SOCIAL SUSTAINABILITY OF BIOGAS PRODUCTION IN SOGWALA VILLAGE, LOWER GWERU DISTRICT, ZIMBABWE

BY

NYARADZO DHLIWAYO

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SUPERVISOR: DR. A. DE WIT

DECLARATION

I, **Nyaradzo Dhliwayo**, declare that this thesis is my own work. It has not previously been submitted for assessment to another University or for another qualification. All sources used and quoted have to the best of my knowledge been properly acknowledged.

DEDICATION

To my dear mother and brothers, with love.

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ABSTRACT

The study has explored the social sustainability of biogas production in a local village of Sogwala which is located in the Lower Gweru District of Zimbabwe. The social sustainability assessment was based on the two concepts of social sustainability, namely human capital and social capital with particular emphasis on their respective elements and aspects. Qualitative and quantitative research methodology methods were used on a sample of 100 households using biogas and some key informants.

Analysis of the variance was used to determine whether biogas production could account for any effects on the social and human capital elements of the Sogwala community. An overview and descriptive statistics analysis of the findings from the study have been provided where the biogas users' experiences, perspectives are discussed and results were assessed. For instance, effects on the aspects of social capital elements which include increases in the social group membership of households after the introduction of biogas production the village; the performance of biogas energy as compared with other fuel sources in terms of accessibility, efficiency and the degree of labour needed for continual production of biogas. In view of the human capital element, assessment is done on the economic status per household before and after the production of biogas, where emphasis is placed on the aspects of employment, education and health indicators within the social sustainability context.

The fundamental benefits from biogas production are considered and discussed with the technical issues surrounding biogas production also being presented. This is not just a technical unit for providing alternative energy supply, but it requires management, labour and knowledge, skills to operate on a daily basis for it to have an impact that can bring positive change to the daily social lives of both the young and old.

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ABBREVIATIONS

LPG-	Liquefied Petroleum gas
SPSS-	Statistical Package for the Social Sciences
HIZ-	Heifer International Zimbabwe
WCS-	World Conservation Strategy
IUCN-	International Union for Conservation of Nature and Natural Resources
NGOs-	Non-governmental Organisations

CHAPTER 1:

INTRODUCTION

1.1 Introduction

In the context of rural development, especially in developing countries, wood has been the common source of energy used by people for domestic purposes (Chenje and Johnson, 1994). The excessive use of fuel wood has notably taken a toll on the environment across Africa and other continents, degrading natural forests and generally causing soil erosion, reduced soil fertility and plant growth (James and James, 2002). For many countries including South Africa, Zimbabwe, China, Namibia, Finland, Sweden and Nepal to name but a few, Biogas, which can be derived from the bio-digestion of animal dung and farm residues, has become a significant strategy as part of sustainable rural development. A number of environmental, economic and social benefits are claimed to be the result of the production and use of Biogas. However, while technology, including that associated with Biogas production, is generally used to improve human wellbeing as part of development programmes, new technologies is known to bring about both positive and negative impacts on sustainability and the lives of people (McKenzie, 2004).

Sustainability manifests in various forms, including environmental, economic and social dimensions. The focus of this study is mainly on the social sustainability of Biogas production via the impact thereof on aspects of human wellbeing. Some researchers including McKenzie (2004) regard the concept of sustainability as essentially structured around the notion of social sustainability with the question of human wellbeing obviously in a pivotal position. This study

furthermore subscribes to a conceptualisation of social sustainability that places two concepts, namely human capital and social capital, following the ideas of Goodland (2002) and Dubois *et al*. (2002), at the core of its enquiry about the impact of Biogas on human wellbeing.

Before the study background and identification of the research problem are outlined, a short synopsis of the technological aspects of Biogas production is presented in the next section.

1.2 The production of Biogas: a synopsis

Biogas as an odourless and colourless flammable gas which burns with a clear blue flame similar to that produced by Liquefied Petroleum Gas (LPG) (Sathianathan, 1975). It is produced from the bacterial decomposition and fermentation of organic matter in a bio-digester. The process is enabled by the addition of water to the organic matter and happens within an optimal temperature range of between 35 and 40 degrees Celsius (Parker, 2007).

One of the main attractions of Biogas technology is its ability to generate a flammable gas from organic waste which is freely available in most rural communities. Although this mainly includes cattle dung due to its abundance in rural settings, other sources of organic waste such as poultry and pigs, and even so-called *'night soil'* (human excreta), are also commonly used (United Nations, 1984; Engler *et al*, 1999). According to Fulford (1988), unwanted plant material, including weeds and invasive species such as water hyacinths can also be used to supplement animal and human waste in bio-digesters.

Biogas produced from the controlled bacterial decay of organic matter in a bio-digester largely consists of methane and carbon dioxide, with these gases constituting two thirds and one third of the total gas output respectively. Small amounts of nitrogen, hydrogen and hydrogen sulphide are also produced (Fulford, 1988; Parker, 2007). The calorific value of Biogas is roughly 20 Mega Joules per m^3 and it usually burns with 60% efficiency in a conventional Biogas stove (Fulford, 1988).

Apart from the flammable gas produced as primary output, bio-digesters also produce a secondary product as the digestion process readily converts organic waste into bio-manure. This by-product, also known as sludge, carries an added advantage in its potential application as a highly nutritious fertiliser (Parker, 2007).

Biogas digesters come in different shapes and sizes, depending on the use thereof and the end-user. The most widely used digesters are dome-shaped underground containers, constructed with inlet and outlet pipes. The organic waste material and water are fed into the digester through the inlet pipe, whilst the by-product material (sludge) eventually flows out through the outlet pipe. A gas pipe connected to the top of the digester collects the Biogas which flows to the end-user in a dwelling for example where the gas is used in various domestic applications (United Nations, 1984).

Biogas production is however also challenged by limitations. Balsam (2006) explains, firstly, that the process of digestion in bio-digesters can be relatively slow. Thus, for Biogas to be delivered at useful rates, a fairly large volume of organic waste as input material would be

required. Secondly, Biogas cannot be easily bottled for transportation and use at a relatively large distance away from the source of production. It is therefore only useful if bio-digesters are located fairly close to the end-users. In view of such limitations, Balsam states that it is important that decision-makers understand what Biogas production entails if it is to be effectively produced and if its advantages are to be enjoyed by people.

1.3 Study background and identification of the research problem

In an effort to meet the food and energy needs in many developing countries, extensive areas have been deforested as people, particularly in rural areas, search for firewood and land for cultivation. These activities frequently have serious environmental consequences, such as the disturbance of ecosystem processes, which raise the need for developing and implementing conservation measures. Such measures are usually of an integrated nature in the sense that apart from nature conservation, they also aim to maintain or improve the wellbeing of communities (WCED, 1987). The World Conservation Strategy (WCS) is an example of a conservation measure that follows an integrated approach in facing the challenges of ecosystem management and sustainable development (WCS, 1980). This strategy, prepared by the International Union for Conservation of Nature and Natural Resources (IUCN), recognises the need for international action to implement, stimulate and support national and local efforts in the restoration of ecosystems, thereby enabling local communities to manage and make the best use of their resources. As such, an important objective of the WCS is to maintain essential ecological processes, such as soil regeneration and protection, the recycling of nutrients and the purification of water on which human survival depends. To meet this objective, one of the approaches

suggested by the WCS involves the use of organic matter to produce Biogas. The general aim in this case is not only to assist rural communities to conserve their naturally available resources, but also to improve their wellbeing in the process.

Zimbabwe, a developing country in southern Africa and host to the case study of this investigation, faces critical challenges in the areas of energy accessibility and affordability (Gumbo, 2004). As such, the Zimbabwean Ministry of Energy and Power Development in partnership with the United Nations actively promotes the development of sustainable energy, particularly in the country's rural areas. In this case, Biogas comes highly recommended as an energy source with long term utilization potential (James and James, 2001). This promotion saw the actual implementation of Biogas production in a number of rural settings since 2003, with Sogwala Village in the Lower Gweru District of Zimbabwe's Midlands Province as one of the first recipients of this technology at the household level. In partnership with the Zimbabwean Ministry of Energy and Power Development and the Local Government Department of Veterinary Services, the installation of Biogas digesters in Sogwala Village was facilitated by the Non-governmental Organization (NGO), Heifer International Zimbabwe (HIZ). The introduction of Biogas to the village has since transformed the preferred choice of energy at the household level. A mix of energy sources is used by households here. Before 2003, fuel wood was the main choice of all households; paraffin was used in 92% of all households; LPG in 56% of all households; and 5% of all households used coal. Since the introduction of Biogas, the last-mentioned figures changed drastically. No households in Sogwala Village primarily rely on fuel wood anymore; paraffin is encountered in only 5% of all households; LPG in 17% and the use of coal has decreased to 3% of all households. Biogas on the other hand has largely been embraced

by the inhabitants of Sogwala Village since its introduction and has become the primary source of energy in all households (Gumbo, 2004).

Much has been written about the benefits of Biogas in terms of its household, industrial and other utilities. Austin (2003) for example states that Biogas holds wide ranging potential at the household level in its domestic application to meet heating needs and to provide energy for cooking, lighting, running water pumps and even generating electricity through internal combustion processes. Akinbami *et al*. (2001) furthermore report that Biogas has equally positive agricultural applications in its use for drying crops, pumping water for irrigation and providing a steady supply of fertiliser as by-product. According to Savola (2006), the organic waste (sludge) produced after digestion, contains nutrients that are present in any other original waste material, contributing an inexpensive form of fertiliser which enhances soil structure, soil fertility and of course crop yields. In its role as a way to conserve soil nutrients and also to manage organic waste, countries such as Finland and Sweden have already formally adopted Biogas technology. Moreover, as the Biogas Research and Training Centre (1989) reports, Biogas has many useful applications in small-scale industrial operations. Apart from its benefits in terms of electricity production, Biogas energy can be used wherever industrial heating applications are required, such as in the case of scalding tanks and drying rooms. In addition to the above, Biogas production is associated with significant advantages in the field of environmental health and environmental management. For example, Biogas production promotes environmental sanitation by transforming biodegradable organic waste from a potential public health liability in the form of pathogens and groundwater pollution into something with positive environmental utility in the form of useful organic fertiliser and a sustainable and inexpensive

form of energy. The latter of course aids air quality by displacing wood and fossil fuels such as charcoal and diesel, thereby reducing deforestation, greenhouse gas emissions as well as air pollution with its negative consequences for human health and respiratory function (Engler et al, 1999). The above amongst others also point towards the benefits of Biogas in an environmental sustainability context in the sense that it has obvious primary and secondary advantages over energy produced by means of wood and fossil fuels. However, as far as social sustainability and the effect of Biogas production on people's wellbeing is concerned, especially in rural settings, empirical research is largely unavailable (Feng *et al*., 2009). Theoretical assumptions nevertheless point towards several benefits. These include the following, namely:

- Biogas being a renewable source of energy produced from readily available inputs such as cattle dung;

- biogas supplying a viable alternative to fuel wood thereby providing rural women and children with more time to spend on daily activities other than searching for wood;

- biogas being an inexpensive source of energy with cost saving implications for the rural poor as far as the financial cost of conventional energy sources such as LPG and paraffin is concerned; and

- biogas contributing to water conservation and more water being available for personal use as a result of the recyclability of water used in Biogas digesters and the consequent secondary utilisation of such water for crop irrigation (Feng *et al*., 2009).

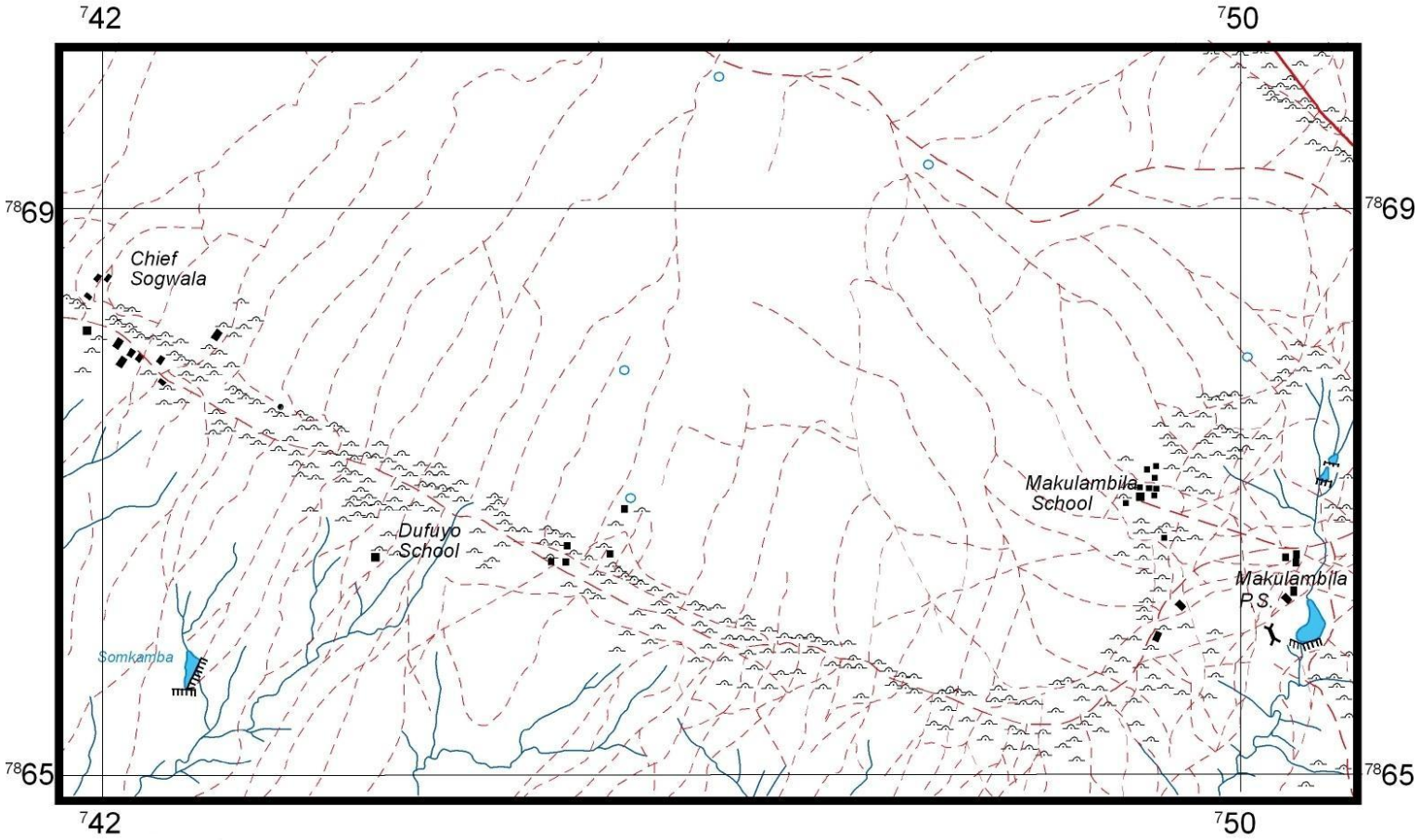
With the last-mentioned social benefits mainly derived through speculation, the time is ripe for an empirical evaluation of the social sustainability of Biogas, especially in a in a developing country such as Zimbabwe where this technology probably has significant social impacts on the largely poor rural population.

1.4 Sogwala Village as the study area

As noted in the previous section, Sogwala Village was one of the first recipients of Biogas technology in rural Zimbabwe. This village (See Figure 1.1) consisting of 300 households is located about 80 kilometres west of the town of Gweru in the Lower Gweru District, one of many districts in Zimbabwe's Midlands Province. Lower Gweru District consists of the Dufuya Ward which contains Sogwala Village and seven other rural settlements. These settlements owe their original establishment to the resources offered by the perennial Vungu River. In contemporary times however, due to the critical problem of rural poverty, the villages are largely supported by the development programmes of the National and Local Government, as well as that of a number of NGOs. These organisations include HIZ whose main development focus is on sustainable livelihood development with associated community support programmes offered in the areas of income generation, sustainable energy, community health and sustainable agriculture.

The Biogas production project in Sogwala Village was implemented with the facilitation and assistance of HIZ as a sustainable energy and conservation branch of a much larger Integrated Wetland Protection, Management and Utilisation project that was put into operation between

MAP OF STUDY AREA: SOGWALA VILLAGE



LEGEND

Road; Narrow Tarred.....

Gravel.....

Track.....

Huts, Staff Quarters.....

Built up area, Building.....

River.....

Dam.....

Borehole.....

Dip

Scale 1: 50 000 or 2 cm represents 1 km

2003 and 2006. The aim of the wetland project was to increase the capacity of local communities to restore and conserve biodiversity and ultimately to utilize wetlands sustainably. Wetlands in the Dufuya Ward were threatened by local livestock grazing practises, deforestation as result of the high demand for wood fuel, and generally unplanned and unchecked human utilization (GEF/SGP, 2006). The work of HIZ has since spread across Zimbabwe to other districts such as, Insiza (Matabeleland South), Matopos (Matabeleland North), Lower Gweru District, (Midlands Province) and Chipinge South (Manicaland), all which today are supplied with inexpensive and efficient energy in the form of Biogas. Local environments in these and other rural cases, according to Duve (2006), have all benefitted from the relief in pressure on natural resources brought about by the introduction of a sustainable source of energy. But, whereas Biogas production has seemingly contributed to environmental sustainability in rural Zimbabwe, not much is known about the social sustainability of Biogas and the associated impacts on people's wellbeing. Sogwala Village in this context is an appropriate case study.

Sogwala Village and its people were subject to a variety of socio-economic and other hardships that are normally associated with rural communities in contemporary Zimbabwe. Unemployment and almost no marketable skills, relatively high levels of household expenses due to large distances to the nearest commercial centre, expensive and hard-to-come-by sources of energy in terms of the time spent to acquire these, are just some of the key issues that defined the lives of the people of Sogwala Village. According to HIZ, the assumption is that the implementation of Biogas in the village would at least have alleviated some of these challenges and contributed to the people's wellbeing (One of the aims of the Biogas project in Sogwala Village for example

involved the transfer of skills to the people). What remains according to HIZ is to verify the extent to which people's wellbeing has been affected by the Biogas project (Maposa, 2009).

1.5 Aim and objectives

The aim of this study is to assess the social sustainability of Biogas production in Sogwala Village. In doing so, the following objectives are pursued:

- A theoretical investigation of the concepts of sustainable development and social sustainability in order to establish their meaning and operational implications.

- A theoretical investigation of human capital and social capital, the two concepts that emanate from the social sustainability concept in its focus on human wellbeing.

- A theoretical investigation of how social sustainability is measured via an empirical approach of human capital and social capital.

- Formulating a social sustainability methodology for the assessment of Biogas production and its impact on the wellbeing of the Sogwala Village community.

- Applying the social sustainability methodology on Sogwala Village as the case study.

- Presenting and discussing the research results produced by the application of the social sustainability methodology to Sogwala Village.

- Presenting a synopsis of research findings and critically evaluating the social sustainability research methodology and results of this study by means of a synthesis. This objective also involves recommendations for future research.

1.6 Study outline

Chapter One introduces the study and provides the contextual background against which the research is conducted. This chapter furthermore provides background information on Biogas energy and its uses and benefits. It also establishes the notion that the social sustainability of Biogas production remains largely unexplored. This chapter also outlines the study's aim and objectives, and provides a brief overview of the study area.

