 9.15).

Objections to an excessive quantity of stakeholder interaction were in a minority. They were made on the grounds that it drew too much attention and too many resources away from the technology development. This viewpoint reflects the force in the upper left corner of the conceptual model in Figure 9.2. The viewpoint which values involvement corresponds more to the force in the bottom right hand corner of this

figure. As outlined in section 9.2, there was a certain amount of tension within the LCDP team between focusing on the technology development and involving stakeholders.

By the end of the three year LCDP duration, I was generally made very welcome by the key stakeholders with whom I interacted frequently. One official even told another employee not to worry what he said as I was *"one of them"* anyway (Comment 9.16). Over the three year LCDP, relationships had been established with several key stakeholders. However, the relationships between the LCDP team and key stakeholders were by no means always harmonious. Just as there was tension between the technology development and stakeholder participation, there was tension between achieving other outputs within the LCDP and stakeholder participation.

The four activities of well siting in Mukono; the production of a construction contract; water quality monitoring and stakeholder input into the technology design were undertaken in slightly different ways. Reflection on these activities enables the tension between outputs and participation to be highlighted.

Following several introductory meetings with Mukono District staff, the LCDP team introduced a consultant hydrogeologist whom they had selected to undertake the Pounder well siting in the District, having already worked to develop a siting methodology for the LCDP. The LCDP team explained to the District that they were trying to develop a suitable way of siting Pounder wells.

The consultant hydrogeologist visited seven locations which had been selected by the District. Site investigation was undertaken together with several District staff, an LCDP team member and one of the private enterprises who would deploy the rig. All of these individuals claimed to have learned a lot about well siting techniques.

Once the Pounder rig failed to drill a successful water source in the second location and the Pounder drilling was halted, the District staff immediately blamed the siting methodology. They had their own people and methods for shallow well siting with which they were familiar. Before undertaking further Pounder drilling in the District they wanted to undertake their own new site investigations.

Box 9.4: Pounder Well Siting Experiences

Pounder well siting in Mukono (Box 9.4) was undertaken on a consultancy basis. Although several key stakeholders participated in the site investigations and claimed to have benefited from the experience, the District staff did not fully participate in the decision making process regarding the siting activities or personnel used. The District had their own ideas about siting methods from the start but these were not brought on board by the LCDP. The fact that the District wanted to return to their own approach as soon as they could suggests a lack of faith in the new approach introduced

by the LCDP. With regards to well siting, the LCDP team failed to ask Mukono District the right questions during the planning process. In trying to develop a high quality method, too much was assumed. The LCDP team were drawn towards trying to produce quality outputs rather than fully involving stakeholders.

The LCDP team also tried to introduce a new and simple "short contract" document to the Districts for Pounder well drilling. However, similar to the case of the well siting in Mukono, the LCDP team had its own ideas which it wanted to introduce to the stakeholders. The LCDP team spent two months (part time) producing a contract document for Pounder well construction. The team subsequently tried to adapt the "NEC Engineering and Construction Short Subcontract" (Institute of Civil Engineers, 2001) for use in Uganda. However, the Districts which had worked with the private sector since 1996 already had several of their own contract documents. They were familiar with these and did not see any need to alter them for the purposes of Pounder drilling. It was one of these contracts which was finally utilised by the District.

Carter (2002b) reflects on the failure of the new contract to be taken up as follows: "w*e did [the short contract] in a very much technical assistance type of mode… We did not consider it particularly important to do it with the stakeholders and to learn together and we paid the price. We rushed in on our own. We spent a lot of time on it, which in the end [did not facilitate the LCDP]"*. In this case, the LCDP team made assumptions about the need for a "better" contract. In the search for quality outputs, participation of key stakeholders was marginalised.

In contrast, the examination of water quality by the LCDP team was undertaken following the articulation by key stakeholders that this was a problem. Although the LCDP team did not really consider water quality to be a major problem (Carter, 2002b), the team respected stakeholder concerns. With the help of additional funds from DANIDA, the LCDP was able to undertake water quality monitoring, and now has data to feed into this debate. In order to reach this position, the articulation of the problem by the key stakeholders was required, the change agents were required to listen and take the issue on board, and additional resources were required.

