Multiple Use Services: Meeting the Productive and Domestic Water needs of the Rural Poor

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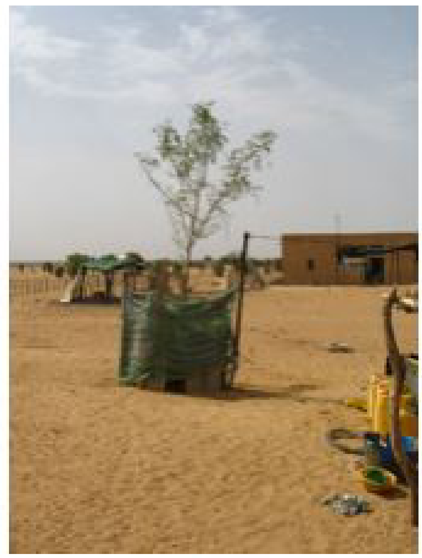

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Abstract

This report uses a detailed 55 household survey in the village of Thidé (pop. 1800) in the southern part of the Islamic Republic of Mauritania to answer the following three questions: Does the net impact of productive water strengthen rural livelihoods and reduce poverty of rural households? If so, to what extent do productive uses of water form an important contribution to these livelihoods? Does it provide opportunities for asset accumulation? Although the realization that the poor and water scarce distribute their water consumption across multiple activities is not a new, attempting to account for these various uses is. The debate regarding the benefits and costs to livelihoods from productive water is currently raging. Estimating these incremental benefits and costs will help governments and non-governmental organizations value water systems appropriately, and can also inform the design of community water systems. Above all, if the balance of costs and benefits at the household level is known it will determine if multiple-use water services (MUS) are truly a superior approach to water resources development. This household level analysis provides an explicit example of how the availability of productive water strengthens rural livelihoods and provides opportunities for asset accumulation in the form of livestock, trees, and revenue from livestock products.

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Chapter 1: Introduction

This report uses an in-depth 55 household survey the village of Thidé in the southern part of the Islamic Republic of Mauritania to answer the following three questions: Does the net impact of productive water strengthen rural livelihoods and reduce poverty of rural households? If so, to what extent do productive uses of water form an important contribution to these livelihoods? Does it provide opportunities for asset accumulation?

The importance to the poor of access to productive water[1] for multiple uses beyond drinking water has recently been recognized as a critical component of demand driven water resources development. The realization that the poor who live in areas of water scarcity distribute their water use across multiple activities is not a new, however, attempting to account for these various uses is. The sources of demand for water are inherently based on the benefits that a household or a community gains from investing in or using productive water. Estimating these incremental benefits and costs will help governments and non-governmental organizations value water systems appropriately, and can also inform the design of community water systems. Above all, knowledge of the net benefits at the household will help determine if multiple-use water services (MUS) are truly a superior approach to water resources development. This thesis aims to contribute to the debate through the analysis of the benefits and costs that accrue to households in the village of Thidé from increased access to productive water.

[1] Productive water is defined with regard to the domestic water supply sector as the quantity of water over and above domestic "basic needs" that is used for small-scale productive uses.

It should be noted that the benefits of multiple-use water services go far beyond the benefits to individual households. There are potentially great community benefits that result from a multiple-use services approach. For example, MUS is said to improve maintenance of water systems, improve coordination between government ministries and non-governmental organizations implementing water supply projects, and to respond to beneficiaries demand. This thesis, however, will address only the benefits and costs that accrue to individual households from access to productive water. While analysis of the larger context may be necessary to understand the true value of a MUS by design system, this thesis seeks only to inform one part of a multiple-use approach to water supply development. In addition, there is a rural focus to this research that comes from a desire to inform water supply interventions in Africa. Africa Sub-Saharan nations are still on average 63% rural, and the demand for multiple-use services is coming from those with diversified livelihoods, who are more likely to live in poor rural areas (WRI, 2007). Once local cultural customs are taken into consideration, the results of this analysis are particularly relevant to any semi-arid rural village in West Africa, and potentially to other semi-arid rural areas of Africa.