Chapter Two examines the concept of sustainable development by providing a theoretical overview and contextual definition of the concept. The social sustainability concept and its principles also receive attention. Further emphasis is placed on the two social sustainability elements that play a central role in determining the impact of Biogas production on community wellbeing, namely human capital and social capital, as well as their methodological implications.

Chapter Three is concerned with the formulation of study's research methodology. This includes the particular research design that was followed and furthermore involves the choice of relevant

indicators, the questionnaire design, fieldwork procedures and ways of data analysis and presentation.

Chapter Four presents the research findings obtained by the application of the study's methodology to the study area. It moreover presents the discussion and analysis of these results.

Chapter Five finally offers a synopsis of the research results, a critical evaluation of the research methodology and recommendations for future research.

CHAPTER 2:

SUSTAINABLE DEVELOPMENT AND SOCIAL SUSTAINABILITY: THEORY AND APPLICATION

2.1 Introduction

The concept of sustainable development was officially introduced to the world more than two decades ago. Sustainable development subsequently emerged as a new development paradigm which combined social, economic and environmental aspects of development into a single concern. These aspects of development are often called the different dimensions of sustainable development and have become an integral part of most contemporary development strategies.

From the outset the sustainable development debate was largely dominated by questions of environmental sustainability (Colantonio, 2007). Following strong protest from civil society against the initial absence of social issues in sustainable development discourse (Steyn, 2002), the relevance of people and their wellbeing was soon reaffirmed and the sustainable development debate thus enriched by the notion of social sustainability (Maloutas, 2003).

In this chapter, the concept of sustainable development is explored with the focus eventually placed on social sustainability. The measurement of social sustainability is unravelled thereafter with the emphasis on the methodological requirements of the

concepts of human capital and social capital. This will aid the formulation of the study's research methodology in Chapter Three.

2.2 Sustainable development

Since social sustainability represents the social dimension of sustainable development as the parent concept, it is necessary to elaborate on the meaning and implication of the latter. This will provide the required theoretical point of departure for the discussion of social sustainability and its measurement that follows later in this chapter.

The state of the environment, broadly defined to include both bio-physical as well as social aspects, as well related challenges facing humanity, have been the subject of increasing popular and academic concern for at least four decades. Challenges such as the increasing degradation of biodiversity, ecosystemic functioning and environmental services, as well as social problems relating to human wellbeing such poverty, inequality and social injustice, have since the early 1970s systematically led decision makers around the world closer to what would eventually became known as sustainable development – a development ethos purposefully conceived to manage and/or prevent the last-mentioned and other related problems (Lawn, 2001).

The actual concept of sustainable development was first officially introduced by the well-known Brundtland Report of the World Commission on Environment and Development (WCED, 1987). This report embodies the climax of global concern about the environmental (bio-physical) and social state of the world at the time and a reaction to the

apparent unsustainable growth and development path of humanity (Reid, 1995). Although sustainable development is known for having attracted a multitude of definitions (Lawn, 2001), one stands out as probably the standard definition by virtue of its universal popularity. This definition is offered by the Brundtland Report (USNRC, 1999) which describes sustainable development as:

> *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED, 1987:43).

In this basic form, the Brundtland definition mostly refers to the issue of inter-generational equity; explained by Castells (2000:118) as follows, namely that *"the conditions under which I live make it possible that my children and the children of my children will live under the same conditions"*. To provide more clarity, the implication of this definition is however also elaborated through several explanations, including:

- The emphasis that human needs are basic and essential; that economic growth needs to be revived to sustain basic need satisfaction, now and in the future, but with adequate consideration for equity and non-materialistic values.

- Efficient public participation, also with an emphasis on equity, is essential and required in order to share resources with the poor.

- Poverty alleviation and ensuring sustainable human wellbeing and population levels are vital since this will reduce pressure on the environment.

- Conserving and enhancing the earth's natural resource base should be emphasized; the integration of economic and environmental factors in decision-making is therefore required to ensure that the bio-physical environment remains resilient in the face of human activity and its effects (WCED, 1987).

The last-mentioned elaboration of what sustainable development entails is furthermore often supported by a number of generic principles (see Table 2.1) which illustrate the all-encompassing scope of this concept.

Since the publication of the Brundtland Report, the notion of sustainable development and related sustainability principles have gained considerable popularity and support worldwide. Sustainable development and all the associated environmental and social challenges, for example, were the focus of attention at several international events, such as the well-known 1992 Earth Summit and the 2002 World Summit on Sustainable Development. Such events also contributed to the establishment of sustainable development as a key and influential concept in development, planning and policy discourse (Steyn, 2002).

Sustainable development, particularly with reference to its Brundtland conceptualisation, has however not been without controversy. Redclift (1987) for example described the concept shortly after its official appearance as inherently self-contradictory, while Mawhinney (2002) warned that the vagueness of its basic definition makes sustainable development vulnerable and may leave it open for abuse. There is nevertheless

Table 2.1 Principles of sustainable development

- *Respect and care for the community of life*: Human activity should not compromise other human groups or any species in the bio-physical environment.
- *Improve the quality of human life*: Development must produce the means for healthy human lives and facilitate access to resources which have an influence on a decent level of human wellbeing.
- *Conserve the earth's vitality and diversity*: The structure of ecosystems, its functionality and bio-diversity must be protected.
- *Minimize the depletion of non-renewable resources*: The depletion of minerals, fossil fuels and other non-renewable resources must be avoided through recycling and the use of renewable alternatives.
- *Keep within the earth's carrying capacity*: Human population numbers and culture must be in harmony with environmental capacity. This capacity must also be enhanced through technology and sound environmental management.
- *Change personal attitudes and practices*: People must re-examine their values and change their behaviour to an ethic of sustainable living.
- *Enable communities to care for their own environments*: Communities must contribute to decisions that influence their own environments.
- *Provide a national framework for integrating development and conservation*: Countries must have legal capacity and viable legal and institutional frameworks to promote sustainable development.
- *Create a global alliance*: All nations must cooperate to advance sustainable living and sustainable development.

Source: Adapted from Fuggle (1998)

widespread support for and consensus about the virtue of what sustainable development ultimately aims to achieve – that is, inter-generational equity, facilitated by a long-term approach to improving human wellbeing through responsible development in the bio-physical environment (Urquhart and Atkinson, 2000). There is also agreement about the logic behind the so-called *'three pillar'* approach that is advocated by the essential implication of sustainable development; in other words, that it unites environmental, economic, and social objectives in an integrated approach (Vitalis, 2001). Sustainable development therefore presents a multi-focal agenda characterised by three inter-locking components, namely social, economic and environmental sustainability. All three sustainability dimensions are concerned with the maintenance of subject specific issues over time, something that is in line with the focus of sustainable development on meeting the needs of the present without compromising the needs of future generations (McKenzie, 2004; Munasinghe and Swart, 2005).

The concept of sustainability, technically, differs from that of sustainable development. According to Oelofse (2001), sustainable development in its Brundtland form may be very difficult or even impossible to achieve given the predominant and entrenched capitalist mode of production worldwide and its emphasis on the exploitation of resources. What matters then is that humanity should at least aim to strive towards sustainable development. This implies a process of change or transition over time towards sustainable development as the ultimate aim (USNRC, 1999), which, according to some proponents and from a pure conceptual point of view, is known as sustainability (Urquhart and Atkinson, 2000; Oelofse, 2001; Maloutas, 2003). The pursuit of

sustainability as progress towards a state of sustainable development has actually become an important feature of contemporary development initiatives and is regularly proclaimed by a range of institutions and political actors (Gibson *et al*., 2005).

With the above-mentioned three main forms of sustainability widely acknowledged in sustainable development discourse, economic sustainability in the first place is mainly geared towards improving human wellbeing via the production and consumption of goods and services (McKenzie (2004). Economic sustainability therefore depicts an economically sustainable system which is able to produce wellbeing related goods and services on a continuing basis while maintaining relevant resources and guarding against factors which may negatively impact on the production process (Goodland and Daly, 1996). Environmental sustainability on the other hand focuses on the protection of the integrity and resilience of ecological systems, achieved only when a stable resource base is maintained and over-exploitation of renewable resources avoided (Harris, 2000). Environmental sustainability thus refers to the maintenance of natural resources, ecosystems and ecosystem services, bearing in mind the needs of future generations (Goodland and Daly, 1996). The question of social sustainability finally involves the maintenance of human wellbeing or the improvement thereof where necessary (Gates and Lee, 2005). It involves a range of issues which obviously includes basic human needs given the prominence thereof in the Brundtland definition. But social sustainability also refers to other wellbeing determinants which relate to the social resource base and shared values of society and its constituent groups and networks (Harris, 2000). This dimension

of sustainability is the focus of this study and comes under closer scrutiny in the following sections.

2.3 Social sustainability

The Brundtland Definition highlights the notion of basic human need satisfaction, now and in the future, as one of the fundamental requirements for sustainable development (WCED, 1987). The question of basic human need satisfaction and the obvious implication of human wellbeing provide the background against which various but related conceptualisations of social sustainability have seen the light (Goodland, 1996; Koning, 2001; Dubois *et al*., 2002; Baines and Morgan, 2004). Social sustainability is defined by Chiu (2004) for example as something that concerns the improvement of people's livelihoods and, simultaneously of course, their wellbeing. This according to Chiu applies to present generations as well as those in the future. Bynner (2002) describes social sustainability in a similar vein as a state in which communities are self-sufficient by having equal opportunities and enjoying access to wellbeing related aspects such as education, employment and other essential social services. The latter descriptions are supported by Gates and Lee (2005) who refine them by adding that a definition of social sustainability should also involve reference to the ability of communities to maintain their wellbeing by developing their own resources and the resilience to prevent and/or resolve any challenges that may compromise a state of community wellbeing. Goodland and Daly (1996) add the notion of equity to the richness of the concept of social sustainability, while McKenzie (2004) supports an idea of the concept that describes it not only in terms

of a particular state of wellbeing, but also as a development process through which the capacity of current and future generations to create healthy and liveable communities are actively supported.

Descriptions of the meaning of social sustainability, such as those mentioned above, have also been synthesised into a number of principles which seek to capture the fundamental goals of socially sustainable communities. Looking at the work of Koning (2001), Dubois *et al*. (2002), Barron and Gauntlett (2002), Baines and Morgan (2004), Gates and Lee (2005) and McKenzie (2004) for example, the following principles can be derived:

- *A decent level of wellbeing.* This on the one hand involves meeting basic human needs at the individual, group as well as the community level. On the other hand it also involves subjective elements including the fact that community members should have a sense of belonging, self-worth, safety and security, connection with nature, empowerment and responsibility, as well as self-reliance. An acceptable level of wellbeing is amongst others also evident in quality education, health and health care, employment and income, housing and infrastructural services, and a clean and safe natural environment. Community members furthermore have opportunities for personal and social development.

- *Inter-generational equity* involves a situation whereby the wellbeing of future generations is not compromised by the activities of current generations.

- *Inclusivity* involves the promotion of community cohesion. Communities are usually socially diverse in nature and this principle therefore aids the acceptance of social difference and tolerating diverse groups of people in communities. It also promotes the avoidance of social exclusion based on socio-economic attributes and consequently the importance of addressing social inequality and distributive injustice.

- *Interconnectedness* involves the promotion of community networks as well as trusting, harmonious and cooperative behaviour between social groups and between individuals. Interconnectedness is the foundation of social mobilisation, community action and a functional civil society.

- *Maintenance of human capacity* involves the maintenance of personal resources that individuals can use in aid of their own wellbeing and the wellbeing of the community as a whole.

- *Democracy and governance* involves the provision of democratic processes and open and accountable governance that facilitate a socially sustainable community. In this case, community members have access to information, knowledge and expertise; they are included in participation processes which are both open and accountable; democratic processes and governance structures are effective; there is integrity in democratic processes and governance and these incorporate social justice and constitutional rights.

- *Equity* refers to the provision of equitable opportunities and outcomes for all members of a community, particularly the poorest and most vulnerable. While equity is listed here as an individual principle, it is such a fundamental aspect of social sustainability that it cannot be separated from the others. Thus, it becomes an essential guideline for all the other principles.

With reference to the above principles, it is important to state that, although they represent a meaningful collection and provide valuable insight into the meaning of social sustainability, not all are equally applicable to all cases. This is largely because social sustainability is a locally produced and historically constructed concept as argued by Sandham and Van der Walt (2004). Some principles may therefore be more applicable than others in the context of place specific challenges. Such principles may even be the point of departure for the operational refinement of the dynamic social sustainability concept. Koning (2001), Goodland (2002), OECD (2001), Dubois *et al*. (2002), Malan (2004) and Gates and Lee (2005) for example focus on the question of human capacity as well as the interconnectedness of social groups and people in order to promote a conceptualisation of social sustainability in terms of human capital and social capital.

Capital is a term that has been defined depending on the particular context of reference. Capital in its traditional form is usually described in terms of produced commodities for use in the production of goods and services and the accumulation of wealth (Halpern, 2005). In the context of sustainability however, capital refers to a range of assets that produce outcomes similar to that promoted by sustainable development (Lin *et al*, 2001;

Green *et al*., 2005). Such assets would include fixed capital (such as machinery or buildings) as well as natural capital (such as natural resources, ecological services, and clean and healthy environments). But it would also include human capital (including people's health and education) and social capital (including social groups, networks and trust). The maintenance and improvement of capital in its last-mentioned forms is of course an essential goal of sustainable development – that is, to ensure that future generations receive similar if not better stocks of capital with which to enable acceptable levels of wellbeing. Whereas the maintenance and improvement of fixed and natural capital allow for the realisation of economic and environmental sustainability respectively, the maintenance and improvement of human and social capital alternatively facilitates and is the concern of social sustainability (Goodland, 2002; Koning, 2001; Dubois *et al*., 2002; Stephens, 2005). It should finally be noted that, since sustainability is a multi-dimensional concept comprising different but highly interrelated domains, the different forms of capital do not act in isolation but contribute and are sometimes dependent on one another (Cuthill, 2003).

Since human and social capital play a central role in this study's social sustainability focus, both concepts are further investigated in the following sections.

2.3.1 Human capital

Human capital was originally used as a concept by economists in the mid 20th century who referred to it as an important determinant of economic prosperity. Human capital in this particular context described the favourable economic consequences of investments in education and health care; aspects in other words that would contribute to individual productivity and the creation of wealth (Laroche *et al*., 1999). Although this conceptualisation remains relevant today, human capital – from a social sustainability point of view and with the focus on human wellbeing – seems to have a wider implication. The Organization for Economic Cooperation and Development for example defines human capital as capital that not only encompasses knowledge, skills and competencies, but also other attributes that facilitate personal, social and economic wellbeing (Appleton and Teal, 1998; OECD, 2001). Similarly, Coleman (1988) explains that human capital refers to an individual's ability to work in order to generate income and it therefore includes a wide range of determinants such as health, safety and security, favourable environmental conditions, skills acquired through training and education, access to social infrastructure and services, as well as people's psychological wellbeing.

The last-mentioned determinants of human capital are naturally related to that of human wellbeing. They also strongly remind of the Social Indicators Movement and its operational approach of human wellbeing via objective and subjective indicators. The Social Indicators Movement, a collective noun describing the research drive focussing people's wellbeing since the early 1970s, established the conseptualisation of human

wellbeing as either an objective or subjective condition (Rossi and Gilmartin, 1980; Møller and Schlemmer, 1983). Objective wellbeing refers in the first place to the extent to which people's basic needs are satisfied (Barreiros, 1988). Such needs include a range of immediate needs such as food, clothing, health, education, and housing for example, as well as other needs such as infrastructural services, transport, income, employment, recreation, and a safe and aesthetic living and natural environment (Doyal and Gough, 1991). Such basic needs generally point to the quality of the physical living conditions of people – as objectively observed from the outside – and it is therefore referred to as objective well-being (Barreiros, 1988). Subjective wellbeing on the other hand refers to human wellbeing as a subjective condition with the focus on the personal experience and perceptions of people via determinants such as their happiness and/or satisfaction (Møller and Schlemmer, 1983).

In social sustainability research and policy application, emphasis is largely placed on addressing problems related to people's objective wellbeing – such as poverty, social injustice and social inequality (Goodland, 2002; OECD, 1998; OECD, 2001). Such problems according to Goodland (2002) are an indication that human capital is inadequately maintained and unevenly developed in societies where it occur, something that has a crippling effect on human capital and evidently on sustainable development and social sustainability as well (Labuschagne *et al*., 2003).

With human capital mainly related to the social sustainability principle of *a decent level of wellbeing* as noted in the previous section, the measurement of this concept is addressed in Section 2.4.1.

2.3.2 Social capital

Social capital relates to the *interconnectedness* principle of social sustainability and is often loosely described as the glue that holds society together (Seralgeldin and Grootaert, 1997). Several more specific definitions were however formulated by numerous authors in recent times. According to Brunckhorst (2002) for example, social capital refers to the state of social relations amongst people in groups or communities, while Grootaert and Van Bastelaer (2002) describes social capital in terms of the institutions, relationships, attitudes and values that govern such interactions. The most well-known definition – judging by its popularity as a reference – however comes from Putnam (1996:66) who equates social capital to the *"the features of social life – networks, norms and trust – that enable participants to act together more effectively to pursue shared objectives"*. Social capital is therefore a resource for collective action in the sense that it can be mobilised by communities (Portes, 1998) in order to collectively achieve a wide range of benefits that are related to the betterment of their lives (Lin et al, 2001; Halpern, 2005; Engbersen *et al*., 2006).

With reference to Putnam's (1996) definition above, networks include a wide variety of formal and informal social groups and communities with an unlimited number of

functions. Networks of friends and families are obvious examples as well as clubs, associations and even political parties. Such networks are also known as structural social capital which highlights the connectedness of people as an important element in social capital. Generally, the more social groups people are involved with, the stronger social capital is (Grootaert and Van Bastelaer, 2002; Field, 2003). Structural social capital is often divided into bonding capital, bridging capital and linking capital in order to illustrate how this form of social capital functions (Coleman, 1988). Bonding capital is something that enables cohesive relationships and cooperation within a single social group or society, while bridging capital facilitates cohesive relationships and cooperation between different social groups (Putnam, 2000a). Linking capital enables the cooperation between communities or groups and external authorities such as governmental departments and NGOs for example (Grootaert *et al*., 2004).

Norms in Putnam's (1996) definition – also known as cognitive social capital (Grootaert and Van Bastelaer, 2002) – underlie the functionality of networks (Uphoff, 2000) and therefore refer to the ingredients which facilitate cohesion and cooperation within and between communities and groups (Fukuyama, 2001). Examples include so-called *'traditional values'* according to Fukuyama such as honesty, reciprocity and even the simple and timeously honouring of commitments. Reciprocity is however sometimes isolated as a key norm in social capital. It entails that mutually supportive behaviour can be expected by members of a social group or community through the reciprocal relationships embedded within (Putnam, 2000a). The same can be said for the issue of trust which, when it is evident amongst members of a community, is an essential and

enabling factor when cooperation is at stake (Pretty, 2002). It follows in conclusion that the strength of social capital is not only a factor of the number of social groups that people belong to, but is also determined by how well such groups cooperate with other groups (within and outside communities) and importantly of course by the state of existing cognitive social capital (trust in particular). Social capital is therefore a complex and highly integrated phenomenon.