The design of the Pounder rig was an activity which steered a path between participation and outputs. The first rig was undertaken by the UK based LCDP design team. In the case of the second rig, although most of the technology design was

undertaken in the UK, there was consultation of Ugandan stakeholders during the field trials and design review (Figure 5.4). The subsequent translation of their ideas into design modifications contributed to a sense of ownership of the technology by certain key stakeholders. *"Remember we identified some problems ...then when you went back to Britain ... you designed a new system and that has really improved [it]"* (Comment 9.17). *"You know, people get on board and they know it is not a masterpiece that came and they cannot change. ... They have put in their [ideas for] change, and now...you are talking about modifications. They feel part of it"* (Comment 9.18).

Although the LCDP consulted key stakeholders during the design review, the design team kept control of the rig design throughout the LCDP. Although some key stakeholders were consulted, local manufacturers were not involved in the design process. Given the limitations of Ugandan manufacture, involvement of the manufacturing sector may have compromised the capability of the Pounder rig.

Figure 9.5 summarises the tension between stakeholder participation and outputs which are highlighted by these four experiences.

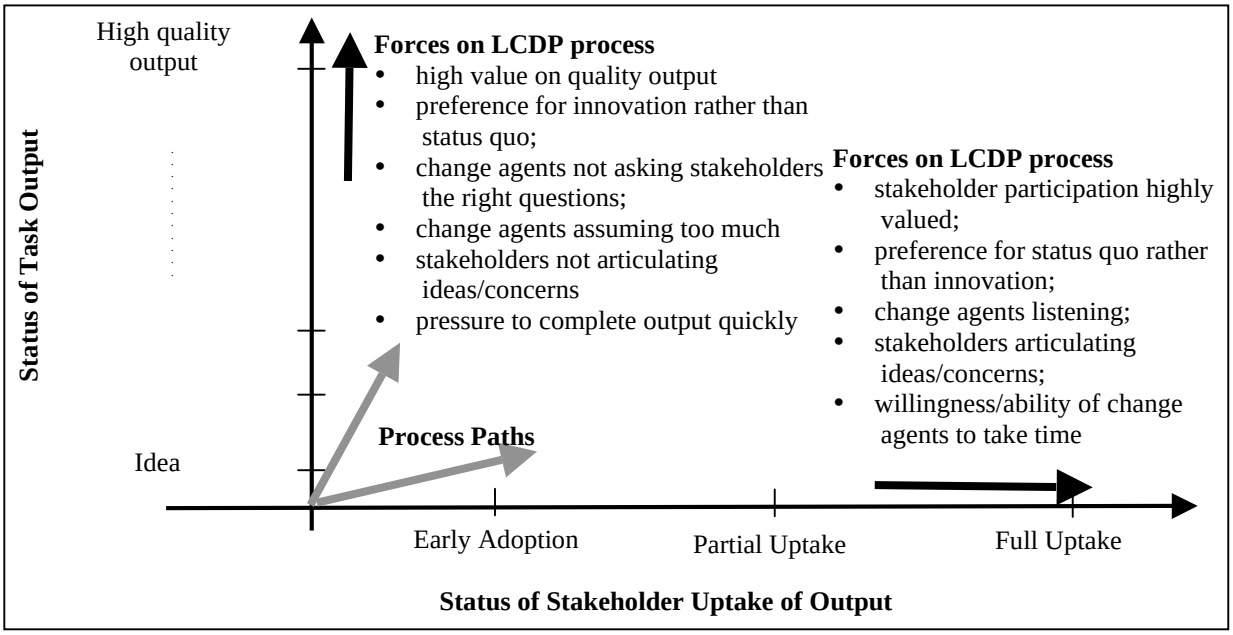

Figure 9.5 : The Process of Reaching Objectives and Stakeholders Uptake

9.3.2 Barriers and Aids to Change Agent Involvement of Stakeholders

In addition to the factors given in Figure 9.5, there were three factors which affected the change agent ability to involve stakeholders in the LCDP. The first relates

to the difficulty of ensuring that meetings with key stakeholders took place, and the second relates to change agent dependency on the stakeholders.