The report is structured as follows: Chapter 1 introduces the subject, explains multiple-use services in detail and describes the context of the Mauritanian Case Study; Chapter 2 presents the relevant literature on the benefits and costs of providing productive water for multiple uses; Chapter 3 begins the Mauritanian Case Study with a description of the country, the methodology used in collecting primary data, and water use and water management in the village; Chapter 4 presents the results of the survey and discussion of the costs and benefits to productive water, and concludes the paper.

What is MUS?

Multiple-Use Services are a demand driven approach to water resources development that is currently emerging as the most appropriate way in which developing countries can invest in water development. The name refers to the multiple end-uses of available water in a community that are increasingly recognized as independent of the intended uses of the system. In meeting people's demand for water for these uses, MUS systems take into consideration all needs in a way that can result in poverty reduction and improved livelihoods.

MUS recognizes that although individual water systems may be built with a single purpose such as water and sanitation or irrigation, for example, the reality is that communities have *multiple* uses for the water provided to them, and these *multiple* uses result in a variety of additional benefits despite the original goal of the infrastructure (Figure 1). Given this outcome chain, there are essentially two types of ad hoc multiple-uses that predominate in the field: productive use of domestic water, or "Domestic Plus," and domestic use of productive water, termed "Irrigation Plus." Domestic Plus uses include: increasing pipe diameters of domestic systems to increase flow; adding taps in locations that are amenable to productive uses, such as gardening and livestock watering; adding cattle troughs to supply points; enlarging, upgrading[2] or deepening family wells to increase extraction rates necessary for agriculture and livestock (van Koppen et al,, 2006; IWMI, 2006, Robinson, 2003). Wastewater reuse is also considered a Domestic Plus use, and is particularly common in peri-urban areas for agriculture (Prinz and Singh, 2000; Inocencio and Sally, 2002). Governments and non-profits are particularly interested in

[2] Upgrading means lining the well, providing windlass, chain and bucket (Robinson, 2003).

the benefits in increased income or asset accumulation that may result from these productive uses of domestic systems. Some of the most beneficial activities include: micro-irrigated agriculture, livestock production and small-enterprises such as cooking, brick and pottery making (WaterAid, 2001; IWMI, 2006; van Koppen, 2003)

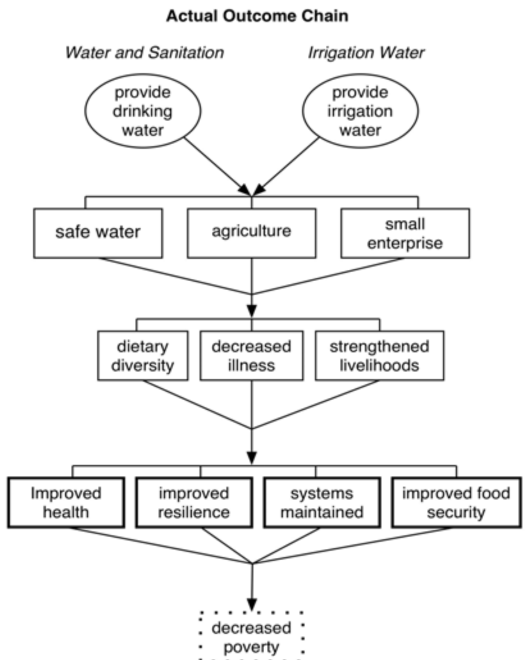

Figure 1:Actual Outcome Chain of Water supply Projects

Irrigation plus refers to irrigation systems that are adapted by communities around the world for other uses (laundry, bathing, drinking). These adaptations take a variety of forms. Communities have organized to allow timed releases of irrigation water for domestic use; they build steps into the sides of irrigation canals to make access easier; they adapt the canals to make aquaculture possible, to water livestock, and attach water powered mills to grind grain; and, they divert overflow from earth dams built for irrigation to storage tanks to be used for drinking water (IWMI, 2006; Rockstrom, 2000; VanDear Hoek et al., 2002; Yoder, 1983).