Much has been written about the value and positive outcomes of strong social capital which, according to Blanco and Campbell (2005), can be observed at all scales. For example, the strength of social capital is an important predictor of long-term economic performance and development at the national level (Luiz *et al*., 1999), while the role of strong social capital is described to have an equally positive effect on local economic development via more adequate and efficient performance of public agencies (World Bank, 1997). It is also at the local level that strong social capital holds numerous potential benefits via community development that relies heavily on collective action and cooperation (Wilson, 1997). Networks, at the level of business corporations, furthermore contribute significantly to information and knowledge exchange and ultimately to productivity and profit (Lin *et al*, 2001). Finally, strong social capital at the level of individuals, through networks and various social ties that enable people to work together, is deemed to facilitate almost limitless personal wellbeing benefits ranging from improved access to employment, housing and social infrastructure to enhanced personal security, health and subjective wellbeing (Coleman, 1988; Putnam, 2000b).

Looking at the above benefits of strong social capital, it is not difficult to appreciate the value of social capital as an important factor of social sustainability in general and people's wellbeing in particular. Rudd (2000) is even of the opinion that the question of social capital provides a nexus for the conceptual basis of social sustainability research. How social capital is measured is the focus of discussion in Section 2.4.2.

2.4 Measuring social sustainability

Moving from the theoretical discussion of social sustainability to an operational level requires, in the context of this study's conceptualisation of social sustainability in terms of human and social capital, that the latter two concepts be subjected to measurement.

The current spectrum of social sustainability assessment techniques and indicators are very wide. Largely the result of the inherent abstract nature of social sustainability (and particularly social capital), this represents a challenge since no universally accepted methodology exists as noted by Griebler (2005). Methodologies furthermore tend to be context specific and are largely formulated to aid place specific policy and decision-making processes (Burdge, 1994; Vanclay, 2002). It would nevertheless be possible to adapt a methodology for application in this study from the wide range of existing techniques and research experience elsewhere. This is the focus of the following two sections.

2.4.1 Measuring human capital

With human capital broadly equated to a state in which people enjoy a 'decent' level of wellbeing, something that will enable them to be economically productive, self-sufficient and to ensure that future generations have the chance to follow suit, this section looks at how human capital can be measured. Looking at the determinants of human capital that were noted in Section 2.3.1 – health, safety and security, favourable environmental conditions, training and education, access to social infrastructure and services, people's psychological wellbeing and so on – an established research tradition developed amidst the activities of the Social Indicators Movement that enables the measurement of such aspects.

Against the background of the determinants of human capital from an objective wellbeing point of view, measurement requires that human capital first be deconstructed into its relevant components. This fundamental step comes from a number of researchers who, amongst others, and throughout the evolution of social indicators research since the early 1970s, focussed on the measurement challenge (Pacione, 1984; Eyles, 1987; Walmsley and Lewis, 1993; Clark and Wilson, 1994; Herbert and Thomas, 1997). These authors all refer to the seminal work of Smith (1973) as point of departure and one of the most influential attempts at measuring objective wellbeing. Smith basically derived a number of components and sub-components – or categories of human needs – from his view of human wellbeing as a state of basic needs satisfaction (See Table 2.2). Since these components remain abstract and not directly measurable on their own, a number of

Table 2.2 Smith's wellbeing components

COMPONENTS	
Income, wealth and employment:	• Income and wealth • Employment status • Income supplements
The living environment:	• Housing • The neighbourhood • The physical environment
Health:	• Physical health • Mental health
Education:	• Achievement • Duration and quality
Social order	• Personal pathologies • Family breakdown • Crime and delinquency • Public order and safety
Social belonging (alienation participation):	• Democratic participation • Criminal justice • Segregation
Recreation and leisure:	• Recreation facilities • Culture and the arts • Leisure available

Source: Smith (1973:70)

measurable social indicators were selected. As an example in this case, Table 2.3 presents a selection of Smith's indicators for economic status, education and health – three important components of human capital. Social indicators such as those in Table 2.3, according to Rao (1978), are also known as objective indicators because they reflect the respective components as objectively viewed by an 'outside' observer (researcher). Data furthermore come from objective sources, usually from census reports or fieldwork surveys gathering objective information.

The number and nature of social indicators that are selected obviously needs consideration but guidelines in this case are very limited. This is mostly the result of the fact that research endeavours in which social indicators are used are usually place specific and highly dependent on what data is available. This leaves individual researchers themselves with the choice on which particular indicators to include and how many. It is nevertheless advised that components at least be represented by carefully selected indicators, even if limited in number (Baster, 1978; Rossi and Gilmartin, 1980; Smith, 1987; Barreiros, 1988). Whereas limited advice can be derived from existing social indicators research concerning the number and nature of indicators, the application of social indicators remain subject to a list of other requirements. Knox (1975), Carley (1986), Armstrong *et al*. (2002) and Hemphill *et al*. (2004) all agree that indicators should be easy to understand and directly measurable; should reflect place specific needs and priorities as well as the aims of policy and planning; and be able to be used as an indication of the outcomes of a system instead of inputs therein.

Table 2.3 A selection of Smith's wellbeing components and social indicators

Components		Objective indicators
Economic status:	• Income	- *Per capita* annual income - % families with annual income < $ 3 000 - % families with annual income > $ 10 000 - % families below poverty level
	• Employment	- Unemployed persons (% of total work force) - % persons aged 16 - 64 working < 40 weeks per year - % white collar workers - % blue collar workers
	• Welfare	- % families on welfare programmes - % pensioners on Old Age Assistance programmes
Health:	• General mortality	- Infant mortality per 1 000 live births - Death rate per 10 000 persons aged ≥ □65 years
	• Chronic diseases	- Cancer deaths per 100 000 population - Stroke deaths per 100 000 population - Heart disease deaths per 100 000 population - New tuberculosis cases per 10 000 population
Education::	• Duration	- % persons aged 18 - 24 years with ≥ 4 year's tertiary education - % persons aged ≥ 25 years with ≤ □8 year's school education - % persons aged ≥ 25 years with 4 year's secondary education - % persons aged ≥ 25 years with 4 year's tertiary education

With human capital subsequently measured by dividing this concept into components and measurable indicators, the focus of attention now moves to the methodological requirements of social capital.

2.4.2 Measuring social capital

Social capital has been defined in Section 2.3.2 – following Putnam's (1996) well-known description – as the social networks, norms and trust which determine the level of cooperation of groups and communities in pursuit of common objectives. But in spite of the popularity of this theoretical definition, social capital is considerably more complex to operationalise than human capital. Firstly, social capital as a concept, with reference to determinants such as norms and trust for example, appears a lot more abstract than human capital. Secondly and according to Bjørnskov and Svendsen (2003), social capital researchers generally do not agree on how to measure this concept. What many researchers subsequently do according to Schuller (2000) and Grootaert *et al*. (2004) is to subscribe to Putnam's (1996) definition or some variant thereof, followed by the selection of an *ad hoc* fieldwork-based methodology.

Social capital is basically measured in the same way as human capital. The concept is defined and then deconstructed into components and measurable indicators (Van Deth, 2002). However, the result of social capital's relatively unconsolidated status when it comes to measurement is considerable methodological difference when various works are compared. According to Mikkelsen (2005) for example, measurement should at least

include some reference to networks, norms and outcomes of social capital, while Grootaert *et al*. (2004) promote a wide variety of components, namely groups and networks, trust and solidarity, collective action and cooperation, information and communication, social cohesion and inclusion, and empowerment and political action. Whiteley (1997) and Halpern (2001) focus only on a single component, namely trust. Thomas (2003) uses two components to measure social capital including group membership and civic engagement, while the focus of the OECD (2001) is on social networks and reciprocity.

Looking at the above, guidelines for the selection of social capital components and indicators are obviously in short supply. General advice nevertheless comes from Krishna and Shrader (2002) who emphasise that empirical research should at least cover the main dimensions of the social capital concept, namely structural and cognitive social capital. When selecting social capital indicators, Stone (2001) highlights that indicators should be informed by social capital theory to ensure that some academic standard and control is at least maintained amidst the wide variety of contemporary methodologies. Stone moreover cautions that indicators of social capital's outcomes – such as those reflecting trends in personal income and employment for example, or increased unity and cooperation within a community (Woolcock, 1998; Smith *et al.,* 2002) – should not be applied as indicators of social capital itself (such as the number of social groups that people belong to or the extent to which people trust one another). Confusing social capital with its outcomes often occurs according to Stone (2001) as a result of a misunderstanding of social capital theory.

Advice such at that noted above is valuable because the number and nature of indicators chosen to measure social capital show great variance between studies with researchers, according to Van Deth (2002) and Munasinghe and Swart (2004), mostly relying on questionnaire surveys to gather data. Putnam's (2000a) social capital indicators are shown in Table 2.4 as an example. This selection meets the basic requirements set by Stone (2001) and Krishna and Shrader (2002) above.

Measuring social capital may present the researcher with a number of challenges, but the international drive to make progress in this case already has gained considerable momentum (Stone, 2001). Until social capital research is as well established as its human capital counterpart, the few methodological guidelines that do exist would play an important role in providing the basic parameters within which empirical investigations are conducted.

Table 2.4 Putnam's components and indicators of social capital

Community or organisational life:

- % of individuals who served on a committee of a local organisation in the past year
- % of individuals who served as an officer of some club or organisation in the past year
- Civic and social organisations per 1 000 of the population
- Average number of club meetings attended in the past year
- Average number of group memberships

Engagement in public affairs:

- Turnout in presidential elections, 1988 and 1992
- % of individuals who attended public meeting on town or school affairs in the past year

Community volunteerism:

- Number of non-profit organisations per 1 000 of the population
- Average number of times worked on a community project in past year
- Average number of times did volunteer work past year

Informal sociability:

- % of individuals who agree that *"I spend a lot of time visiting friends"*
- Average number of times entertained at home past year

Social trust:

- Percentage of individuals who agree that *"most people can be trusted"*
- Percentage of individuals who agree that *"most people are honest"*

Source: Adapted from Putnam (2000:291)

2.5 Conclusion

With sustainable development and particularly social sustainability as focus, this chapter has explored the theoretical context within which the current study plays out.

Sustainable development in its most basic conceptualisation places emphasis on two essential outcomes: a) that basic human needs satisfaction and acceptable levels of human wellbeing are paramount and should be achieved, and b) that this should happen without distracting from the integrity and functionality of the bio-physical environment, or from the potential of future generations to achieve the same. With sustainable development in this form as the ultimate aim, sustainability is the transitional process through which progress towards this aim is made. Principles of sustainability which support the last-mentioned conceptualisation of sustainable development represent a wide spread of issues that are subsumed within at least three sustainability dimensions - economic, environmental and social sustainability.

Social sustainability places a heavy premium on basic need satisfaction and the maintenance or improvement of human wellbeing where necessary so that future generations may enjoy similar prospects. By implication, social sustainability is a concept that is inclusive of a particularly broad range of concerns and principles. Some researchers have however refined its focus to the implication of two concepts, namely human capital and social capital.

Human capital encompasses attributes that facilitate and/or determine human wellbeing, such as people's health, their safety and security, skills acquired through training and education, and the access they have to social infrastructure and services and so on. Measuring such attributes takes place through the use of components of human capital and the selection of relevant and representative indicators.

Social capital or the interconnectedness of people on the other hand is also strongly linked to human wellbeing, but through a particular conceptualisation that emphasises attributes such as social networks, norms and trust. These are viewed as significant determinants of personal and community wellbeing. They also influence how well groups and communities cooperate in pursuit of common and wellbeing related objectives. Social capital is measured by means of indicators of its constituent components, such as structural capital (social networks for example) and cognitive capital (including the essential issue of trust).

Finally, the emphasis of this study is not a generic one; in other words it does not concern itself with the state of social sustainability as it generally manifests in a rural Zimbabwean village. The focus rather is on the social sustainability of a renewable form of energy, namely Biogas, and specifically the influence thereof on social sustainability via its impact on human and social capital. With the theoretical background in this chapter as point of departure, a suitable research methodology is formulated in the next chapter.

CHAPTER 3:

RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter presented a theoretical background of the social sustainability concept and its empirical assessment via human and social capital. The present chapter expands this theoretical background into the formulation of a place specific methodology for application to the case study, namely Sogwala Village and the social sustainability of Biogas production there.

This chapter commences by discussing the formulation of a methodological framework for application to Sogwala Village. Included are the methodologies for assessing the social sustainability of Biogas production in the village via its impact on human and social capital. This involves the selection of human and social capital indicators and its translation into a questionnaire format and interview schedules. An elaboration of how data was collected in Sogwala Village through the application of a pre-designed fieldwork procedure follows. The chapter is concluded by an outline of the way in which the collected data is finally presented and analysed.

3.2 Methodological framework for application to Sogwala Village

The aim of this study is to assess the social sustainability of Biogas production in Sogwala Village. With sustainability referring to a process of change or transition to sustainable development, this aim implies that the researcher looks at ways in which Biogas production contributes to or distracts from the progression towards social sustainability in Sogwala Village. This requires, apart from an obvious focus on the influence of Biogas production in human and social capital in the village, that a typical before-and-after approach be followed when relevant indicators are formulated. Against this background, the following sections specifically highlight the selection of human and social capital components and indicators for application in Sogwala Village. It furthermore outlines the use and application of key informant interviews as well as the particular fieldwork process that was followed.

3.2.1 Assessing the impact of Biogas production on human capital in Sogwala village

A conceptualisation of human capital is supported in this study that conforms to the discussion in Section 2.3.1 of the previous chapter and its collusion that human capital basically refers to a state within which people enjoy a decent level of wellbeing. An approach to assessing human capital in Sogwala Village was therefore followed similar to the way in which human wellbeing related components are assessed by researchers in the Social Indicators Movement (See Section 2.4.1). This means breaking the human capital concept down into its constituent components and then selecting measurable indicators

for each.

For operational purposes of this study, a definition of human capital is supported that corresponds to the way in which this concept is generally approached in a social sustainability context – that is, human attributes that facilitate personal, social and economic wellbeing (See Section 2.3.1). In order to deconstruct this abstract description into more operational parts, a wide range of components for possible inclusion exist (See Table 2.1 for example). It was nevertheless decided to limit the range of human capital components to three only – that is, economic status, education and health. The following considerations informed this decision:

- The main consideration that influenced the selection of only three human capital components firstly lies in the rural and relatively undeveloped character of Sogwala Village. The social economic conditions of the village to a large extent can be described as mostly egalitarian. The 300 households of this village live in traditional structures and dwellings for example (mud walls and thatched roofing) with none of the infrastructure and services present that one would normally associate with a developed urban suburb. It would therefore make little sense to include components that are related the development levels of urban areas such as housing, infrastructure and services as this is not likely to yield significant results.

- Although several components of human capital can possibly be selected for empirical investigations, economic status, education and health capture the essence of the concept and are therefore key components (Malan, 2004; McKenzie, 2004).

The meaning that each component assumes in this study, following OECD (1998), Coulombe *et al*. (2004), Malan (2004) and McKenzie (2004) can be described as follows:

- The *economic status* component in the first place involves the productive capacity of people and their economic wellbeing with reference to their employment, skills and the applicability thereof, household expenses, and unproductive time (time spent looking for fuel wood for example that could have been spent otherwise).

- The *education* component secondly involves the empowerment of people with reference to their educational attainment.

- The *health* component finally involves the physical wellbeing of people with reference to aspects that contributes to or distracts from their physical health.

The indicators selected to represent each component are shown in Table 3.1. The selection of indicators is mainly the result of the fact that no objective information, such as census data, exists for Sogwala Village. The application of a questionnaire survey would therefore be the only way to gather data on human capital. Since the assessment of social capital in the village survey forms part of this survey, the number of questionnaire

Table 3.1 Human capital components and indicators for application to Sogwala Village

Economic status:
• Persons (age > 15) employed before Biogas production
• Persons (age > 15) employed after Biogas production
• Skills gained from the Biogas production project
• Applicability of skills gained from Biogas production
• Domestic expenses before Biogas production
• Domestic expenses after Biogas production
• Time spent per household to acquire energy sources before Biogas production
• Time spent per household to acquire energy sources after Biogas production
Education:
• Highest school qualification per household (age < 18) before Biogas production
• Highest school qualification per household (age < 18) after Biogas production
Health:
• Health related advantages / disadvantages of Biogas production per household

items had to be limited in order to keep the size of the instrument manageable. This according to Neuman (2003) is an important requirement in order to ensure that an acceptable response rate is obtained in questionnaire surveys.

In line with the description above, the *economic status* indicators aim to assess the impact of Biogas production on the economic situation of people in Sogwala Village. It therefore includes indicators of the way in which people's employment status was influenced by Biogas production; the possible skills gained by them through the Biogas implementation

and production process; as well as the applicability of such skills in aid of their economic status. These related indicators follow on one of the secondary aims of the Biogas project in Sogwala village – that is, the fact that the project, apart from benefits in the field of environmental sustainability, is also assumed to hold socio-economic benefits for the community. This amongst others includes the transfer of marketable skills to the villagers which would hopefully influence their employment status (See Section 1.4). The particular age cohort used for the employment indicators comes recommended from CSO (2002) and ILO (2008) and makes sense in the context of Zimbabwe where people from a relatively young age these days have to engage in economic activity in order to make a living.

It is also expected that the use of Biogas would have had an impact on domestic expenses since its inception. For example, less money would now be spent on conventional energy sources (mainly paraffin, LPG and coal) while the availability of fertiliser in the form of sludge would potentially lead to an increase in local food production and a subsequent decrease in food related expenses. Indicators subsequently assessed the impact of Biogas production on domestic expenses as well. The actual expenses that were selected for investigation include food, clothing, health care, transport and education. This collection is not only aligned with the importance of basic human needs in the concept of human capital, but could possibly be linked to Biogas production following preliminary and informal discussions with households in Sogwala Village. These were conducted for reconnaissance purposes with the traditional leadership and a number of households in Sogwala Village about the general impact of Biogas on their daily lives.

The final economic status indicators assess the impact of Biogas production on the dilemma of unproductive time – that is, the time spent by members of the community to acquire conventional energy sources, including wood fuel. By virtue of its rural location and unavailability of electricity, inhabitants of Sogwala village had to spend a considerable amount of time travelling in order to purchase sources of energy and/or to gather wood fuel.

The *education* indicators aim to assess the educational attainment of people as a result of Biogas production. These indicators follow the assumption that, with the availability of Biogas energy, people's educational status would have improved as a result of more time available for education and learning, as well as the fact that illumination after hours is no longer the limiting factor that it used to be.

The *health* indicator aims to assess the impact of Biogas production on people's physical health by obtaining a comparative view of health related impacts of different sources of energy, biogas included. The way this indicator is formulated in the relevant questionnaire item was also the result of preliminary and informal discussions with households in Sogwala Village.

The indicators in Table 3.1 are translated into questionnaire items which are formulated to provide the necessary data with which to assess the impact of Biogas production on

human capital in Sogwala Village (See Appendix A).