Numerous arrangements with key Government stakeholders were cancelled, sometimes at the last minute. Frequently individuals simply did not turn up for meetings. This was not due to a lack of interest but rather a reflection of the culture within the partner organisations. Individuals with a higher status are given priority rather than the individuals who have arranged a meeting first. The difficulty in planning meetings within the organisations was well known. … *you don't feel that you are in charge of your work day. You are not in charge. You just get a mission from here or there. And they want a meeting with you, so you just have to uproot and go to that meeting. ...[say] a World Bank meeting is there, I am pulled in. I have one minute notice for that. … We are not organised*" (Comment 9.19).

Once I grew to understand the "*meetings culture"* I dealt with it by confirming meetings by telephone right up until the last minute in order to try and avoid unnecessary travel. Reconvening meetings again and again required perseverance and patience. This patience was commented on by one stakeholder. *"... the external project team has really a lot of patience. Do you remember how many times have you gone to DWD? How many times have you gone to DANIDA? Looking for this and [that]. Patience pays. Hadn't you been patient I think maybe we should have failed. You ask how things are and no, it will be tomorrow. Then you say OK, I will do it tomorrow, and this patience has been a very big, part of the success of this project"* (Comment 9.20). Involving key stakeholders requires persistence and a certain degree of patience.

Change agent dependency on local stakeholders was a vital component of stakeholder participation. This dependency comes in different guises – dependency for knowledge and dependency for resources. Both of these types of dependency provide for a more equal partnership between change agents and key stakeholders.

In the early days of the LCDP, my lack of knowledge of the Ugandan context and naivety regarding the technology meant that I was very open to listening and taking on board the ideas and concerns of my Ugandan colleagues and others within the sector. I depended on them for information and support and wanted to learn from them. Rather than being the expert, I was learning and thus very open.

As the LCDP progressed I tended to push the ideas of the LCDP team more than I had at the start. Carter (2002b), who observed this gradual transition summarises it as follows: *"...[your] dependence on others, in particular other Ugandan colleagues ... has been an important feature to me and one that has not been a weakness. In fact [it is] the opposite. It was a feature that strengthened your relationships with people. There was a tendency for that to diminish towards the end. As you grew and learned, your dependency on others diminished. And that affected the partnership [negatively]. …I would say that it should be a very significant lesson for you".*

9.3.3 Flexibility and Continuity

Despite the logframe (Table 4.1) setting out the LCDP outputs and activities, the LCDP was quite flexible. Priorities shifted in response to stakeholder concerns and lessons learned through field experiences. A certain amount of flexibility was essential for the participative approach of the LCDP. The LCDP team did not, and could not know the issues which would affect the early adoption and wider uptake of the technology at the LCDP planning stages. Additional funds during the LCDP helped to facilitate a flexible approach. These funds enabled the business analysis and training, water quality testing, and research into siting to be undertaken. In addition, flexibility of Government funds enabled the first rig to be tested to a limited extent before community wells were drilled.

However, the flexibility also meant that not all the areas which were researched were followed by action in the three year LCDP duration. Local manufacture, micro-finance and irrigation wells are three such topics. Like the technology design process, the action research was *"messy"*.

This *"messiness"* was understood by the LCDP team and key stakeholders who were well aware of the complexity of the work. However, concerns were raised from within the team regarding how this messiness was perceived from the outside: *"[Lack of milestones in the LCDP] leaves room for a lot of changes, which might be positive as far as the Project is concerned, but on the other side, it compromises the trust [in the LCDP] ... because not everyone [realises why*]"(Comment 9.21). *"Let me point out. That company…We talked to them, they appreciated our idea. They promised to put money [into it], but they did not see us again. The problem when you do not come back is that someone may think you have bad objectives, or you came to poach ideas. If*

someone has that in mind, next time they won't appreciate.....It is bad for the future" (Comment 9.22). One of the difficulties of the LCDP's flexible approach was the raising of expectations which could not be fulfilled.