The Value of Productive Water in Mauritania: A Case Study

In order to determine if the availability of productive water strengthens rural livelihoods and reduces poverty of rural households it is essential that the case study under scrutiny present both the costs and benefits to the household of having productive water. The Islamic Republic of Mauritania provides an ideal case for studying the impact of productive water on livelihoods because most households are engaged in productive water activities, which for nine months of the year use ground water sources requiring significant financial investment to develops.

In Mauritania, water has always been at the same time a limiting factor and a motor for development (Organisation Mondiale de la Sante, 1983). Mauritanians are traditionally a communal nomadic people, and livestock production forms the basis of their livelihoods and their assets. The government began providing water points for human and animal needs along pastoral routes and in population centers in the 1950s (Boumeiss and Moujtaba, 1992). Recurrent droughts, however, in the 1970s and 1980s have caused a huge rural exodus (Table 1), and put serious pressure on existing water infrastructure (Ministère de l’Hydrolique, 2007).

Location	**Year**				
	1965	**1977**	**1988**	**1995**	**2005**
Nomadic	73.3	36.3	12	NA	NA
Rural Š sedentary	17.6	42	48.3	49.1	36.7
Urban	9.2	21.7	39.7	50.9	64.3

Table 1: Population Changes Overtime (Source: Boumeiss and Moujtaba, 1992; WRI, 2007)

In response to these droughts and with funds from the International Water and Sanitation decade, boreholes equipped with motorized or mechanical pumps became the focus of water supply investments in Mauritania. The water investment plan for 1990-

2000 aimed to build 300 cement wells, 620 boreholes with motorized pumps, 670 with mechanical hand or foot pumps, and 40 gravity fed distribution systems.[3] They were able to accomplish 95% of this goal (Ministère de L'Hydrolique, 2007). At this time the *Ministère de l'Hydraulique* developed a strong working relationship with the Japanese government, who until today continues to finance and provide technical support for many of the gravity fed distribution system, such as exists in the village of Thidé (Personal Communication ANEPA, 2007).

More recently, the *Ministère de l'Hydraulique* has based their water supply investment plan on population figures: villages with more than 150 people with a modern well (cement well or borehole with a hand or foot pump), and population centers of more than 500 people with a gravity fed distribution system.[4] They have even gone so far as to aim at providing 10% of households in population centers of more than 1000 people with household connections (Boumeiss and Moujtaba, 1992). These initiatives are driven by Mauritania's commitment to the Millennium Development Goals (adopted in 2000), in particular MDG 7, Target 10[5], and by their Poverty Reduction Strategy Papers.

In rural areas, Mauritanians will do all they can to keep at least one sheep or goat in their compound year round. The animal serves multiple purposes including providing dairy products, "savings" that can be traded or sold on a moments notice to pay for essential family needs, and supporting religious and cultural traditions of sharing livestock and their products. Villages with a permanent source of drinking water that has

[3] Strategic planning documents from the *Ministere de l'Hydraulique* do not indicate the population that this was intended to serve.
[4] Gravity fed systems pump ground water from a borehole to an elevated water storage tank, which then distributes water by gravity to a centralized distribution system of public and/or private taps.
[5] Target 10 aims to reduce those living without access to potable water by half.

a flow beyond what is necessary for domestic needs tend to keep a few animals in the compound year round; communities with only enough drinking water send their animals out to graze in the southern and eastern parts of the country, only reaping the nutritional and social benefits from the animal in the short rainy season (early July to late October) when surface run-off water is available in and around the village. In many cases, even when a household has only a small amount of water for domestic uses, they will keep a few animals and water them with waste-water from dishes, laundry and cooking.