3.2.2 Assessing the impact of Biogas production on social capital in Sogwala village

An operational conceptualisation of social capital is supported in this study that approaches this element of social sustainability in terms of two components, namely *structural* and *cognitive social capital*. This follows the advice from Krishna and Shrader (2002) that social capital research should at least cover the main dimensions of the concept. A third component was also selected for application to the village, namely *social capital outcomes*. This according to Grootaert *et al.* (2004) refers to some of the key ways in which social capital operates or manifests itself in a community. This component is often found in social capital research (Woolcock, 1998; Smith *et al.*, 2002).

The indicators selected to represent each component are shown in Table 3.2 and were largely adapted from the work of Grootaert *et al.* (2004) who, under the auspices of the

Table 3.2 Social capital components and indicators for application to Sogwala Village

Structural social capital (groups and networks):

- Social group membership per household (number of social groups) before Biogas production
- Social group membership per household (number of social groups) after Biogas production
- Influence of Biogas production on social group membership per household
- Roles performed in the most important social group per household (and the influence of Biogas)
- Diversity of members in the most important social groups that households belong to
- Frequency of interaction of the most important social group that households belong to with social groups outside the village (after Biogas production)
- Possibility of financial assistance from people outside immediate family circles (after Biogas production)

Cognitive social capital (trust):

- General level of trust in the community before Biogas production
- General level of trust in the community after Biogas production
- Willingness to support a community project for the benefit of the wider community
- Level of trust expressed towards community leaders
- Level of trust expressed towards non-governmental organisations

Social capital outcomes:

- Social cohesion – social unity within the community after Biogas production
- Cooperation – cooperation within the community after Biogas production
- Subjective wellbeing – global satisfaction and the influence of Biogas production
- Empowerment – personal control over issues which may influence the course of life (and the influence of Biogas production)

World Bank, developed a valuable and comprehensive measuring instrument (lists if indicators and guidelines) to support social capital surveys at the household level.

In the case of this study, the *structural social capital* component mainly refers to the dynamics surrounding *groups and networks* and the subsequent utility that flows from this important element of social capital. Relevant indicators in Table 3.2 therefore include:

– Social group membership of respondents (before and after Biogas production).

– The frequency of interaction of social groups in Sogwala Village with other groups on the outside.

– The possibility of financial assistance from people outside immediate family circles (after Biogas production).

The *cognitive social capital* component mainly refers to the essential issue of trust, with indicators in Table 3.2 including the following:

– The level of trust in the community before and after Biogas production.

– The trust expressed by respondents towards community leaders as well as relevant NGOs (HIZ as the Biogas implementing agency as well as the Netherlands

Development Organisation who act as a market for surplus food as will be explained in Chapter Four) (including the influence of Biogas production).

– The willingness of respondents to support a community project for the benefit of the wider community.

In the case of Sogwala Village, community leaders (traditional leadership) and HIZ (the implementing agency) played an essential facilitating role in the Biogas project. The viability of the project and its sustainability related consequences, following the ideas of Pretty (2002) concerning the role of social capital in community based development, is assumed to be amongst others a product of the extent to which community members trust such actors. Expressions of trust towards government officials were however not included in the above indicators. It was noted in Section 1.3 that the Zimbabwean Ministry of Energy and Power Development and the Local Government Department of Veterinary Services are partners in the Biogas project, but the actual roles performed by these authorities in the Sogwala Biogas project are merely indirect and peripheral in nature. The trust expressed by community members towards their traditional leadership and relevant NGOs was furthermore not assessed in the typical before-and-after Biogas production fashion. NGOs were in the first place not directly active in the community before Biogas production started, while preliminary and informal discussions with households in Sogwala Village before the survey revealed that levels of trust concerning the traditional leadership of the village remained stable regardless of the benefits brought by Biogas. Since both actors, especially in a rural context, represent critical elements in

local development, the level of trust expressed by the community towards them was nevertheless assessed.

The *social capital outcomes* component refers to three expected outcomes, namely social cohesion, cooperation and empowerment. Since these variables demonstrate how social capital operates in a community, they represent important measures (Grootaert *et al.*, 2004). Relevant indicators in Table 3.2 include the following:

– Social unity within the community after Biogas production.

– Cooperation within the community. The notion of cooperation in this case is not linked to a specific activity but was used to assess the degree to which people in Sogwala Village tend to work together in a general communal sense.

– Empowerment which involves the extent to which people have control over issues which may influence the course of their lives.

It should be noted that the influence of Biogas production on the social capital indicators in Table 3.2 were particularly sought from respondents via open ended questions. The indicators in Table 3.2 were translated into questionnaire items which are formulated to provide the necessary data with which to assess the impact of Biogas production on social capital in Sogwala Village (See Appendix B). As in the case of the social capital

indicators, the corresponding questionnaire items were also adapted from the work of Grootaert *et al.* (2004).

The human and social capital indicators, applied via questionnaires, produced information at the household level in Sogwala Village. In addition, key informant interviews were also used to add to and verify the last-mentioned information.

3.2.3 The use of key informant interviews applied in the case of Sogwala village

The Sogwala Village Biogas project obviously involved all households of the settlement as recipients of this technology and that is why the above human and social capital indicators were applied at the household level. The project however also involved other stakeholders such as HIZ as well as the traditional leadership of the village. It was consequently decided to also include these actors in the research process in order to provide an inclusive and balanced view in the assessment of the social sustainability of Biogas production in Sogwala Village. To include the traditional leadership of the village is particularly important since no research investigation would have been possible there without the involvement of this authority.

Two interview schedules were prepared for application to HIZ (See Appendix C) and the traditional leadership of Sogwala Village (See Appendix D) respectively. These schedules are of a semi-structured nature and include a range of questions that guided the researcher during the interviews. In line with the human and social capital indicators,

questions were generally formulated to provide the researcher with information on the impact of Biogas production on the wellbeing of the Sogwala community. What Denscombe (1998) calls face-to-face interviews were conducted with the HIZ project officer assigned to the Sogwala case on the one hand as well as the village chief and village headman on the other.

3.2.4 Fieldwork process

The fieldwork process, formulated to provide information for the purposes of this study, involved three main activities – that is, a) the pre-fieldwork procedure, including preliminary informal interviews; b) the household survey, and c) key informant interviews.

Pre-fieldwork activity is an essential part of any research process. This, according to Traynor (2005) provides the foundation for a positive working relationship between the researcher and the target community. In the case of Sogwala Village, the pre-fieldwork procedure (before the household survey and key informant interviews) involved the following:

– Introductory meetings with HIZ and the traditional leadership of Sogwala Village, during which the researcher was introduced to these key stakeholders. The rationale of the study, its aim and objectives with particular reference to the expected empirical research process in the village, as well as the importance of community participation

therein, were also outlined to them. This secured their trust and support for the household survey and key informant interviews. The traditional leadership furthermore informed the researcher of the cultural norms and values of the village community which were strictly adhered to.

– Initial informal interviews (discussions) with HIZ, the traditional leadership of Sogwala Village, and selected households for reconnaissance purposes as noted in Section 3.2.1 above. Although unstructured, the researcher through these discussions attempted to get a feeling for the area and its people, as well as the impact that Biogas production generally had on aspects related to human and social capital in the village. This was used to inform some of the indicators as noted above as well as some of the response options that were used in the human capital questionnaire (the question on the health impacts of different sources of domestic energy for example).

– The request for and subsequent provision of an educated interpreter from the community, who would also act as a guide, by the chief of Village. This was an essential element of the initial informal interviews and eventual fieldwork process as far as the household survey is concerned. After thoroughly training this person in the appropriate interpretation of the household questionnaire items, valuable assistance was provided in the translation of the questionnaire items into the local Ndebele dialect, communicating it to respondents, and translating all responses. Although all households in Sogwala Village are fully literate in terms of the English language, the researcher did not want to risk the possible misinterpretation of questionnaire items and/or responses. At the same time, the interpreter assisted the researcher in locating

the individual households which were selected as part of the survey sample; an important task since Sogwala Village by virtue of its rural character does not have the structured layout and plan that are associated with urban suburbs for example.

The **household survey** involved the application of the human and social capital indicators via questionnaires to a representative sample of all households in Sogwala Village. From all the sampling techniques that are available, the researcher adopted the systematic random sampling approach. This involves a process of numbering all the units (households in the case of this study) in a statistical population and then selecting units at a particular interval (Mikkelsen, 2005). The total number of households in Sogwala Village using Biogas is at a total of 300 units (the sampling frame) relatively small. It was subsequently decided to sample at least one-third of this population (100 households in total) which translates to a sampling interval of three. This sample size was thought by the researcher to be adequate in order to describe the research results in terms of meaningful descriptive statistics such as percentages. To facilitate the random selection of households, the researcher used the steps that are usually taken, following Neuman (2003), when a systematic sampling process is carried out. As such, the researcher was firstly assisted by HIZ who provided a list of 300 surnames representing the households in Sogwala Village who use Biogas. On this list the researcher randomly selected a single surname as the starting point and then proceeded in selecting every third surname until the required sample size of 100 households was reached. As explained above, the interpreter who also acted as a local guide assisted in physically locating the chosen households (by surnames) in the village. After locating the prospective respondents, the questionnaires were self-administered by the researcher with the assistance of the

interpreter as noted above. This was a time-intensive exercise but ensured maximum control over the quality of the research process.

The **key informant interviews**, conducted by the researcher and involving HIZ and the traditional leadership of Sogwala Village (See Section 3.2.3), complete the fieldwork process.

Finally, it is important to note the ethical considerations attached to all key informant interviews and respondents of the household survey. In both cases, the purpose of the study was firstly explained to all respondents in detail and their voluntary participation obtained. Secondly and most importantly, it was explained that all responses would be subject to the essential ethical criterion of anonymity – that is, under no circumstances would responses be linked to the names and addresses (exact residential locations) of the respondents. It was also communicated that responses would be used in the research report, but that respondents would obviously remain unidentifiable.

3.2.5 Data presentation and analysis

From the application of the questionnaires that were used in this study, quantitative as well as qualitative data was produced, with the latter originating from responses to the numerous open ended questions. Responses to open ended questions were eventually coded by the researcher according to predominant response types as the practice usually is (Neuman, 2000). Frequency distributions in the form of frequency distribution tables

were finally used – facilitated through the use of the SPSS software – to produce the coded data from which many of the discussions Chapter Four flows.

Taking into account the relative juvenile status of especially social capital research, the researcher was also interested in how human and social capital manifests in Sogwala Village. Relationships between the various indicators therefore needed attention in order to learn more about the way in which human and social capital plays itself out in the village. The most appropriate tool for this investigative purpose is probably to subject the indicators to correlation analysis. Recorded data for selected human capital and social capital indicators were subsequently subjected to Pearson's well-known product-moment correlation coefficient (r), allowing the researcher to describe the relationships between indicators. Correlation coefficients naturally range between -1.0 and +1.0 signifying an inverse and positive relationship between two variables respectively (Neuman, 2000). However, describing the relationship between two variables that may be statistically located anywhere between the last two extreme values is a challenge.

Guilford's qualitative classification of the correlation between two variables was used in this case to aid discussion (Table 3.3).

Table 3.3 Guilford's qualitative classification of the correlation between two variables

Correlation (r_{xy})	Description of the degree of r_{xy}	Relationship between *x* and *y*
< .20	Slight correlation	Positive, but insignificant
.20 - .40	Low correlation	Definitively positive, but small
.40 - .70	Average correlation	Substantially positive
.70 - .90	High correlation	Remarkably positive
.90 - 1.00	Very high correlation	Very reliable positive relationship

Source: Adapted from Guilford (1946:428)

Before the recorded human and social capital data could be inter-correlated however, it had to be standardised. For this purpose, raw data was transformed to standard scores, otherwise known as z-scores. A z-score indicates the relative position of an indicator's raw value by expressing its deviation from the average of all relevant raw values in standard deviation units (Martinez-Pons, 1999). Different indicators that may be measured in terms of different numeric units now become comparable, such as, in the case of this study, the willingness of people to support a community project for the benefit of the wider community (measurable in terms of a five-point scale) and the general level of trust in the community (measurable in terms of a two-point scale). All the z-scores for the relevant indicators can furthermore be combined into what is known as a

composite indicator. This is done by first adding such z-scores and then obtaining the z-scores for the totals which produces the composite indicator.

3.3 Conclusion

The methodologies applied by the researcher to assess the social sustainability of Biogas production in Sogwala Village were outlined in this chapter. Social sustainability, as explained in Chapter Two, can be conceptualised and therefore assessed in terms of two concepts – human and social capital. This study follows this approach in that it investigates the social sustainability of Biogas production in a rural Zimbabwean village according to its impact on human and social capital. Components and measurable indicators of human and social capital were consequently selected. In the case of human capital, the focus is on three popular components, namely economic status, education and health. Social capital on the other hand was deconstructed into its main components, namely structural and cognitive social capital. A third component, social capital outcomes, was also added. In the case of a number of human and social capital indicators, specific emphasis was placed on assessing the situation before and after Biogas production in the village in an attempt to determine the influence of this technology on social sustainability.

Human and social capital indicators were translated into questionnaire items and applied to a sizeable sample of households in Sogwala Village. In addition, key informant

interviews were conducted with the Biogas implementing agency, HIZ, as well as the traditional leadership of the village.

Frequency distributions and correlation matrices awarded the researcher the necessary tools with which to analyse the social sustainability of Biogas production in Sogwala Village. The results of this are presented in the next chapter.

CHAPTER 4:

RESEARCH RESULTS AND DISCUSSION

4.1 Introduction

The research results that were produced by the application of the study's methodology to Sogwala Village are presented in this chapter. Discussions commence with the results obtained from the human capital indicators in the village and the impact of Biogas production thereon. Attention is also given to the question of inter-relationships between the indicators in order to speculate on the nature of human capital data. The same structure plies to the presentation of research results as far as social capital in the village is concerned. Towards the end of the chapter, a synthesis of results is finally presented.

4.2 Human Capital and Biogas production in Sogwala Village

The following sections specifically look at the role of Biogas production in Sogwala Village in relation to human capital. Components and indicators of human capital are firstly presented and discussed via their associated responses summarised in the form of frequency distributions. Such discussions also include responses to the related open-ended questions which were useful to obtain insight into the villager's perceptions of how Biogas impacted on their lives in general and human capital in particular. This is followed by an exploration of the nature of human capital in Sogwala Village through the discussion of the results obtained through correlating relevant indicators.

4.2.1 Components and indicators of human capital in Sogwala village

Human capital in Sogwala Village was assessed through three components – economic status, education and health. Starting with economic status, Table 4.1 shows the **employment** situation before and after Biogas production.

Table 4.1 People employed per household before and after Biogas production

Number of people employed per household (response options) [#]	Household responses - before Biogas production (%)	Household responses - after Biogas production (%)
0	12	9
1	41	36
2	23	22
3	24	33
Total	100	100

[#] The range of responses varied between 0 and 3

According to the information in Table 4.1, 12% of all households in Sogwala Village had no member employed before Biogas production commenced. This figure has since decreased by 3%. Households with only a single member or two members employed have also decreased after Biogas production. The total decrease in unemployment in the 0 to 2 category (9%) has been absorbed by the final category which shows an increase of 9% in households with at least three members employed. In the absence of local industry and other potential employment sectors, a possible link between these employment changes at the household level and Biogas was discovered during the key informant interviews. Both HIZ and the traditional leadership of Sogwala Village indicated that since the introduction Biogas to the village, some of the

community members found employment related to the construction and maintenance of the Biogas digesters within Sogwala Village as well as in neighbouring rural districts, particularly the districts of Insiza and Matopo (Matabeleland South Province) as well as Chipinge (Manicaland Province) where this technology was subsequently also introduced. According to both groups of key informants, deliberate skills and knowledge development by the implementing agency (HIZ) can be linked to changes in the local employment situation. It must be noted however, as was also pointed out by the traditional leadership of Sogwala Village, that such employment opportunities are mainly of a contractual nature and thus do not hold any guarantee of permanent employment.

Skills and knowledge transfer to the villagers, as communicated to the researcher by HIZ, was an essential element of the viability and sustainability of the Biogas project. The majority of household respondents (92%) indicated that a range of skills and knowledge was acquired by them through attending a series of training workshops as well as regular in-service training events hosted by HIZ. These respondents further indicated that skills and knowledge were developed in the following areas:

- The technical aspects of constructing bio-digesters and relevant infrastructure (installation of gas pipes, valves and so on).
- The technical aspects involved in maintaining and monitoring the functioning of bio-digesters and relevant infrastructure.
- The management of organic household waste material through the composting and recycling component of Biogas production.

- An understanding of the usefulness of the regular availability of a cheap, accessible and reliable energy alternative to traditional sources such as wood, LPG, coal and paraffin.
- Household self-sufficiency through food gardening using the digester sludge as fertiliser.
- How skills and knowledge can be applied to make money through contract employment.
- Conservation of the local natural environment and resources via the adoption of Biogas technology.

According to the above respondents, the acquisition of skills and knowledge played an important role in improved employment opportunities for them. The villagers in this context have been applying their newly acquired knowledge and skills in the construction, maintenance and monitoring of bio-digesters, not only in their own village, but also in other rural settlements where Biogas was introduced.

Apart from employment spin offs, HIZ informed the researcher that people's acquired skills and knowledge have no doubt contributed to the functionality of Biogas production in Sogwala Village. Through their constant maintenance and monitoring of the production process, Biogas has been delivered to households without the process being limited by interruption or mechanical failure – as a result of broken or leaking gas pipes or through the over-feeding of digesters for example. The significance of this was also reflected by households during informal pre-fieldwork interviews when they highlighted the value of being a self-sufficient community as far as the availability of energy is concerned.

The issue of **household expenses** was furthermore investigated to assess the impact of Biogas production on the economic status of the Sogwala Village community. Table 4.2 shows the level of household expenses before Biogas production as far as food, clothing, health care, transport and education are concerned.

Table 4.2 Household expenses before Biogas production

Items	High (%)	Neither high nor low (%)	Don't know (%)	Low (%)	No expense incurred (%)	Total
Food	88	12	0	0	0	100
Clothing	59	40	1	0	0	100
Health care	52	40	8	0	0	100
Transport	20	66	8	0	6	100
Education	50	25	25	0	0	100
Total	269	183	42	0	6	500

It is clear from Table 4.2 that most of the household expenses before Biogas production concentrate around the 'high' response option. Food related expenses notably occupy the top spot in this case, with 88% of all respondents indicating that their household expenses for this item were relatively high in the past. The only item in the table that does not dominate the 'high' response option is transport, with 66% of all respondents indicating that this expense was 'neither high nor low'. It must however be added in this case that these respondents explained that due to the high cost of transport and the scarcity of fuel, coupled with the generally high cost of living, they limited their travelling to the absolute minimum. The 6% of respondents who did

not incurred any travelling expenses in the past belong to the ranks of the elderly in Sogwala Village and therefore, as explained by the relevant respondents, do not travel at all.

Table 4.3 shows the level of household expenses after Biogas production for the same items.