9.4 BARRIERS TO KEY STAKEHOLDER PARTICIPATION

Stakeholder participation in the LCDP was not only dependent on the extent to which it was initiated by the change agents. Key stakeholders also a played a role in facilitating their own participation. The LCDP team found some stakeholders to be more motivated and interested in the project than others. Where motivation and interest was high, it was considerably easier for the change agent to establish relationships. However, an analysis of the psychology of individual participation is beyond the scope of this thesis.

High levels of motivation and interest in the LCDP work were not always sufficient to enable high levels of stakeholder participation. Other work commitments had a negative impact on the full involvement of key stakeholders.

Government staff who participated in the LCDP were not released from their regular duties and thus had to fit LCDP activities and meetings around their ongoing work. One key stakeholder (Comment 9.23) expressed frustration at this . *"It is not that we were not involved, it is just that we were not available. We had other commitments. ... We could have given [the LCDP] more thought, more time... I have been involved a lot [but] somewhere along the way ... I was distracted to do other things. I would have loved to give it more time".* Observers have pointed out that the DWD and District staff have more work to undertake than they can cope with. *"...I think that they have a capacity problem within [DWD]. There has been a lot of retrenchment. ... [And the] people still there ... are really overwhelmed with project work, ministry work. If you look at the project co-ordinators, they have two or three jobs. They have their project role, [and others]"* (Comment 9.24).

By the end of March 2000, DWD and District Government were preoccupied with the decentralisation process in rural water supply. Given the deadlines and targets for planning and budgeting, participation in the LCDP became less of a priority (Danert, 2000a).

9.5 CONCLUSION

The way in which the LCDP phase 1 finished in June 2001 was particularly dissatisfying to the five members of the LCDP team (Box 9.5). The team were in a difficult position towards the end of the funding period. They were seeking additional funding for future work. It was difficult to know whether to continue as though the funds would come, or shut down the work completely. We opted for the former, hoping that the break in activities would only be for a few months, enabling reports to be written and some reflection to take place. Considerable effort was spent with donors and the Government of Uganda to arrange a follow-on phase, but it has not materialised yet.

"We did set out as a project .... all in all we are coming to the end of it all, assuming money does not come. Well to me, I will leave rather unsatisfied. ... We really don't have much message to the private sector. DWD understands our problems, but the private sector, the people we have been working with, they can't access the rig, they can't hire it, they can't buy it. You know, I think that we can't say that tomorrow we reach a stage where we can say that market forces take over" (LCDP Team Member 1).

"*They got their grant from DFID and by and large done it. You presumably go on and produce a Ph.D. document and tick they have got a Ph.D. out of it. What it says or what it achieves may be very irrelevant to the future of the Pounder ….Someone needs to carry the project forwards"* (LCDP Team Member 2).

"...[the] people are ready, and [the project] is ending. So my recommendation is that it be given more time, and that means more funds" (LCDP Team Member 3).

"We *have made partial progress that is incomplete in almost every area. So it did not round off nicely. And I suppose that the reason for that is that we were hoping, thinking, planning, intending that there would be an extension which would have led on but it did not. So there was not really closure at the end of the three year period"* (LCDP Team Member 4).

"We have managed so much but we are really just starting to get technology uptake, and now everything is being left hanging" (LCDP Team Member 5).

Box 9.5: LCDP Team Comments Regarding the End of the Low Cost Drilling Project

Promotion and Demonstration

The LCDP team raised the expectation of stakeholders in Government and the private sector with respect to the technology. The LCDP thus succeeded to a certain extent in promoting and demonstrating the technology (principle 13, "*the technology must be promoted and demonstrated to the potential users*"). However, due to funding limitations, the product design and lack of spares availability these expectations, raised in good faith were not able to be fulfilled.

Evolution

The rig was left in Uganda to be hired from a local entrepreneur. It was used subsequently by one commercial enterprise, which adopted the technology. However, they could not drill more than a few wells due to a lack of spares. This relates directly to principle 15, (*" The technology must be adaptable and the local institutions able to facilitate its evolution"*). The technology was not designed to easily enable independent evolution in Uganda.

Time

Many other commercial enterprises have expressed interest in using the technology both during and beyond the end of the funding period. District Governments, DWD and NGOs likewise continue to express a keen interest in the technology. However, widespread technology uptake takes time. This relates directly to principle 16 ("*Adequate time and appropriate timing of the technology transfer process and its component stages must be allowed for*"). The LCDP timing was very appropriate, in light of privatisation, additional funds for the water sector and interest in shallow well drilling technology. However, insufficient time was allowed in the project for wider technology uptake and its support.

The *"messiness"* of technology development and its tension with stakeholder participation contribute to the unpredictability of resource (both human and time) requirements. This contradicts with the fixed (and often short) funding periods for such work.

Without additional dedicated resources, the technology will not be taken up more widely. Even if spares are made available, training and support of the private enterprises and site supervisors will be required. Given the heavy demands on Government staff in Uganda's water sector at this time, the institutionalisation of the Pounder technology would also benefit from dedicated support. DWD have made it quite clear that they see long term uptake of the Pounder technology as requiring someone from outside who pushes things through Government[73]. This situation raises the question of whether sufficient long term funding and support may be a reason that technology transfer projects often fail to make their desired impact.

[73] Personal communication with DWD staff on several occasion in 2001.

Participation

Given the short term nature of projects like the LCDP, stakeholder ownership of the technology and issues which relate to its adoption are crucial if technology uptake is to be successful in the long term. Principle 1 addresses this issue directly *:"the actors who will be affected by the technology, or who can affect its uptake, must actively participate and be empowered to take part in decision making in technology design and project implementation, thus developing a sense of ownership of the technology".*

Participation in the Pounder Rig design, test and other LCDP activities enabled some key stakeholders in Government and private enterprise to develop a sense of ownership of the Pounder technology and LCDP outputs. A consultant to the LCDP commented *" I think it [the interaction] is good because the idea was to work with the people so that the technology can be owned [here]. ... I must say, that the interaction to me has been as if I was part of Project team."* (Comment 9.25). Ownership by a District government official is illustrated by the use of the word "us" in the following: *"Keep the rig in the hands of the project. Then people can come and hire from us…* (Comment 9.26). Ownership by a DWD official: "*Me, I think that this is ours together. We are partners. That we did not participate enough is our own failure"* (Comment 9.27).

Different stakeholders expressed a *sense* of ownership of the LCDP and the technology. In some cases this sense of ownership was more individual than truly joint (Comments 9.28; 9.29; 9.30). However, there is a considerable difference between having a *sense* of ownership and *real* ownership. *Real* ownership of the technology came to be defined by the monopoly in relation to spares supply, which drew ownership away from Ugandan stakeholders.

Change Agent and Change Agency

The change agents and change agency are charged with considerable responsibility in order to understand the context and facilitate the technology design and uptake within that context. This relates directly to principle 3 (*"the change agent must be (a) credible to the stakeholders, (b) have a bias towards them and some homophily with them, (c) adapt to the local culture and (d) communicate effectively"*) and principle 4 ("*the change agency must (a) be transparent, (b) show respect for the participants and (c) be able to relinquish power*").

The analysis presented in this chapter lends its support to principles 3 and 4. The change agent must endeavour to understand the local stakeholders on their own terms if the technology development and requisite support is to take the context fully into account. However, the research also indicates that the drive in development projects such as the LCDP for outputs can be in conflict with a more participatory and understanding approach. Narrow viewpoints which focus on the technology only and fail to consider the wider picture, and an excessive dependence by the change agents on their own assumptions are at odds with stakeholder participation and power sharing.

Cultural issues relate not only to the technology and its deployment, as presented in the *culture* principle in Table 3.1, but also to the process of technology development and transfer for development. Hall (1973) said that *"culture hides more than it reveals"*. Differences with respect to uncertainty avoidance, planning for the future, an orientation towards people over technology and attitudes towards appointments were found across the different cultures involved in the LCDP. These differences only became apparent over time. An awareness of such differences from the start of such work may have helped the stakeholders to navigate the process more smoothly.