Table 4.3 Household expenses after Biogas production

Items	High (%)	Neither high nor low (%)	Don't know (%)	Low (%)	No expense incurred (%)	Total
Food	0	29	0	71	0	100
Clothing	0	38	0	62	0	100
Health care	0	38	0	62	0	100
Transport	0	65	0	28	7	100
Education	0	60	0	13	27	100
Total	0	230	0	236	34	500

Table 4.3 reflects a significantly different picture when compared with the situation in Table 4.2 as the community clearly experienced a shift in key household expenses. No responses occurred in the 'high' category with the bulk of responses clearly concentrating in the 'neither high nor low' response option. Household expenses according to the information in Table 4.3 therefore show a general decrease after Biogas production commenced in Sogwala Village. Virtually all respondents (97%) communicated the following links between decreased household expenses and Biogas production in the village:

– The bio-digester byproduct, sludge, was now available as fertiliser and widely used by villagers to boost local food production. In addition to this type of household response, the

traditional leadership of Sogwala Village expressed their satisfaction with the fact that the bio-digester sludge used as fertiliser significantly increased local crop yields, especially when the situation is compared to food production in other rural communities where Biogas is yet to be introduced.

– Surplus food (mainly vegetables) is either exchanged for money or bartered for a range of products or services including clothing, transport, schoolbooks and stationery (It must be added that Biogas cannot take all the credit for lower educational expenses since the start of the Biogas project coincided with the introduction of educational grants for child-headed households in Sogwala Village and elsewhere).

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– Health care expenses decreased as a result of a healthier domestic environment with less smoke from burning wood, paraffin or coal in some cases. Respondents particularly noted a decrease in ailments such as chest pains and headaches amongst the elderly. Less regular visits to the nearest primary health care clinic and a consequent lower need to travel is the result.

– Lower transport costs for households resulted not only from less frequent visits to the nearest primary health care clinic, but also from Biogas being a readily available source of household energy. This means less travelling to purchase the energy sources that the community relied on before, namely LPG, paraffin and coal.

On the question of **time spent acquiring sources of household energy**, Table 4.4 shows the time frequency at which members of the Sogwala community (mostly females and children)

acquired sources of energy in the past. A considerable amount of time used to be generally spent on such activity. It must be kept in mind that Sogwala Village is located about 80 kilometres from the town of Gweru, the closest commercial source of LPG, coal and paraffin. According to the information in Table 4.4, more than six out of every ten households in the village engage in either the daily routine of finding fuel wood in the surrounding bush or at least three times per week. Making the return trip to Gweru at least twice per week to buy paraffin or LPG occupies members from at least almost a quarter of all households. Coal is used by only 5% of households who nevertheless also take the journey to Gweru twice per week.

Table 4.4 Time spent by respondents to obtain fuel sources before Biogas production

Items	Daily (%)	Three times a week (%)	Twice a week (%)	Once a week (%)	Not applicable (%)	Total
Fuel wood	44	18	35	3	0	100
Paraffin	0	0	31	61	8	100
LPG	0	0	23	23	54	100
Coal	0	0	5	0	95	100

Table 4.5 portrays a much different situation after Biogas production in Sogwala Village in the form of a drastic change in the time spent by household members to obtain sources of energy. The frequencies reported by respondents in this case were significantly lower, so much so that a different scale had to be used. The percentage of households who used to look for fuel wood on a daily basis in the past (44%), changed to a situation where 37% of households now do this at least once per week or even less often in the case of 63%. An equally noteworthy situation occurs in the case of 5 and 17% of households who do not spend any time anymore travelling to

Gweru to buy paraffin and LPG respectively. Time spent to buy paraffin for example similarly shows a remarkable decline if Table 2.4 and 2.5 are compared; from 61% of households who bought this source of energy at least once per week to 68% who now do this only once per month. All respondents who indicated some or other decrease in the frequency at which they collected/bought sources of energy, attributed this to the availability of Biogas which according to them brought considerable relief in the time spent doing this. According to Table 4.5, all respondents continue to use fuel wood in spite of the introduction of an alternative form of energy. But fuel wood, and paraffin to an extent, is now mostly used to prepare food during occasional large community or family gatherings where Biogas on its own would not be sufficient. The critical difference compared to the time before Biogas was introduced to Sogwala Village, according to all respondents, is that the urgency and time consuming activity (up to three hours per day) of collecting fuel wood on a daily basis have hugely subsided. In this context, the village traditional leadership specifically highlighted the benefits of Biogas for the vulnerable in Sogwala Village, such as elderly and widowed people, who do not always have family members around to collect fuel wood on a regular basis.

Table 4.5 Time spent by respondents to obtain fuel sources after Biogas production

Items	No time anymore (%)	Once a week (%)	Twice a month (%)	Once a month (%)	Not applicable (%)	Total
Fuel wood	0	37	41	22	0	100
Paraffin	5	4	15	68	8	100
LPG	17	2	5	22	54	100
Coal	3	0	0	2	95	100

Whereas Biogas seems to have had a significant influence in the case of the economic status indicators above, its influence in the case of **education** is uncertain. Table 4.6 shows the highest school qualification per household in Sogwala Village before and after Biogas production. Biogas production commenced in the village in 2003 and almost six years have passed during which households have enjoyed improved and sustainable lighting after hours and more time available for its members to pursue their education. From Table 4.6 it is clear that the response range concerning the highest school qualification per household before Biogas production is relatively limited (from no qualification to Grade Eleven) with a sizeable percentage of adults (63%) concentrating between Grade Five to Grade Eight. It must also be noted that a quarter of adults are completely unqualified in this case. Looking at Table 4.6, the situation after the commencement of Biogas production in the village (almost six years later) has obviously changed for the better with the percentage of households with no educationally qualified adults decreasing over this period by a considerable 16%. The response range has also extended to the full possible spectrum with a concentration on responses in the highest two categories (Grade Eleven and Grade Twelve). Whereas a clear improvement of educational status is apparent, it is not easy to attribute this to the use of Biogas in Sogwala Village. This is largely due to the fact that respondents, although giving Biogas some credit, were not convincingly able to communicate the role thereof in their improved educational status. Only 30% of all respondents in this case explained that Biogas may have had educational advantages in the sense that it reduces the time spent cooking meals allowing more time for study purposes, which in the evening is further enabled by improved household illumination. The remaining respondents indicated that, although Biogas enabled them to barter food and vegetables for schoolbooks and

Table 4.6 Highest school qualification per household before and after Biogas production

School qualifications	Highest school qualification per household before biogas production (%)	Highest school qualification per household after biogas production (%)
No qualification	25	9
Grade 1	0	0
Grade 2	0	0
Grade 3	7	2
Grade 4	0	0
Grade 5	10	3
Grade 6	14	0
Grade 7	19	0
Grade 8	20	3
Grade 9	0	4
Grade 10	0	5
Grade 11	5	43
Grade 12	0	31
Total	**100**	**100**

stationery, and that they have a relatively improved ability to pay school fees; their educational performance is more likely determined by their own diligence and perseverance.

The reaction of the respondents in terms of the impact of Biogas on health related aspects in Sogwala Village, compared to education above, revealed a much clearer link between Biogas and health. Table 4.7 shows how the respondents evaluated the various energy sources, including Biogas, on a number of health related aspects. Almost all respondents associate fuel wood with smoke, regular eye and throat irritations and something that regularly causes headaches. Apart from assessed as being smoky by all respondents, paraffin fares generally relatively better, but almost half of the respondents still regarded this energy source as detrimental in view of the relevant health related aspects. Biogas, according to all respondents on the other hand, is not associated with any of the listed detrimental effects. In fact, when asked to explain their view of the health related benefits of Biogas, 60% of the respondents echoed their particular assessment of Biogas in Table 4.7, while 40%, surprisingly, identified the fact that diarrhoea has significantly decreased amongst members of their households since the start of Biogas production. These respondents explained that this is largely the result of improved sanitary conditions around their dwellings, achieved by them not discarding organic waste in makeshift informal dumps anymore. Such waste is now destined for the bio-digesters and is no longer un-hygienically decomposing in the open attracting rodents, flies, gnats and mosquitoes. The final word in the case of health comes from the traditional leadership of Sogwala Village who, with specific reference to the quality of ambient air, highlighted their observation that since the introduction and use of Biogas in the village, the air smells much better and is considerably cleaner than before.

Table 4.7: Evaluation of health impacts by respondents of various energy sources used in Sogwala Village

	Smoky (%)	Changes the ordinary smell of the air (%)	Causes regular irritation to the eyes (%)	Causes regular irritation to the throat (%)	Causes regular headaches (%)
Fuel wood	98	98	98	98	98
Paraffin	100	72	49	47	48
LPG	42	52	18	21	24
Biogas	0	0	0	0	0

In view of the discussions above, it seems that the introduction of Biogas in Sogwala Village by and large had a positive impact on human capital and the wellbeing of the villagers. Before the results of the social capital survey are presented in order to provide a complete picture of social sustainability, the next section provides a view of the nature of the human capital data by looking at inter-relationships between relevant indicators.

4.2.2 Relationships between human capital indicators in Sogwala village

Human capital as a significant factor in people's wellbeing is conceptualised in this study in terms of three components (economic status, education and health) and a number of indicators. It therefore is useful to look into the nature of the data produced with reference to statistical relationships between the indicators. For this purpose, a correlation matrix is used with correlations between the indicators calculated by means of Pearson's product-moment correlation coefficient as explained in Section 3.2.5. The logical way to approach the presentation of the results is to separate the indicators with regards to the situation reflected before the production of Biogas in Sogwala Village and after.

Table 4.8 shows the correlations for the human capital indicators before Biogas production in Sogwala Village. With the aid of Guilford's qualitative classification of the correlation between two variables (Table 3.3), the following remarks can be made about some outstanding relationships in Table 4.8.

Table 4.8 Correlation matrix for human capital indicators – Sogwala Village (before Biogas production)

Indicators											
1. Employment	–										
2. Household expenses - food	-0.15	–									
3. Household expenses - clothing	-0.05	0.48	–								
4. Household expenses - health care	-0.12	0.59	0.35	–							
5. Household expenses - transport	0.00	0.72	0.44	0.48	–						
6. Household expenses - education	-0.02	0.23	0.07	0.15	0.32	–					
7. Time spent to acquire energy sources - fuel wood	-0.20	0.16	-0.06	-0.07	0.12	-0.17	–				
8. Time spent to acquire energy sources - paraffin	-0.17	-0.09	-0.22	-0.26	-0.29	-0.19	-0.04	–			
9. Time spent to acquire energy sources - LPG	-0.12	0.08	0.06	0.19	-0.09	-0.13	0.05	-0.15	–		
10. Time spent to acquire energy sources - coal	-0.04	-0.08	-0.19	-0.06	-0.17	-0.17	0.00	0.35	0.26	–	
11. Highest school qualification before biogas production	-0.09	-0.17	0.03	-0.10	-0.25	-0.49	-0.05	0.29	0.09	-0.04	–
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
						Indicators					

- The first observation concerns the relationship between employment and the household expenses indicators. The relationship is clearly dominated by negative correlations, most reflecting a *slight* inverse but *insignificant* relationship. An inverse relationship is what one would normally expect in this case – that is, the higher levels of employment in Sogwala Village are, the lower household expenses naturally would be. The same relationship is generally reflected between employment and time spent by villagers in the acquisition of energy sources. However, with the exception of the time spent by villagers looking for fuel wood, the relationship in both the above cases is insignificant. Comments about this will follow later.

- The second observation concerns the indicators of household expenses which show an aggregated *average* inter-correlation of 0.50, a *substantially positive* relationship according to Guilford's classification. Transport expenses, as can be expected due to Sogwala Village's rural location, play a dominating role here with correlations varying from 0.32 (a *definitively positive, but small* relationship) in the case of education expenses, to 0.72 for food expenses (a *remarkably positive* relationship).

- The third observation concerns the relationship between education expenses and educational qualifications. This is characterised by an inverted relationship (r = -0.49) which means that, statistically, the lower the household expenditure for example, the higher the level of qualifications would be, something that normally does not make sense. This can be referred to as an anomaly in the numerical relationship between some indicators.

- The final observation concerns the indicators of the time spent by villagers to acquire sources of energy. Apart from correlations between paraffin and coal, and LPG and coal (both characterised by *low* positive correlations that are *definitely positive, but small*), these indicators generally do not yield any significant results when correlated with other indicators. Although these indicators yielded important results (See Table 4.4), they clearly operate in relative isolation.

In view of the above outstanding observations, the following comments can be made. Firstly, insignificant numerical relationships between some indicators in the matrix could be a symptom of a lack of sensitivity on behalf of such indicators. Employment as an indicator for example relied on absolute values, with the actual response range being between zero and three, while household expenses were reflected by a simple scale. If such measures in future could reflect the relevant conditions with more sensitivity, allowing for a larger response range, numerical relationships between all the human capital indicators, which on average stand at $r = 0.09$ at the moment) could possible improve in significance.

As far as the data anomalies are concerned, it must be kept in mind that correlation coefficients only indicate numerical relationships between variables and not causality. Thus, while a certain relationship may normally (theoretically) be expected, reality could dictate otherwise. In the case of the final observation above, namely educational expenses and qualifications, variables other than expenditure are probably more important. Data anomalies may therefore indicate areas that would require further investigation in order to develop a more comprehensive picture of human capital in Sogwala Village.

Table 4.9 shows the correlations for the human capital indicators after Biogas production in Sogwala Village. The following remarks can be made about some outstanding relationships in this correlation matrix.

- As in the case of Table 4.8 above, the first observation concerns the relationship between employment and the household expenses indicators. The relationship is also clearly dominated by negative correlations. Apart from one expenses indicator (transport) all reflect *low* inverse relationships that can be described as *small* in terms of Guilford's classification. Compared to the situation before Biogas production in Sogwala Village however, the inverse relationship after Biogas production is apart from transport not *insignificant* anymore. This may be the result of considerably different responses in especially the household expenses situation after Biogas production (See Table 4.3).

- At an aggregate of 0.53, the indicators of household expenses secondly continue to reflect *average* inter-correlations as can be expected. The difference however is that the role of transport expenses is not as dominating as before, especially in the case of food expenses (r = 0.46 as opposed to 0.72 before Biogas production).

- As above, the final observation also concerns the indicators of the time spent by villagers to acquire sources of energy that generally do not yield significant results when correlated with other indicators, with the same conclusion. The relationship between paraffin and LPG stands out (r = 0.51) as *substantially positive*. This makes sense in the context that the time spent to obtain both has decreased dramatically after Biogas was introduced in Sogwala Village.

Table 4.9 Correlation matrix for human capital indicators – Sogwala Village (after Biogas production)

Indicators											
12. Employment	–										
13. Household expenses - food	-0.34	–									
14. Household expenses - clothing	-0.31	0.82	–								
15. Household expenses - health care	-0.42	0.63	0.83	–							
16. Household expenses - transport	-0.05	0.46	0.33	0.25	–						
17. Household expenses - education	-0.38	0.23	0.36	0.39	0.16	–					
18. Time spent to acquire energy sources - fuel wood	0.03	-0.06	0.03	-0.08	0.27	0.25	–				
19. Time spent to acquire energy sources - paraffin	0.05	-0.08	-0.22	-0.22	-0.13	-0.13	0.02	–			
20. Time spent to acquire energy sources - LPG	0.00	0.03	-0.01	-0.06	0.00	-0.01	0.15	0.51	–		
21. Time spent to acquire energy sources - coal	0.04	0.09	0.11	-0.18	0.16	0.21	0.25	0.06	0.13	–	
22. Highest school qualification before biogas production	0.00	0.05	0.26	0.30	-0.09	-0.19	0.20	-0.15	0.09	0.05	–
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
						Indicators					

Apart from revealing the apparent nature of the data that was produced in terms of particular relationships between different indicators, the inter-correlations also provide the opportunity to critically review the integrity of the measuring instruments (indicators). Comments on this issue will be made in the next chapter.

4.3 Social Capital and Biogas production in Sogwala Village

The following sections consider the role of Biogas production in Sogwala Village in relation to social capital. As in the case of human capital, the components and indicators of social capital are presented and discussed via their associated responses, summarised in the form of frequency distributions. Discussions also refer to the responses to open-ended questions which provide clues to the ways in which Biogas has impacted on social capital in the village. The numerical relationships between social capital indicators are finally explored by examining the results of the inter-correlation of such indicators.

4.3.1 Components and indicators of social capital in Sogwala Village

Social capital in Sogwala Village was assessed through three components – structural social capital (groups and networks), cognitive social capital (trust) and social capital outcomes.

As explained in Section 3.2.2, **structural social capital** for the purposes of this study refers to groups and networks and the utility that flows from this. Table 4.10 shows the number of social groups that households in Sogwala Village belonged to before Biogas production, contrasted with the situation thereafter. Before the commencement of Biogas production, according to the

information in Table 4.10, all households belonged to 1.78 groups on average – with the membership in the case of 87% of households falling in the range of between one and three groups. The situation after Biogas production has changed considerably. Social group membership in the case of 68% of all households has now shifted to a concentration between three and five groups, with households belonging to 3.61 groups on average.

Table 4.10 Social group membership by households before and after Biogas production

Number of social groups[#]	Social group membership - before Biogas production (%)	Social group membership - after Biogas production (%)
0	9	9
1	34	7
2	31	4
3	22	14
4	4	38
5	0	16
6	0	12
Total	**100**	**100**
Average number of social groups	**1.78**	**3.61**

[#] The range of responses varied between 0 and 6

Of all the household respondents, 62% expressed that Biogas production in their village contributed to the increase of their social group memberships. The following motivations were communicated to the researcher:

– Social and community life in the rural Sogwala Village are to a large extent organised through a variety of social groupings that allow the inhabitants the opportunity from time-to-time to discuss a variety of livelihood related issues (politics, food and nutrition, health and welfare, income and employment, education and so on) which affect their daily lives. Throughout the time of the Biogas production project, the villagers became acutely aware of the advantages of Biogas compared to their situations before. In the case of the health and sanitation benefits of Biogas (See Section 4.2.1) the respondents were encouraged to join existing groups such as local health (sanitation) and school committees, in order to share with others how such benefits have impacted on them. These and other social platforms were also used to encourage others in Sogwala Village who has not yet fully integrated Biogas into their domestic arrangements. School committees specifically served as a platform for some villagers to encourage teachers to include aspects of renewable energy in the local school curriculum.

– In Section 4.2.1 it was noted how the bio-digester byproduct, sludge, was used by the villagers after it became available to boost local food production. As villagers generated income from the sale of surplus food (mainly vegetables), many became members of the local finance / credit group which provides assistance in the area of financial management. Following on the increased production of food in Sogwala Village, some have also joined new groups in the village such as the local food garden cooperative in order to gain and share information and experience about food gardening and farming.

– The introduction of Biogas production in Sogwala Village in essence presented its people with a community based project. As such, HIZ introduced essential training and capacity

building on an ongoing basis in the field of project management. Apart from Biogas related aspects (construction, maintenance, monitoring and so on), this also includes generic modules such as planning, implementing, monitoring and reviewing projects in general, as well as aspects of communication and the motivation of project members and beneficiaries. The idea behind training and capacity building was therefore not only limited to the demands of the Biogas project, but it also focused on building community capacity to eventually conceive and develop potential projects in the future. Due to the perceived success of the Biogas project in their village, the training and capacity building sessions were well subscribed to and soon, in the form of various related groups, became a permanent part of community social life. It was also communicated by the respondents that the sense of self-sufficiency brought by Biogas also cultivated a sense of self-worth amongst the people and this contributed to increased social group membership in Sogwala Village via their willingness to interact and share experiences with others.