Within the LCDP team there were also different cultures and characters. These added to the complexity of the technology transfer process and were the cause of tension as well as learning. Some individuals were more people-orientated while others were more focused on the technology. Some were used to European objective-oriented projects while others preferred more of a process approach, focused on the clients. Some members were pushy with stakeholders and others more reactive. Cross-cultural issues are thus just as important to the process as they are to the technology.

10 Conclusions

10.1 BACKGROUND

The literature on Third World development and technology transfer, and its synthesis into 16 wide ranging principles indicates that in order for technology transfer to be successful as a Third World development intervention, a wide range of issues require detailed consideration. The field based research presented in this thesis shows that the 3 year project to develop and transfer to the private sector low cost technology for shallow water wells has not provided a panacea either for rural domestic water supplies or Third World development.

Nevertheless, the new technology was considered to be compatible with privatisation, decentralisation and technology policies in the water sector by key stakeholders. It was considered able to provide exciting new opportunities for Ugandan private enterprise in the water sector. It was also viewed as able to overcome some of the limitations of other related technologies.

These perceptions provided fertile ground in which to plant the seed of technology transfer. Nurturing the seed through its first faltering stages of growth presented challenges. The analysis of these challenges has provided insights into both technology transfer and current mainstream Third World development thinking.

The research has yielded wide ranging insights into:

- opportunities for and barriers to uptake of the new technology;
- key stakeholder attributes and linkages;
- the context which those stakeholders are required to navigate; and
- the *process* of technology development and transfer.

These insights, which have peppered the preceding chapters are drawn together in the discussion below. Individually they present little which was not already known. The novelty lies in the synthesis which has general application to technology transfer as a Third World development intervention. These insights would not have been possible without the personally involved, action research approach which was taken. They reflect a reality which, although drawn from a single technology development and transfer project, are believed to have very wide application.

10.2 INSIGHTS INTO TECHNOLOGY

Rogers (1995) utilises a definition of technology as *"a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome"*. The Pounder rig technology does not fit this definition. The deployment of this technology brings considerable uncertainty in terms of whether it is able to provide a successful shallow well or not and how much the endeavour will cost. Thus all technologies do not provide certainties.

This *uncertainty* provides a key barrier to the uptake of the Pounder technology, as with other low cost groundwater technologies. The problem is *who* should bear the risk associated with this uncertainty. If this problem cannot be solved in a way which is acceptable to communities, private sector operators, Government, and donors who fund the sector, there is little hope of widespread uptake of the new technology.

The technology cannot be considered in isolation from the organisations and individuals who deploy it . As the full cost of the well which the Pounder rig provides is not affordable by communities, the technology cannot be considered in isolation from the public sector institutions which provide the majority of the funding. In order to ensure successful technology uptake, the linkages between the technology, individuals and organisations need to be established. Barriers which inhibit the formation of such linkages need to be overcome. These linkages include cultural norms, policy issues and institutional capacity.

The uptake of the new technology implies and imposes change. This change is not only in terms of establishing user familiarity with its operation. Change is also required in terms of how institutions deal with the uncertainty that the technology carries. Such changes takes time. As an example, the use of drilling equipment in exploratory mode requires a major change in the mindset of key stakeholders who currently consider these two activities separately. It also poses a need for training, support and suitable funding mechanisms.

10.3 INSIGHTS INTO BUSINESS

Many attributes of Ugandan enterprises and public institutions are defined by Ugandan culture. Networks and patronage are key norms of this culture. Navigation of these norms proved to be difficult. In all of the cases where we tried to circumnavigate

existing networks and patronage, we failed to move forwards. Funding organisations and change agents may perceive these norms as inefficient, incompetent, corrupt or nepotic and they thus take a stance against them.

Given the corruption prevalent at the interface between the public and private sector, working according to local cultural norms may mean accepting what appears to be corrupt practice. It can be a catch 22 situation between allowing organic development to take place on one hand and condoning corruption on the other. This aspect of development intervention deserves considerably more research.

Ugandan businesses do not operate according to western business textbook practice. The business and family are interwoven in such a way that financial and human resources tend to move freely from one to the other. In order to spread risk, enterprises tend to have fingers in many pies and are networked to other enterprises, politicians and public sector employees. Enterprises do not tend to keep written records or sign written contracts so an understanding of them from the outside is highly dependent on the narrative, or story telling. Further research is needed to investigate appropriate business development which builds on local culture yet improves business practice.

10.4 INSIGHTS INTO THE PUBLIC SECTOR AND COMMUNITIES

Despite funding increases to the water sector in Uganda, there remain other obstacles which undermine the development of sustainable domestic water supplies. Lack of technology with the requisite capability and which can be afforded and managed by local enterprises is but one of these obstacles.

Decentralisation comes hand in hand with increased demands for skills on staff at the local level, demands which cannot always be fulfilled. Districts and sub-counties vary enormously in terms of their capacity to mobilise communities, supervise construction work and administer contracts with the private sector. Adequate mobilisation is fundamental to stimulate demand for the new technology and to equip communities to maintaining their water source. Supervision is fundamental in order to ensure construction quality and thus improve the chance of well sustainability. Limited experience of tendering and contract management is a major obstacle to the success of privatisation policies and technology uptake.

Local contributions to water source improvements, often raised through local taxes are not always available or forthcoming. Low incomes and the low local tax base is at odds with the high national budget allocation for water supplies. District Governments are thus faced with the choice of *either* not requesting local contributions, (ie a supply driven rather than a demand drive approach) *or* not fulfilling their targets.

Reorganisation of the public sector has detracted from the new technology as individuals are too busy to fully participate in bringing about the requisite change which is required in order to support its uptake. Uptake of the technology in Uganda was constrained by reorganisation of the public sector.

Technological innovation in Uganda is constrained by poverty and the fight to combat it. Household and business poverty leaves little scope for the risk taking that technological innovation often requires. Many public sector employees are overworked and most are underpaid. Low salaries, chasing targets, budgets and following strict guidelines leaves little room in Government not only to innovate in terms of technologies, but also to try and find innovative ways of supporting the use of existing (or new) technologies. There is thus a need to find methods as well as human and financial resources which can support local innovation and its diffusion.

Uncertainty with respect to further retrenchment (redundancy) in the public sector coupled with privatisation has forced many individuals to operate with one foot in the public sector and the other in the private sector. This has proved beneficial for stimulating interest in the Pounder technology as it provides a potential means of improving individual livelihoods. This may partially explain the lack of major social or political challenges to the technology by Government. Attitudes may have been different had the work concerned the development and promotion of rainwater harvesting technology. This technology is considerably more accessible to artisans and small enterprises than the Pounder technology and could thus undermine current power distribution in the public and private sector.

10.5 INSIGHTS INTO THE PROCESS OF TECHNOLOGY TRANSFER

The technology can not be considered in isolation from the process of its development. Care and reflection needs to be taken in order to prevent the technology development process from undermining technology uptake. Stakeholder participation in the development process is key to ensuring that the technology is owned locally and can

become firmly rooted in the local context. This can conflict with the desire for high quality technology. Making this potential conflict explicit may help to reduce tension between stakeholders and help all to stand back from the process.

Joint planning between the external team and many Ugandan stakeholders was difficult. The foundation from which planning was considered as able to take place was different for different cultures. Where the external change agents tended to be prepared to plan despite uncertainties, local stakeholders in general were not. This difference needs to be taken into account in project design as well as implementation in order to avoid project failure due to deadlocks caused by cultural imperialism. A stage by stage process whereby one aspect of a project is completed before the next is planned may be more appropriate that trying to plan around uncertainties.

Designers and manufacturers of technology can easily wield disproportionate power in relation to other stakeholders. This can undermine equitable participation. Letting go of this power and maximising stakeholder participation can be extremely difficult. If technology development is to be truly participative, mechanisms need to be set up which redress this inherent power imbalance and allow real dialogue to take place. However, these mechanisms must also provide the space for innovation.