Structural social capital is not only a factor of the organisation and connection of people in social groupings, but also includes the interaction of such groups with groups elsewhere. Table 4.11 subsequently shows the frequency of interaction between the most important social groups that respondents belong to with groups outside Sogwala Village.

Table 4.11 Frequency of interaction between the most important social groups that respondents belong to with groups outside Sogwala Village

Response options	(%)
The groups meet occasionally	8
Don't know / not applicable	38
The groups meet frequently	54
Total	100

Slightly more than half of the respondents indicated that the most important group that they belong to meet frequently with groups outside Sogwala Village, while 8% responded that this happens occasionally. Of this total, 63% of the respondents confirmed that Biogas production plays a role in the interaction between social groups within the village with groups and people on the outside – mainly in neighbouring communities. They communicated the following motivations to the researcher:

– Biogas production opened up opportunities for some Sogwala villagers elsewhere as their newly gained expertise was used to assist in the construction of bio-digesters in other communities, both within and outside the Lower Gweru District. Of the respondents who communicated that Biogas plays a role in their interaction with social groups elsewhere, 16% attributed this to their involvement in the implementation of Biogas and the construction of bio-digesters elsewhere.

– The production of surplus food in Sogwala Village also flowed into new contacts and a business partnership with groups elsewhere. In the case of 8% of the relevant respondents,

surplus food is often sold for cash or kind in neighbouring communities, facilitated by food and nutrition related groups, while a business partnership with the Netherlands Development Organisation was established. This NGO is involved in community development and welfare in rural Zimbabwe and now serves as a market for surplus food produced by the villagers.

– It is not only the trade in surplus food that facilitated interaction with groups on the outside, but trade in the fertiliser by-product of the bio-digesters as well. With trade facilitated by the food garden cooperative and transactions also involving information exchange, 31% of the respondents have indicated that this brought them closer to people and groups in neighbouring communities.

– Respondents (8% of all households) also felt that individuals within Sogwala Village generally became more aware of the fact that they share certain common needs, such as the need for a sustainable source of energy, with people elsewhere. As people from elsewhere came to the village to trade for vegetables or fertiliser, this common bond according to the respondents contributed to a sense of unity between villagers and people on the outside.

While it seems, looking at the above, that Biogas has been a significant factor in structural social capital in Sogwala Village, it is also important to gain understanding into the utility of people's interconnectedness. Table 4.12 presents the results of the indicator that Grootaert *et al*. (2004) suggests provide some insight in this case.

Table 4.12 Possibility of financial assistance from people outside the immediate family circle

Response options	(%)
Definitely	87
Probably	13
Unsure	0
Probably not	0
Definitely not	0
Total	100

The response to the question related to the possibility of financial assistance from people outside the immediate family circle was overwhelmingly positive as is evident from Table 4.12. Of all respondents in this case, 68% confirmed the influence of Biogas as follows:

– In the face of rural socio-economic adversity, Biogas brought a new interconnectedness (*'Ukubumbana'* in the predominant Ndebele language was the word that was used by respondents) between people in the village, not only in social groups but also individually. This is the result of the closer cooperation between community members that was necessitated by the demands of the Biogas project and consequently the development of a better understanding that most villagers share similar life challenging issues.

It was also pointed out by the interpreter that the word *'Ukubumbana'* is strongly related to the issue of trust, which suggests that this essential element of social capital has possibly grown via the increased connectedness of people in the village. The hint of trust which may be at play in the last-mentioned case also introduces the question of **cognitive social capital**. Structural social

capital and the groups and networks component is but one of the essential components of social capital. Cognitive social capital is what determines the functionality of the latter.

Table 4.13 indicates the general level of trust amongst the members of the Sogwala community before and after Biogas production.

Table 4.13 Trust in Sogwala Village before and after Biogas production

Response options	Before Biogas production (%)	After Biogas production (%)
People could be trusted	26	97
You could not be too careful	74	3
Total	100	100

A clear switch has taken place considering the question of trust in the community and the fact that the statement *'people could be trusted'* after the introduction of Biogas has gained ground amongst the respondents by a considerable 71%. The link between this increase and Biogas sought by the researcher was discovered in the unanimous response that previous disunity and self-centredness between community members caused by competition over scarce livelihood resources is now largely a thing of the past. A more united village community, according to respondents and also the traditional leadership of Sogwala Village, was brought about by the various utilities of Biogas and also the resulting communal sense of self-sufficiency.

The trust expressed by community members towards their community leaders (traditional leadership) and NGOs was not assessed in the typical before-and-after Biogas production fashion as explained in Chapter Three. It is clear from Table 4.14, where the findings of these indicators

are presented, that contemporary levels of trust in the two cases almost mirror that of the above image of trust in the Sogwala community in general (Table 4.13).

Table 4.14 Trust expressed towards community leaders and NGOs in Sogwala Village

Response options *'How much do you trust …'*	**Community leaders (%)**	**NGOs (%)**
To a very small extent	4	0
To a small extent	0	3
Neither great nor small extent	21	10
To a great extent	54	35
To a very great extent	21	52
Total	100	100

With the number of respondents who trust their community leaders and relevant NGOs to a great and a very great extent at 75% and 87% respectively – and of course given the favourable picture in Table 4.13 – trust seems to be a considerable community asset at the moment as far as cognitive social capital is concerned. During preliminary and informal discussions with households in Sogwala Village before the survey, most respondents revealed that the traditional leadership of Sogwala Village had always shown real and honest concern for their welfare. This motivation was generally encountered amongst the above-mentioned 75% of respondents who trust their community leaders to a great and a very great extent. Regarding the two relevant NGOs (HIZ as the Biogas implementing agency and the Netherlands Development Organisation), the 87% of respondents who trust them to a great and a very great extent generally said that these organisations actually deliver on their promises. The idea of a promise

(*'Isethembiso'* was the word that was used by respondents) as explained by the interpreter is significant in this case since a commitment from someone or an organisation to do something is automatically viewed in the local cultural context as a promise. If such a commitment is followed by non-delivery for whatever reason, reciprocity (Referred to as *'Ukubambamisana'* by respondents) is likely to be compromised at the expense of trust between two parties.

Results concerning the willingness of people in Sogwala Village to support a new hypothetical project that will benefit the community but not necessarily the individual reflected the above outcomes that surround the question of trust. From Table 4.15 it is clear that almost all the respondents will actually support such a project, even if it means that they will not directly benefit from it. The motivation for this potential generosity, from 95% of the respondents, involves the sense of self-sufficiency, self-worth and subsequent unity in the community brought about by Biogas and its utilities. As an actual demonstration of their benevolence in this case, some of these respondents specifically referred to the so-called *'Pass on the Gift'* (*'Dhlulisa isipho'*) project which followed the introduction of Biogas in Sogwala Village. An initiative of HIZ and the traditional leadership of the village, *'Pass on the Gift'* involves village members sharing some of their animals' offspring with less fortunate others. This is done to extend a network of hope, dignity and self-reliance within the community.

Table 4.15 Willingness to support a new hypothetical project for the benefit of the community

Response options	(%)
Will support	96
Unsure / don't know	0
Will not support	4
Total	100

The final social capital component refers to the **outcomes of social capital** or the key manifestations of social capital in a community as noted in Chapter Three. Table 4.16 presents the results for the three social capital outcomes that were assessed, namely social unity, cooperation and empowerment. Looking at the social capital results thus far, these variables are almost predictable, especially if the above-mentioned results on the possibility of financial assistance (Table 4.12), trust (Table 4.13 and the willingness of people to support a hypothetical project (Table 4.15) are taken into account. Social capital is an integrated phenomenon and 'good' levels of cognitive social capital for example are therefore bound to be reflected by social capital outcomes.

The notion of improved social unity in Sogwala Village was already used by respondents to explain why they would support a hypothetical project for the benefit of the wider community. This is well reflected by Table 4.16 (a) and the fact that the great majority of respondents are of the opinion that their community is united. Reasons for this according to their motivations are mainly twofold:

Table 4.16 Social capital outcomes

a) Social unity

Response options	(%)
The community is always united	24
The community is mostly united	73
Unsure / don't know	1
Conflict sometimes occurs	2
Conflict occurs frequently	0
Total	100

b) Cooperation

Response options	(%)
Members of the community always cooperate	62
Members of the community sometimes cooperates	38
Members of the community does not cooperate at all	0
Unsure / don't know	0
Total	100

c) Empowerment

Response options	(%)
I am totally able to change my life	81
I am mostly able to change my life	7
I am neither able nor unable to change my life	3
I am mostly unable to change my life	9
I am totally unable to change my life	0
Total	100

– Social unity is firstly the result of the new interconnectedness (*'Ukubumbana'*) between people that developed from good cooperation between community members in the face of the Biogas project. The same kind of motivation was also provided by most respondents when they explained their view regarding the possibility of financial assistance from people outside the immediate family circles.

– Social unity secondly replaced disunity and self-centredness between community members when the utilities of Biogas mitigated competition for scarce livelihood resources.

As far as cooperation is concerned, favourable responses in Table 4.16 (b) were relatively less with 62% of the respondents indicating that members of the community always cooperate. This however remains almost two thirds of all respondents whose motivations can be grouped around the various incentives and utilities that flowed from Biogas production in Sogwala Village. Thus, what spurred people on to cooperate according to the respondents (whether in the different contexts of the various social groups in the village or to meet the demands of the actual Biogas project) is based on the tangibles that they get out of the Biogas project, such as employment for some, better food security, sustainable energy, cleaner and more sanitary conditions around dwellings of the village and so on. This response was verified by HIZ as well as the traditional leadership of the village.

The question of empowerment in the last place assessed the degree to which people have control over issues which may influence the course of their lives. Most of the respondents indicated that they are totally able to change their lives. This level of empowerment according to them mainly

resulted from an increasing sense of self-sufficiency brought about by Biogas and self-worth compared to their hardship before. A small number of respondents have however stated that they do not consider themselves empowered for personal reasons – the fact that they lack confidence in themselves to make important decisions that could change their lives.

In view of the social capital research results of this section, an apparent link between Biogas production in Sogwala Village and good social capital is evident. The introduction of Biogas in this village therefore seems to have generally improved and/or facilitated this dimension of social sustainability. The next section looks at the nature of the social capital data by investigating some of the inter-relationships between relevant indicators.

4.3.2 Relationships between social capital indicators in Sogwala Village

As in the case of human capital above, social capital was also conceptualised in this study in terms of a number of components (structural and cognitive social capital, and social capital outcomes) and representative indicators. Whereas social capital components and indicators in the previous section were mostly looked at in isolation, this section explores the relationships between the latter. As before, a correlation matrix is used with correlations between the indicators calculated by means of Pearson's product-moment correlation coefficient. Since some of the indicators only reflected the situation in Sogwala Village after Biogas production, a before-and-after comparison will not be made. Only the status of social capital after the introduction of Biogas is therefore considered in Table 4.17. This table also shows the inter-relationships between a composite social capital indicator and the other indicators present.

Table 4.17 Correlation matrix for social capital indicators – Sogwala Village (after Biogas production)

Indicators											
23. Social group membership per household after Biogas production	–										
24. Frequency of interaction with social groups outside the village (after Biogas production)	0.26	–									
25. Possibility of financial assistance from people outside immediate family circles	0.36	0.09	–								
26. General level of trust in the community after Biogas production	0.33	0.12	0.28	–							
27. Level of trust expressed towards community leaders	0.06	0.11	-0.02	0.04	–						
28. Level of trust expressed towards NGOs	0.31	-0.04	0.14	0.31	-0.08	–					
29. Willingness to support a community project for the benefit of the wider community	0.35	0.10	0.37	0.81	0.14	0.25	–				
30. Social cohesion	0.35	0.19	0.35	0.39	0.36	0.07	0.58	–			
31. Cooperation	0.34	0.15	0.30	0.39	-0.24	0.09	0.37	0.36	–		
32. Empowerment	0.39	0.25	0.24	0.31	0.21	0.16	0.41	0.18	0.10	–	
33. Composite social capital indicator	0.48	0.43	0.53	0.68	0.31	0.43	0.75	0.63	0.30	0.63	–
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
						Indicators					

A composite social capital indicator presents a combined view of all the relevant indicators; an image of social capital as a whole in other words (See Section 3.2.5). Used in a correlation matrix it allows the researcher to identify, within the limits of statistical correlations, the relative contribution of a particular indicator to the phenomenon of social capital as a whole.

A noteworthy attribute of the correlation matrix in Table 4.17, in comparison with the human capital matrix in Table 4.9, is the average inter-correlation between all indicators which stand at $r = 0.29$ (*a definitively positive, but small correlation*). With the significance of the numeric relationships between the indicators generally positive, the following remarks can be made about some outstanding features in the matrix:

- The first observation concerns the apparent significance of people's social group membership which correlates positively with all but one of the other indicators. With average inter-correlations in this case at $r = 0.31$, social group membership seems to be a significant factor of social capital in Sogwala Village. A *substantially positive* correlation of 0.48 moreover exists between this indicator and the composite social capital indicator.

- One of the most numerically significant inter-correlations in the matrix ($r = 0.81$) manifests between the important trust in the community indicator (general level of trust in the community after Biogas production) and the willingness of people to support a community project for the benefit of the wider community. This *high* and *remarkably positive* correlation is indicative of a relationship that one would normally expect, against the background of social capital theory, between the indicators in question – in other words, a community's

performance on the question of trust in the context of social capital would normally be matched by the benevolence of its members.

- Another noteworthy numerical relationship in the matrix exists between the willingness of people to support a community project for the benefit of the wider community and that of the social capital outcomes indicator, namely social cohesion ($r = 0.58$). This *substantially positive* correlation makes sense in the context of social capital since people's willingness to contribute to community welfare without direct beneficiation is probably a symptom of a unified community and *vice versa*. In fact, the above-mentioned trust indicator as well as people's willingness to support a community project are reasonably well related to the three social capital outcomes indicators; on average $r = 0.36$ in the case of trust, and $r = 0.45$ for the willingness to support a community project.

- Furthermore, on average all indicators in the matrix relate in a *substantially positive* way with the composite social capital indicator or social capital as a whole ($r = 0.52$). Thus, while the correlation of some indicators – such as the trust that people express towards their traditional leadership, and cooperation in the village – resulted in relational anomalies, all indicators in their relationship with the composite social capital indicator behave statistically according to social capital theory. This in other words means that an increase in social group membership for example, or any of the other indicators in the matrix for that matter, is reflected by a reasonably corresponding increase in the strength of social capital as a composite phenomenon.

- Finally, on the above-mentioned issue of data anomalies in the matrix, it must be kept in mind as in the case of human capital that correlation coefficients only indicate numerical relationships between variables and not causality. Anomalies could be caused by an number of factors such as indicators not being sensitive enough as mentioned before as well as the fact that some of the indicators could actually be unrelated in reality – such as the trust that people express towards their traditional leadership and the level of cooperation in Sogwala Village (r = -0.24).

As in the case of the correlation matrix for the human capital indicators above, the same opportunity exists to critically review the integrity of indicators of social capital. Comments on this follow in the next chapter.

4.4 Conclusion: the social sustainability of Biogas production in Sogwala Village

With the social sustainability of Biogas production in Sogwala Village assessed via the impact Biogas had on human and social capital in the village, the following conclusions are presented:

In view of the research results concerning the influence of Biogas production on human capital, the overall impression is that the impact on the lives and wellbeing of the people of in Sogwala Village was generally positive. Biogas production firstly opened up opportunities for employment via development skills, although this is mainly of a non-permanent nature. Key household expenses were also positively impacted upon in the sense that Biogas production contributed to increased food production through the use of the fertiliser by-product, new trade and bartering opportunities presented by the production of surplus food, improved health related

conditions as a result of cleaner energy, and less travelling to purchase conventional sources of energy. The last-mentioned factor was also instrumental in households generally spending less time to acquire the sources of household energy that were traditionally used by them in the past. The cleaner attributes of Biogas via of less smoke, smells and associated ailments, as well as better sanitary conditions, according to the respondents, meant that Biogas was also well received in terms of its health related benefits. The only indicator that proved relatively inconclusive was the impact of Biogas production on educational status.

The research results as far as the impact of Biogas production on social capital is concerned were almost overwhelmingly positive. Biogas production and the utilities thereof saw a significant increase in social group membership within Sogwala Village as bonding social capital seemingly improved in the community. Biogas also provided for interaction with other groups and people outside the village as a result of incentives for the establishment of bridging social capital. Biogas was furthermore linked by respondents, via the increased connectedness of people in the village (bonding social capital), to an improved trust situation; not only between people in the village, but also between them and external organisations (NGOs) via adequate linking social capital. An extraordinary expression of benevolence, influenced by biogas production, was also received by the researcher in the form of the general willingness of people in Sogwala Village to support projects that will benefit the community at large. In view of the research results for structural and cognitive social capital, social capital outcomes (social unity, cooperation and empowerment) reinforced the idea of a positive link between Biogas and good social capital in the village.

Looking at the research results presented in this chapter and the above-mentioned conclusions, it appears that Biogas production has definitely contributed to the wellbeing of the people of Sogwala Village instead of being just another community based project with negligible results. In this particular case, one can therefore conclude that the social sustainability of Biogas production here has to be viewed in a generally positive light.

CHAPTER 5:

SYNTHESIS

5.1 Introduction

This chapter contains a review of the social sustainability methodology that was followed in this study as well as the essence of the research results that were produced. The chapter therefore commences with an overview of the achievements of the methodology and research results in relation to the aim and objectives of this study. This is followed by a critical perspective of the study's research methodology as well as recommendations for future research.

5.2 Summary

This study aimed at assessing social sustainability of Biogas production and its role in Sogwala village - in terms of the community's quality of life. The study findings are based on the evidence established from theoretical and descriptive analyses of the social sustainability concept, Biogas production in Sogwala village and the inter-linkages between the two.

A point of departure for this research was a presentation of a theoretical background of the social sustainability concept and its empirical assessment via human and social capital in Chapter Two. From literature many countries like Botswana, Tanzania, China, and South Africa have adopted Biogas because of its social, environmental and economic sustainability in rural and urban areas. However there is a dearth of literature on the social sustainability of Biogas use in developing countries like Zimbabwe hence this research.

A specific methodological framework linked to the study's aim and objectives for application to Sogwala village was also formulated. This framework was used to assess the social sustainability of Biogas production in the village via its impact on Human and Social capital. The process involved selection of Human and Social capital components and indicators. These were translated into questionnaire format and interview schedules using before and after approach. Interview schedules were also intended for key informants made up of project managers from the Biogas project implementing agencies and Sogwala village community leaders. These schedules allowed more information to be gathered regarding the role played by Biogas production in the social and human capital aspects of the Sogwala community.

As explained in Chapter Two, in relation to Human capital, an approach was followed which conforms to the way in which human wellbeing related components were assessed by researchers in the Social Indicators Movement (see Section 2.4.1). This meant breaking the human capital concept down into its constituent components and then selecting measurable indicators for each. Following the way in which human capital concept is approached in a social sustainability context, with a wide range of possible components for possible inclusion and because of the rural and relatively undeveloped character of Sogwala village, a limited range of human capital components was adopted. These were mainly the economic, education and health status components. Measurable indicators were further selected to represent each component and this was done as a result of the fact that no objective information such as census data existed for Sogwala village and thus the application of a questionnaire survey. The indicators for each of the human capital components were translated into questionnaire items which were formulated to

provide the necessary data with which to assess the impact of Biogas production on human capital in Sogwala village (See Appendix A).

Following research advices that social capital research should at least cover the main dimensions of the concept for the assessment of social capital, two main components namely structural and cognitive social capital were assessed (see Chapter Three). To add to these two components a third one, social capital outcomes, was identified for application to the village, which refers to the ways in which social capital operates in a community. As previously adopted for the assessment of human capital, measurable indicators were largely adopted from the work of Grootaert et al (2004), who under the auspices of the World Bank developed a valuable and comprehensive measuring instrument to support social capital surveys at the household level. As the human capital indicators were translated into questionnaire items so were the social capital indicators for each of its components to provide the necessary data with which to assess the impact of Biogas production on social capital in Sogwala village. The corresponding questionnaire items for the social capital indicators were also adopted from the work of Grootaert et al (2004).

In essence, the human and social capital indicators applied via questionnaires produced information at the household level in Sogwala village. In addition key informant interviews, as mentioned earlier, were used to verify the information collected through questionnaires. Components and indicators of both human and social capital concepts were firstly presented and discussed via their associated responses and summarised in the form of frequency distributions. Such discussions also included responses to the related open-ended questions which were useful

to obtain insight into the villager's perceptions of how Biogas impacted on their lives in general and specifically on human and social capital.

The overall impression from the results of this study is that the impact of Biogas production on the human wellbeing of Sogwala community was generally positive whilst on social capital the results were almost overwhelmingly positive.

Table 5.1 gives a summary of these results.

Table 5.1: Influence of Biogas production on Human Capital and Social Capital

Human Capital	**Social Capital**
Economic status:- - opened up employment opportunities via development skills to the villagers; - reduced household expenses; -increased household income through new trade and bartering opportunities presented by the production of surplus food; - replaces chemical fertilizer through the bio-digester fertilizer byproduct (sludge); -boosts local food production (improved soil fertility from use of the by-product of sludge); and - improved knowledge and skill on waste management and construction of biogas digesters **Education status:** - reduces the time spent cooking meals allowing more time for study purposes **Health status**: - improved health related conditions as a result of cleaner energy (non-smoky, no smoke associated ailments); - less travelling to purchase conventional sources of energy (wood and paraffin); and -improved sanitary conditions.	**Structural social capital** ***Social group membership:-*** - increased social group membership within Sogwala Village; and - improved interaction between members of social groups from Sogwala village and people outside the village. **Cognitive social capital** ***Trust:-*** - improved trust between the community and people; - improved trust between community and government officials, external organisations (NGOs) and community leaders; and - increased general willingness of people in Sogwala Village to support projects that will benefit the community at large. **Social capital outcomes:** ***Social cohesion:-*** -brought a new interconnectedness (*'Ukubumbana'*) between people in the village ***Cooperation:-*** -replaced disunity and self-centeredness between community members ***Empowerment:-*** - Community gained power to make important decision that could change the total course of their lives.

It must be noted in relation to the employment status indicator, the traditional leadership of Sogwala Village pointed out that the employment opportunities arising from the Biogas production project activities were mainly of a contractual nature and thus did not hold any guarantee of permanent employment. Among other beneficial aspects, the community gained knowledge and skills to monitor the production of gas, to check leaking of the gas as the methane content of it contributes to the greenhouse effect. Thus, it is important to monitor the apparatus in order to advocate Biogas as a sustainable renewable energy source and technology.

Apart from revealing the nature of the human capital data that was produced in terms of particular relationships between different indicators, inter-correlations provided the opportunity to critically review the integrity of the measuring indicators. The correlation coefficients only indicated numerical relationships between variables and not causality (involving Biogas production). In view of considerable observations (as detailed in Chapter Four) insignificant numerical relationships (intercorrelations) between some indicators were identified which could be a symptom of a lack of sensitivity on behalf of such indicators. For instance employment status indicators (human capital) relied on absolute values, with the actual response ranging from zero and three, while the household expenses were reflected by a simple scale. In future if such measures could reflect the relevant conditions with more sensitivity that allow for a larger response range, numerical relationships between all the human capital indicators, could possibly improve in significance.

As Biogas production has had significant influence in the case of these and other human capital indicators, its influence in the case of education status as shown in Chapter Four, has been

uncertain. A clear improvement of educational status was apparent from the results, but it is not easy to attribute this to the use of Biogas in Sogwala Village. This is largely due to the fact that respondents, although giving Biogas some credit, were not convincingly able to link the role thereof in their improved educational status. Some of the respondents indicated that, although Biogas enabled them to barter food and vegetables for schoolbooks and stationery and that they have a relatively improved ability to pay school fees, their educational performance is more likely determined by their own diligence and perseverance.

Following this background of observation, the research process did not extensively highlight on the actual impact of Biogas production on the economic, education and health statuses given the not so convincing responses on specific impact details (such as percentage totals). For instance, drawing results on the actual household economic savings. This could have been due to lack of reports on the operations and outputs of the biogas production technology all of which are vital for an in-depth sustainability assessment. However, Biogas production has been found to have the potential to deliver considerable benefits to its users, though some socio-economic hardships may still remain. Biogas has therefore improved the wellbeing of Sogwala village community as they practically revealed some of its social sustainability effects.

5.3 Recommendations

After analysis of the impacts of Biogas on the social sustainability components (human and social capital) of Sogwala village the researcher recommends:

- An in-depth understanding through periodic monitoring of existing Biogas production systems, to fulfil the ultimate purpose of using Biogas as an alternative complementary renewable energy source. This would also prove its actual social sustainability effects.
- Continuous training in form of refresher courses (using participatory approaches) for farmers and the rest of the Sogwala villagers as a supplementary measure for the maintenance of bio digester plants and effective production of Biogas should be carried out.
- In-depth field and analytical research on Biogas production as a sustainable energy system in relation to economic, health (waste water, sewage and municipal waste treatment) and education aspect to improve on its adoption in any rural communities.
- Concentrate efforts on the promotion of Biogas production in villages and shifting to larger networks, such as rural co-operatives or organizations, because dissemination at these levels is easier against the background of the economic activities within the communities.

LIST OF REFERENCES

Akinbami, J.F.K., Illori, M.O., Oyebisi, T.O., Akinwumi, I.O. and Adeoti, O. 2001. Biogas Energy use in Nigeria: Current status, future prospects and policy implications. **Renewable and Sustainable Energy Reviews**, 5(1): 97-112.

Antonius, R. 2003. **Interpreting Quantitative Data with SPSS**. London & New Delhi: SAGE Publications.

Appleton, S. and Teal, F. 1998. Human Capital and Economic Development Centre for the study of African Economies. **Economic Research Papers.** Number 39**.**

Armstrong, A., Francis, R., Bourne, M. and Dussuyer, I. 2002. **Difficulties of Developing and Using Social Indicators to evaluate Government Programmes: A Critical Review**. Paper prepared for the Australian Evaluation Society International Conference, Wollongong, 29 October – 1 November.

Austin, G. 2003. **Biogas Energy and Sanitation in South Africa.** South Africa: ESI Africa.

Baines, J. And Morgan, B. 2004. Sustainability Appraisal: Asocial Perspective. In: Dalal-Clayton, B. and Sadler, B. (eds), **Sustainability Appraisal: A Review of International Experience and Practice**. London: International Institute for Environment and Development: (95-111).

Balsam, J. 2006. **Anaerobic digestion of Animal waste: Factors to consider**. Fayetteville: National Centre for Appropriate Technology.

Barreiros, L. 1988. Operationalising Concepts and Measurements of Poverty and Basic Needs. In: Teeken, R. (eds), **Theory and Policy Design and Basic Needs Planning**. Aldershot: Arebury: (27-51).

Barron, L. and Gauntlett, E. 2002. **Housing and Sustainable Communities Indicators: Stage 1 Report (Model of Social Sustainability).** Australia: Lotteries Commission of Western Australia.

Baster, N. 1978. Work on Development Indicators by National Governments, Research Institutes and Individual Scholars: A Selective Review and Discussion of Issues and Problems, In: Rao, M.V.S., Porwit, K., Baster, N. (eds), **Indicators of Human and Social Development: Report on the state of the art.** Tokyo: United Nations University: (181-226).

Becker, G.S. 1975. **Human Capital: A theoretical and empirical analysis with special reference to education, Second edition**. Chicago: University of Chicago Press.

Becker, H.A and Vanclay, F. 2003. **The International Handbook of Social Impact Assessment: Conceptual and Methodological Advances.** United Kingdom and United States of America: Edward Elgar Publishing.

Bell, S. and Morse, S. 2003. **Measuring Sustainability: Learning by doing**. London: Earthscan Publications.

Binns, T. 1995. **People and Environment in Africa**. Chichester: John Wiley.

Bjomskov, C. and Svendsen, G. T., 2003. **Measuring Social Capital: Is there a single underlying explanation?** Working Paper 03-05. Department of Economics Aarhus School of Business: Aarhus.

Blanco, H. and Campbell, T. 2006. Social capital of cities: Emerging networks of horizontal assistance**. Technology in Society,** 28 (1-2): 169-181.

Bourdages, J-L. 1997. **Sustainable Development: Conditions, Principles and Issues.** Paper presented at the Parliamentary Conference of the Americas. Science and Technology Division, Quebec City.

Brunckhorst, D. J. 2002. Institutions to sustain ecological and social systems. **Ecological Management and Restoration**, 3 (2): 108-116.

Buckingham, A. and Saunders, P. 2004. **The Survey Methods Workbook: From Design to Analysis**. United States of America: Polity Press.

Burdge, R.J. 1994. **A community guide to Social Impact Assessment**. Middleton: Social Ecology Press.

Burdge, R.J. et al. 1994. **A Conceptual Approach to Social Impact Assessment**. Middleton: Social Ecology Press.

Bynner, J. 2002. **Social and Human Capital for Sustainability: Consensus and Conclusions. Social and Human Capital in the Knowledge Society: Policy Implications**. Paper presented in Brussels, 29 October 2002.

Carley, M. 1986. Tools for Policy Making: Indicators and Impact Assessment. In: Bulmer, M. (eds). **Social Science and Social Policy**. London: Allen and Unwin: (126-154).

Castells, M. 2000. Urban sustainability in the information age. **City: Analysis of Urban Trends, Culture, Theory, Policy, Action,** 4 (1): 118-122.

Centre for Good Governance, 2006. **A Comprehensive Guide for Social Impact Assessment.** The Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment.

Central Statistical Office (CSO), **Zimbabwe Census Preliminary Report (Census 2002)**. Harare, Zimbabwe: Central Statistical Office.

Chenje, M., and Johnson, P. 1994. **State of the Environment in Southern Africa.** Harare, Zimbabwe: Southern African Research and Documentation Centre.

Chiu, R. L. H. 2004. **Housing, Theory and Society.** Taylor and Francis Group**, 21 (2): 65-76**.

Clark, G. P. And Wilson, A. G. 1994: Performance indicators in Urban planning: The Historical Context. In: Bertuglia, C. S., Clarke, G.P. and Wilson, G. (eds), **Modelling the City: Performance, Policy and Planning**. London. Routledge: (4-19).

Colantonio, A. 2007: Measuring Social Sustainability: Best Practice from Urban Renewal in the European Union, 2007/01. **EIBURS Working Paper Series.** United Kingdom: Oxford Institute for Sustainable Development, European Investment Bank.

Coleman, J. 1988. Social capital in the creation of Human Capital. **American Journal of Sociology.** 94 (Supplement): S95-S120.

Coulombe, S., Tremblay, J.-F. and Marchland, S. 2004. International Adult Literacy Survey: Literacy scores, human capital and growth across fourteen OECD countries. Canada: Statistics Canada.

Cuthill, M. 2003. The contribution of human and social capital to building community wellbeing: A research agenda relating to citizen participation in local governance in Australia. **Urban Policy and Research.** 21 (4): 373-391.

Dalal-Clayton, B., Sadler, B. 2004. **Sustainability Appraisal: A Review of International Experience and Practice.** England, UK: IIED.

Denscombe, M. 1998. **The good research guide: for small-scale social research projects.** Philadelphia: Open University Press.

Doyal, L. and Gough, I. 1991. **A Theory of Human Need**. London: MacMillan.

Dubois, J. L., Mahieu, F-R., Poussard, A., Elliot, J. A. 1999. **An Introduction to Sustainable Development, Second Edition**. London and New York: Routledge.

Dubois, J.L., Mahieu, F.R., Poussard, A. 2002. **Social Sustainability as a component of Human Development.** http://www.st-edmunds.cam.ac.uk/vhi/research/dubois.pdf

Duve, M. 2006. Dufuya Integrated Wetland Protection, Management and Utilisation. **Global Environment Facility/Small Grants Programme Final Report (2003-2006).** Harare: Africa 2000 plus Network.

Engbersen, G., Snel, E. and Leerkes, A. 2006. Transitional involvement and social integration. **Global Networks, A journal of transitional affairs**. 6 (3): 285-308.

Engler, C.R., Jordan, E.R., McFarland, M.J., Lacewell, R.D. 1999. Economics and environmental impact of biogas production as a manure management strategy. In: **Proceedings of the 1999 Texas Animal Manure Management Conference**. USA, Texas A and M University.

Eyles, J. 1987. Poverty, Deprivation and Social Planning. In: Pacione, M. (red). **Social Geography: Progress and Prospect.** London: Croom Helm (201-251).

Feng, Y., Chen, Y., Yang, G. and Sweeney, S. 2009. **Household biogas use in rural in China: A study of opportunities and constraints**, 14 (1): 545-549.

Field, J. 2003. **Social Capital**. London: Routledge.

Field, J. 2008. **Social Capital**. London: Routledge.

Fries, G., Starr-McCluer, M. and Sunden, A.E. 1998. **The Measurement of Household Wealth using Survey Data: An overview of the Survey of Consumer Finances.** Paper prepared for the 44th annual conference of the American Council on Consumer Interests. Washington D.C.

Fukuyama, F. 2001. Social capital, civil society and development. **Third World Quarterly**, 22 (1): 7-20.

Fuggle, R.F. and Rabie, M.A. 1996. **Environmental Management in South Africa.** South Africa: Juta and Company, The Rustica Press.

Fuggle, R. F. 1998: Environmental Management: An Introduction. In: Fuggle, R.F. and Rabie, M.A. (eds), **Environmental Management in South Africa**. Cape Town. Juta: (1-10)

Fulford, D. 1988**. Running a Biogas Programme: A handbook.** London: Intermediate Technology Publications.

Gates, R. And Lee, M. 2005. City of Vancouver. **Sustainability Group.** Policy Report: Social Development.

Gibson, R. B., Hassan, S., Holtz, S., Tansey, J. and Whitelaw, G. 2005, **Sustainability Assessment: Criteria, Processes and Applications**. London, United Kingdom: Earth Scan.

Goodland, R. and Daly, H. 1996. Environmental Sustainability: Universal and non-negotiable. **Ecological Applications**. 6:1002-1017.

Goodland, R. 2002. Sustainability: Human, Social, Economic and Environmental. **Encyclopaedia of Global Environmental Change,** John Wiley and Sons.

Green, G., Grimsley, M. and Stafford, B. 2005. **The Dynamics of Neighbourhood Sustainability.** York: Joseph Rowntree Foundation.

Griebler, E., Littig, B. 2005. Social sustainability: a catchword between political pragmatism and social theory. **International Journal of Sustainable Development**. 8 (1/2): 65-79.

Grootaert, C., Narayan, D., Jones, V.N. and Woolcock, M. 2004. **Measuring Social Capital: An Integrated Questionnaire.** The World Bank: The World Bank Paper No.18.

Grootaert, C., and Van Bastelaer, T. 2002. **Understanding and measuring social capital: A Multidisciplinary Tool for Practitioners.** Washington DC: World Bank.

Guilford, J. P. 1946, **New standards for test evaluation: Educational and Psychological Measurement**, 6: 427- 439.

Gumbo, R. 2004. **Biogas Promotion in Zimbabwe (2000-2003)**. Harare: Ministry of Energy and Power Development.

Halpern, D. 2005. **Social Capital.** United States of America: Cambridge Polity Press.

Harris, J. M. 2000. Basic Principles of Sustainable Development: **Global Development and Environment Institute.** Working Paper 00-04.

Hemphill, L., Berry, J. And McGreal, S. 2004: An indicator-based approach to measuring sustainable urban regeneration performance: part 1, conceptual foundations and methodological framework. Urban Studies, 4(14): 725-755.

Herbert, D. T. and Thomas, C.J. 1997. **Cities in Space: City as Place.** London: David Fulton.

Hesser-Biber, S.N. and Leavy, P. 2006. **Emergent Methods in Social Research.** London & New Delhi: SAGE Publications.

Honadle, G. and Van Sant, J. 1985. **Implementation for Sustainability: Lessons from Integrated Rural Developmen**t. West Hartford: Kumarian.

Hugo, P. 1990. **Truth is in the field: Social Science Research in Southern Africa**. South Africa: Department of Political Sciences, University of South Africa.

Irwin, A. 2001. **Sociology and the Environment: A Critical Introduction to Society, Nature and Knowledge.** United States of America: Polity Press.

James and James, 2002. **Renewable Energy World Review**. London: Science Publishers.

Kenny, M. and Meadowcroft, J. 1999. **Planning Sustainability.** United Kingdom: Routlegde.

Kirkpatrick, C. and Lee, N. 1997. **Sustainable Development in a Developing World: Integrating Socio-economic Appraisal and Environmental Assessment.** United States of America: Edward Elgar.

Knox, P.L. 1975. **Social wellbeing: A Spatial Perspective**. London: Oxford Press.

Koning, J. 2001. **Social Sustainability in a Globalizing World: Context, theory and Methodology Explored**. Paper presented for the UNESCO/MOST Meeting. The Hague, Netherlands.

Krishna, A. And Shrader, E. 2002: The social capital Assessment Tool: Design and Implementation. In: Grootaert, C. and Van Bastelaer, T. (eds). **Understanding and Measuring Social Capital: A Multidisciplinary Tool for Practitioners**. Washington D.C, World Bank: (17-40).

Labuschagne, C., Brent, A.C., and Claasen, S.J. 2003. Environmental and Social impact considerations for sustainable project life cycle management in the process industry. **Corporate Social Responsibility and Environmental Management,** 12(1):38-54.

Laroche, M., Merette, M. and Ruggeri, G.C. 1999. On the concept and dimensions of human capital in a knowledge-based economy context. **Analyse de Politiques,** 25(1):87-100.

Lawn, P.A. 2001. Scale, Prices and Biophysical assessments. **Ecological Economics**, 38:369-382.

Laws, S. 2003. **Research for development: A practical guide.** London: SAGE.

Lesser, E. L. 2000. **Knowledge and Social Capital: Foundations and applications.** Boston: Butterworth-Heinemann.

Lin, N., Cook, K. and Burt, R.S. 2001. **Social Capital: Theory and Research**. New York: Aldine de Gruyter.

Luebker, M. 2008. Employment, unemployment and informality in Zimbabwe: **Concepts and data for coherent policy-making**. Issues Paper Number 32 and Integration Working Paper Number 90. International Labour Organisation (ILO): Harare

Luiz, J., Fedderke, J. And De Kadt, R. 1999. Economic growth and social capital: A critical reflection. **Theory and Society**, 28: 709-745.