The Pounder technology requires considerable demonstration of its capability and applicability, including how its use is to be financed and institutionalised. The Pounder rig was demonstrated as being capable of providing successful water sources in geological formations containing hard layers. However, the extent of this demonstration in terms of number of wells drilled and geographic scope was limited. Further demonstration of the technology is required in order to encourage uptake.

The research findings suggest that more of a hands off approach by change agents may enable the new technology to be adopted more widely. The technology was taken up beyond the end of the project funding in the only District with whom the change agents had very little contact. However, given the decline in use of the hand auger equipment in Uganda, which was diffused with a hands off approach, this aspect of innovation diffusion requires further research.

Local availability of the new technology and requisite spares is paramount if organic uptake is to be enabled. Co-operation with local manufacturers and suppliers should have been much more extensive from early on in the project despite the

reservations about assuring quality. Technology transfer projects either need to be more aware of their relative short life and plan accordingly, or funding mechanisms and time horizons for such projects need to be jointly re-examined by the project funders, change agents, developers and key stakeholders.

Participative technology development is difficult to achieve given the inherent "messiness" of the process, ie its unpredictability and shifting goal posts. Further, when change agents depend on key stakeholders, they are opening themselves up to the possibility that things may not move in the direction that they choose. This can be very disturbing to those who are used to being in control.

Although the LCDP approach of developing a technology while facilitating its uptake by private enterprise has proved to be very challenging, it has allowed a strong interest and sense of ownership in the technology to be developed by a range of key stakeholders. Given the start-stop nature of project funding, this interest may be more important than the design of a high quality technology which is yet to be promoted. Certainly, there needs to be further research into the benefits of different approaches of stakeholder involvement in technology transfer for development.

The way in which donors fund and support such technology transfer projects can have an enormous effect on the success or failure of the intervention. There is a need for a *real* understanding on behalf of the donors of the project. There is a need for more interaction between funding bodies and change agencies. If donor staff knew more about the field realities, perhaps the projects with a positive impact would be able to stand out and be supported for sufficient time and with the requisite flexibility. Development as it is understood today, in particular "participative development" requires such *time* and *flexibility* on the part of the change agents. This requires time and flexibility on the part of the donors.

10.6 INSIGHTS INTO DEVELOPMENT

Private sector participation in rural water source provision is one aspect of current mainstream development thinking. However, where technology deployment requires significant labour inputs, a conflict exists between free community participation and paying for unskilled labour. This conflict has the potential to undermine technology deployment and community ownership.

Private sector participation in infrastructure development needs to take local capacity, culture and governance into account if equitable access to markets is to be realised. If this is not done, private sector participation in development may exacerbate the inequalities and poverty which development aims to overcome.

The concept of decentralisation suggests reduced centralisation. However, Uganda's decentralisation policies coupled with conditional grant funding actually mean that the workload of local Government has increased, but the power to decide how flexibly finances are spent still lies with central Government and the donors. The effects of this on the possibility for local innovation needs to be examined. In addition, in debating the merits of decentralisation for Third World development, there is the need for clear definitions of where power lies.

The approach followed by the LCDP has provided a vehicle from which to understand the effects of national policy and structural change at the local level. By developing a technology which was compatible with policy, trying to bring about its uptake and feeding incompatibilities back to policy level, the LCDP was able to straddle national policy and micro intervention.

Such an approach may provide a challenge to the *"impasse"* in Third World development (Booth, 1995). Small scale interventions such as these can provide a way of linking local development with macro policy, and a means of monitoring both - a reality check. Although Third World development may well benefit from more co-ordinated and more focused intervention, we must not forget the importance of considering such intervention from different angles, including the local level.

All stakeholders play a key role in enabling technology transfer to contribute to development. In the case of the LCDP, the change agents who facilitate the technology development, the donors who finance such initiatives, the donors who support Government, the Government which provides markets, the private sector which utilises the technology and the communities which benefit from the service the technology provides, are all fundamental to successful technology uptake.

One of the key insights that I take away from this research is the need for real dialogue and mutual understanding in order to facilitate Third World development. This dialogue includes real listening and a willingness to suspend one's own beliefs and

preconceptions. This is where the real learning begins and where development can be defined from within.

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