Malan, S. 2004. **Social Assessment of the proposed Le Grand George Golf Estate for the scoping phase of environmental assessment,** (**Draft 2)**. South Africa, Hoekwil.

Maloutas, T. Contextual parameters for promoting social sustainability: The case of Athens. **National Center for Social Research**. Working Papers 2003/5.

Maposa, L. 2009. Gweru: Heifer International Zimbabwe. (Personal communication).

Martinez-Pons, M. 1999. Emotional intelligence as a self-regulatory process: A social cognitive view. **Imagination, Cognition and Personality**, 19: 331-350.

Maser, C. 1997. **Sustainable Community Development: Principles and Concepts**. Florida: St Lucie Press.

Mawhinney, M. 2002. **Sustainable Development**. Oxford: Blackwell Science.

McKenzie, S. 2004. Social sustainability: Towards some definitions. **Hawke Research Institute Working paper series,** Number 27.

Mengwe, M.S. 2004. **An analysis of mining in Selebi-Phikwe (Botswana) 1973-2004: An economic necessity with diverse impact**. South Africa: Unpublished Thesis, University of Port Elizabeth, Port Elizabeth.

Mikkelsen, B. 1995. **Methods for Development Work and Research: A New Guide for Practitioners.** London and New Delhi: SAGE Publication.

Mikkelsen, B. 2005. **Methods for Development Work and Research: A New Guide for Practitioners (Second edition).** New Delhi: SAGE Publication.

Mincer, J. 1993. **Studies in Human Capital**. University Press, Cambridge, Volume 1.

Møller, V. and Schlemmer, L. 1983. Quality of life in South Africa: Towards an instrument for the assessment of quality of life and basic needs. **Social Indicators Research,** 12:225-279.

Moser, C. and Mcllwaine, C. 1999. **Environment and Urbanization: Participatory urban appraisal and its application for research on violence.** International Institute for Environment and Development: SAGE Publications.

Munasinghe, M., Swart, R. 2005. **Primer on Climate Change and Sustainable Development: Facts, Policy Analysis and Applications.** Cambridge: University Press.

Neuman, L. 2000. **Social Research Methods: Qualitative and Quantitative Approaches (**Fourth Edition). United States of America: Pearson Education Company.

Neuman, W. L. 2003. **Social research methods: Qualitative and quantitative approaches.** Boston.

OECD, 1998. **Human Capital Investment: An International Centre for Educational Research and Innovation.** Paris: Organisation for Economic Cooperation and Development.

OECD, 2001. **The Wellbeing of Nations: The role of Human capital and Social Capital, Education and Skills**. France: OECD Centre for Educational Research and Innovation.

Oelofse, C. 2001. Sustainable Development: Theoretical and Conceptual Issues. In: Sekesha, A. and M. Sowman (eds). **Resource Manual for the Local Agenda Training Course in South Africa.** Environmental Evaluation Unit, University of Cape Town: (1-19).

Pacione, M. 1984. Revealed preferences and Residential Environmental Quality. In: Pacione, M. and Gordon, G. (eds). **Quality of Life and Human Welfare.** Norwich: Geography Books: (51-64).

Parker, N. 2007. **Integrated Biogas Solutions**. Cape Town, South Africa: Agama Energy.

Portes, A. 1998. Social Capital: Its Origins and Applications in Contemporary Sociology. **Annual Review of Sociology**, 24: 1-24.

Pretty, J. 2002. People, Livelihoods and Collective Action in Biodiversity Management. In: 'O' Riordan, T. and Stoll-Kleeman, S. (eds). **Biodiversity, sustainability and Human communities: Protecting Beyond the Protected.** Cambridge: Cambridge University Press: (61-86)

Putnam, R.D. 1996. Who killed civic America? **Prospect**, 6: 66-72.

Putnam, R. D. 2000a. **Bowline Alone: The Collapse and Revival of American Community**. New York: Simon and Schuster.

Putnam, R.D. 2000b. Social Capital: Measurement and Consequences. In: Helliwell, J. F. (ed). **The contribution of Human and Social Capital to Sustained Economic Growth and Wellbeing: International Symposium Report**. Quebec City. OECD: (1-15).

Rao, M.V.S., 1978. Concept, Scope and Methodology of Development Indicators. In: Rao, M.V.S., Porwit, K. and Baster, N. (eds). **Indicators of Human and Social development: Report on the State of the Art**. Tokyo: United Nations University: (77-101).

Redclift, M.R. 1987. Sustainable Development: Exploring the Contradictions. London: Methuen.

Redclift, M. 2005. Sustainable Development (1987-2005): An oxymoron comes of age. **Sustainable Development**, John Wiley and Sons, 13(4):212-227.

Reid, D. 1995. **Sustainable Development: An Introductory Guide**. London: Earthscan.

Roche, C. 1999. **Impact Assessment for Development Agencies: Learning to Value Change**, Oxfam GB: Oxford Publishing.

Rossi, R.J. And Gilmartin, K.J. 1980. **The Handbook of Social Indicators: Sources, Characteristics and Analysis.** New York: Garland STPM Press.

Rudd, M. A. 2000. Live long and prosper: collective action, social capital and social vision. **Ecological Economics**. 34: 131-144.

Sandham, L.A. and Van der Walt, A.J. 2004. Social aspects of sustainable rural development: A case study in Lepelfontein. **South African Geographical Journal**. 86(2): 68-75.

Sathianathan, M.A. 1975. **Biogas: Achievements and Challenges**. New Delhi: Association of Voluntary Agencies for Rural Development.

Savola, H. 2006. **Biogas Systems in Finland and Sweden: Impact of Government policies on the diffusion of anaerobic digestion technology**. Unpublished Master's Thesis, Lund University, Lund, Sweden.
http://lup.lub.lu.se/luur/download?func=downloadFile&recordOld=1512554&Old=1512560

Schuller, T. 2000. Social and Human Capital: The search for appropriate technomethodology. **Policy Studies**. 21(1):25-35.

Seralgeldin, I., Grootaert, C., 1997. **"Defining Social Capital: An Integrating View."** Paper presented at Operations Evaluation Department Conference on Evaluation and Development: The Institutional Dimension, Washington D.C.

Sharpe, A. 2001. **The Development of Indicators for Human Capital Sustainability Paper presented for the Centre for the Study of Living Standards**. Canada: Ontario.

Silverman, D. 2006. **Interpreting Qualitative Data, Third Edition**. London & New Delhi: SAGE Publications.

Smith, D. M. 1973. **The Geography of social wellbeing in United States: An Introduction to Territorial Social Indicators**. New York: McGraw-Hill.

Smith, D. M. 1987. **Geography, Inequality and Society**. Cambridge: Cambridge University Press.

Smith, S.S. and Kulynych, J. 2002. It may be social, but why is it capital? The social construction of social capital and the politics of language. **Politics and Society**. 30: 149-186.

Statistical Package for the Social Sciences (SPSS) Incorporated. 1998. **SPSS Base 8.0 for Windows User Guide**. Chicago IL: SPSS Inc.

Stephens, C. 2005: Measuring Sustainable Development. Statistics Brief No. 10. Paris: Organisation for Economic Co-operation and Development.

Stone, W. 2001. Measuring Social Capital: **Towards a Theoretically Informed Measurement Framework for Researching Social Capital in family and community life**. Research Paper Number 24. Australian Institute of Family Studies: Melbourne.

Steyn, P. 2002. Global environmental management: an exploration of the World Summit on Sustainable Development. **Journal for Contemporary History,** 27(3): 1-13.

The Inter-organizational Committee on Guidelines for Social Impact Assessment, 2001**. Social Justice Research.** Plenum Publishing Corporation, 14 (4).

Thomas, L. 2003. **Is Social Capital a useful tool for public health and development? Insights from Social capital theory and a South African case study**. Africanus 33(2):18-28.

Traynor, C.H. 2005. **The SLUSE Model of Natural Resource Management: From Theory to Practice through field based training – experiences from Southern Africa.** University of KwaZulu Natal, South Africa: Southern African Consortium of Universities for Environment and Development- Sustainable Land Use (SACUDE-SLUSE) Project.

United Nations. 1984. Updated Guidebook on Biogas Development – Energy Resources Development Series. **United Nations**. Number 27.

Uphoff, N. 2000. **Understanding Social Capital: Learning from the Analysis and Experience of Participation.** In: Parthadas, G. and Serageldin, S. (eds). Social Capital: A Multifaceted Perspectives. Washington D.C.: World Bank.

Uphoff, N. And Wijayaratna, C.M. 2000. Demonstrated benefits from social capital: the productivity of farmer organisations in Gal Oya, Sri Lanka. **World Development**, 28: 1875-1890.

Urquhart, P. and Atkinson, D. 2000. **A Pathway to Sustainability: Local Agenda 21 in South Africa.** University of Cape Town, South Africa: The Environmental Evaluation Unit.

USNRC. 1999. **Our Common Journey: A Transition Toward Sustainability**. Unite States National Research Council. Washington D.C.: National Academy Press.

Vanclay, F. 2002. Conceptualising social impacts. **Environmental Impact Assessment Review**. 22(3): 183-211.

Vanclay, F. 2003. **Impact Assessment and Project Appraisal.** Beech Tree Publishing, 21(1): 5-11.

Van Deth, J.W. 2002. Measuring social capital: Orthodoxies and continuing controversies. **International Journal of Social Research Methodology**. 1(1):79-92.

Vetter, H. And Steffens, G. (eds) 1988. Joint Meeting of FAO Bodies. In: Marchaim, U. 1992. **Biogas processes for sustainable development**. Rome: Food and Agricultural Organisation (FAO).

Vitalis, V. 2001. **Measuring Sustainable Development**. Round Table Report on Sustainable Development. Paris: Organisation for Economic Co-operation and Development.

Walmsley, D.J. and Lewis, G.J. 1993. **People and Environment: Behavioural Approaches on Human Geography**. Essex: Longman

WCS, 1980. **World Conservation Strategy: Living Resource Conservation for Sustainable Development.** Gland: International Union for Conservation of Nature and Natural Resources.

Whiteley, P.F. 1997. **Economic growth and social capital**. Paper presented at the workshop on Social Capital and Politico-Economis Performance, ECPR Joint Sessions, Switzerland, Bern.

Wilson, P.A. 1997. Building social capital: A learning agenda for the twenty-first century. **Urban Studies.** 34(5/6): 745-760

Woolcock, M. 1998. Social capital and economic development: Towards a theoretical synthesis and policy framework. **Theory and Society**. 27: 151-208.

World Bank. 1997. World Bank Report. **The state in a changing world**. Oxford: Oxford University Press.

World Bank, 2002. **Building a Sustainable Future: The Africa Region Environment Strategy**. Washington D.C.: The World Bank.

World Commission on Environment and Development (WCED), 1987. **Our Common Future**, Oxford: Oxford University Press.

APPENDIX A

HUMAN CAPITAL QUESTIONNAIRE

ECONOMIC STATUS:

1. Employment status before biogas production

Household member (age > 15 at the time before biogas production)	**Employment status (code)**
1.	code
2.	code
3.	code
4.	code
5.	code
6.	code

2. Employment status after biogas production

Household member (age > 15 at the time after biogas production)	**Employment status (code)**
1.	code
2.	code
3.	code
4.	code
5.	code
6.	code

Codes:
1 = Employed permanent/ full-time
2 = Self-employed
3 = Contract/ temporary employment
4 = Casual employment
5 = Unemployed and looking for work
6 = Unemployed and choose not to work
7 = Student (e.g. university/ college, etc.)
8 = Scholar (e.g. primary/ secondary school)
9 = Home-maker / housewife
10 = Pensioner / retired person / too old to work
11 = Unable to work due to illness or disability
12 = Seasonal worker not working presently

3. *Was any skills and knowledge obtained by you via the Biogas project?*

1 = Yes	2 = No	3 = Don't know

4. *If YES at Question 3, which skills and knowledge were obtained and how were these obtained?*

Skills/ knowledge	**How obtained**
1.	
2.	
3.	
4.	
5.	

5. Household expenses before and after biogas production

Would you say that your household expenses for the following items were high, neither high nor low, that you don't know, that it was low, or that no expenses were incurred before Biogas production? Also indicate the same for the situation after Biogas production.

Items	**High = 1**	**Neither high nor low = 2**	**Don't know = 3**	**Low = 4**	**No expense incurred = 5**
Food	Before / After	Before / After	Before / After	Before / After	Before / After
Clothing	Before / After	Before / After	Before / After	Before / After	Before / After
Health care	Before / After	Before / After	Before / After	Before / After	Before / After
Transport	Before / After	Before / After	Before / After	Before / After	Before / After
Education	Before / After	Before / After	Before / After	Before / After	Before / After

6. Explanation by the respondent of the extent to which Biogas has influenced household expenses

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7. *On how many occasions did you (or members of your household) spent time to obtain the following energy sources before Biogas production (for example, daily; once, twice, or three times per week; or once per month, twice per month, etc.? Also indicate the same for the situation after Biogas production.*

Energy sources	**Occasions (before Biogas)**	**Occasions (after Biogas)**
Fuel wood		
Paraffin		
LPG		
Coal		

8. Explanation by the respondent of the extent to which Biogas has influenced the time spent to obtain energy sources

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EDUCATION:

9. Highest school qualification per household before Biogas production

Household member (age > 18 at the time before biogas production)	**School qualification (code)**
1.	code
2.	code
3.	code
4.	code
5.	code
6.	code

Codes:
1 = No qualification
2 = Grade 1
3 = Grade 2
4 = Grade 3
5 = Grade 4
6 = Grade 5
7 = Grade 6
8 = Grade 7
9 = Grade 8
10 = Grade 9
11 = Grade 10
12 = Grade 11
13 = Grade 12

10. Highest school qualification per household before Biogas production

Household member (age > 18 at the time before biogas production)	**School qualification (code)**
1.	code
2.	code
3.	code
4.	code
5.	code
6.	code

11. Explanation by the respondent of the extent to which Biogas has influenced educational attainment

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HEALTH:

12. Evaluation by respondent of the health impacts of different sources of domestic energy

Energy sources	Smoky	Changes the ordinary smell of the air	Causes regular irritation to the eyes	Causes regular irritation to the throat	Causes regular headaches
Fuel wood	code	code	code	code	code
Paraffin	code	code	code	code	code
LPG	code	code	code	code	code
Biogas	code	code	code	code	code

1 = Yes 2 = No 3 = Don't know

13. Explanation of health related benefits of Biogas by the respondent

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APPENDIX B

SOCIAL CAPITAL QUESTIONNAIRE

STRUCTURAL SOCIAL CAPITAL (Groups and Networks):

14. *I would like to start by asking you about the groups, organizations, networks or associations to which you belonged to before and after the introduction of Biogas in your village. These could be formally organised groups or just groups of people who get together regularly to do an activity or discuss things. Of how many such groups have you been a member?*

Number of social groups before Biogas	**Number of social groups after Biogas**
number	number

15. Explanation by the respondent of the influence of Biogas production on social group membership

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16. *How would you describe the network relationship(s) between the most important groups that you belong to and groups from outside your village community?*

The groups meet occasionally	***Don't know / not applicable***	***The groups meet frequently***
1	2	3

17. Explanation by the respondent of the influence of Biogas production on the frequency that the most important groups that he/she belong to interact with groups from outside the village community.

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18. *If you suddenly needed to borrow a small amount of money (enough to pay for the expenses for your household for one week), are there people beyond your immediate household and close relatives to whom you could turn and who would be willing and able to provide this money?*

Definitely	**Probably**	**Unsure**	**Probably Not**	**Definitely Not**
5	4	3	2	1

19. Explanation by the respondent of the influence of Biogas production on the possibility of financial assistance from people outside immediate family circles.

COGNITIVE SOCIAL CAPITAL (Trust):

20. *Would you say that most people in your community could be trusted or that you could not be too careful in dealing with people - before (and after) Biogas was introduced to your village?*

Before Biogas production		**After Biogas production**	
1 = People could be trusted	*2 = You could not be too careful*	*1 = People could be trusted*	*2 = You could not be too careful*

21. Explanation by the respondent of the influence of Biogas production on whether people in his/her community could be trusted.

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22. How much do you trust:

Community leaders

1 = To a very small extent	*2 = To a small extent*	*3 = Neither great nor small extent*	*4 = To a great extent*	*5 = To a very great extent*

NGOs

1 = To a very small extent	*2 = To a small extent*	*3 = Neither great nor small extent*	*4 = To a great extent*	*5 = To a very great extent*

23. Explanation by the respondent of his/her response regarding the level of trust expressed towards community leaders.

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24. Explanation by the respondent of his/her response regarding the level of trust expressed towards NGOs, and the influence of Biogas.

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25. *If a community project does not directly benefit you but has benefits for many others in the community, would you support the project?*

1 = Will not support	*2 = Unsure / don't know*	*3 = Will support*

26. Explanation by the respondent of his/her response regarding the willingness to support a community project that does not directly benefit him/her, but has benefits for many others in the community, and the influence of Biogas.

SOCIAL CAPITAL OUTCOMES:

27. How would you describe the social unity (togetherness) of your community?

1 = Conflict occurs frequently	*2 = Conflict sometimes occurs*	*3 = Unsure / don't know*	*4 = The community is mostly united*	*5 = The community is always united*

28. Explanation by the respondent of his/her response regarding the social unity of his/her community and the influence of Biogas.

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29. To what extent do people in your community cooperate these days?

1 = Unsure / don't know	*2 = Members of the community does not cooperate at all*	*3 = Members of the community sometimes cooperates*	*4 = Members of the community always cooperate*

30. Explanation by the respondent of his/her response regarding the extent to which people in the community cooperate, and the influence of Biogas.

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31. Do you feel that you have control over issues which may influence the course of your life?

1 = I am totally unable to change my life	*2 = I am mostly unable to change my life*	*3 = I am neither able nor unable to change my life*	*4 = I am mostly able to change my life*	*5 = I am totally able to change my life*

32. Explanation by the respondent of his/her response regarding the control he/she has over issues which may influence the course of his/her life, and the influence of Biogas.

APPENDIX C

KEY INFORMANT INTERVIEW SCHEDULE (HIZ)

This schedule is of a semi-structured nature and includes a range of questions that should guide the researcher during the interview. Questions are generally formulated to provide the researcher with information on the impact of Biogas production on the wellbeing of the Sogwala Village community. The interview with HIZ was scheduled around the following key issues:

- Support during Biogas implementation
- Programmes facilitating knowledge creations and skills transfer
- Outcomes of the latter (employment)
- Other community development initiatives
- General assessment of wellbeing impacts of the Biogas project

APPENDIX D

KEY INFORMANT INTERVIEW SCHEDULE

(SOGWALA VILLAGE TRADITIONAL LEADERSHIP)

This schedule is of a semi-structured nature and includes a range of questions that is should guide the researcher during the interview. Questions are generally formulated to provide the researcher with information on the impact of Biogas production on the wellbeing of the Sogwala Village community. The interview with the traditional leadership of the village was scheduled around the following key issues:

- General socio-economic conditions before Biogas production
- General assessment of wellbeing impacts of the Biogas project (employment; food production)
- General assessment of social capital related impacts of the Biogas project