The case study presented here is a typical example of a Domestic Plus system. The community has adapted its domestic water system for multiple uses, and gains economic and social value from it. Thidé is a village of 1800 ethnically Pulaar pastoralists who have been settled in the village since 1950s, and get water primarily from a gravity-fed reticulation system built in 1996 by the Japanese and Mauritanian governments intended for drinking water. Villagers use this water to sustain goats, sheep, cows, poultry and donkeys or horses; to water trees and to repair mud-brick houses or make bricks for construction. These uses make up approximately 38% of water consumed by Thidé households.[6] Essentially, a detailed investigation into the costs and benefits that occur to Thidé households will help determine the extent to which access to productive water strengthens livelihoods, builds assets and reduces poverty of households in Thidé.

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[6] The exact percentage here refers specifically to households with a tap. The amount of water used by households without a tap for animals, trees and construction is difficult to estimate because the sample size is small, and for non-tap households only one keeps trees and only one cow. See the section “Water Use” starting on 35 for more detailed description of use.

Chapter 2: Costs and Benefits of providing productive water for multiple uses

Should water systems be designed to include productive water, there are certain costs and benefits that will accrue to households within these systems. This literature review briefly describes each of the most significant costs and benefits of developing water resources to provide for multiple-uses. The analysis of the literature, as well as the case study uses a sustainable livelihood framework (DFID, 1999).

Social Capital: *The social resources upon which people draw in pursuit of their livelihood objectives: networks and connectedness, membership of more formalized groups, relationships of trust, reciprocity and exchanges that facilitate cooperation, reduce transaction costs.*

Human Capital: *Human capital represents the skills, knowledge, ability to labor and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives.*

Natural Capital: *The natural resource stocks from which resource flows and services (e.g. nutrient cycling, erosion protection) useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity to divisible assets used directly for production (trees, land, etc.).*

Physical capital*: The basic infrastructure and producer goods needed to support livelihoods. Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive. Producer goods are the tools and equipment that people use to function more productively. (DFID, 1999)*

Box 1: Livelihood Framework Definitions

Benefits

Physical Capital

Productive use of domestic systems has long been seen as a means for households to accumulate physical capital in the form of livestock, livestock products, fruit trees, expansion of agricultural land; and, expanded or reinforced dwellings built with locally made bricks, (Perez et al., 2003; Perez de Mendiguren and Carlos, 2003; Matthew, 2003; Yoder, 1983). Animals and fruit trees can also be seen as natural capital (Matthew, 2003; DFID, 1999).

Financial Capital

While the cost of adding on or redesigning a system to provide productive water is impossible to avoid, allowing water use for productive purposes provides opportunities for income-generation that are enough in many cases to pay off the loan required to build the systems in three to five years. The use of low-cost micro-irrigation technologies in India and Zimbabwe have allowed for lucrative profits; as domestic systems are developed to provide micro-irrigation, land under cultivation increases and boosts farm incomes either through profit generation or expenditure-savings from self-production (Polak, 2003; Robinson, 2003). It is important to recognize, however, that valuing small-enterprise is difficult; profits may vary widely across enterprise and across time (seasons), and some enterprises are expenditure-saving while others are income earning (James, 2003).

Time savings are another well-recognized benefit to provision of productive water. In many cases, adaptations to provide productive water significantly reduce the collection time necessary, and this time may then be spent on productive income-generating activities or in school, if children are the primary collectors (James, 2003; Moriarty et al., 2003; WaterAid, 2001).

Many studies also propose that domestic plus systems may improve willingness to pay for services and maintenance of the system (Perez de Mendiguren and Carlos, 2003; Moriarty et al., 2004; Perez et al., 2003; Mahoo et al., 2003; Matthew, 2003). However, this potential increase in the sustainability of the system depends on myriad factors such as initial income level of the household, how the additional income earned from the productive water is invested, and who pays the water bill.[7] There is a more solid consensus that ignoring multiple uses in the design of a water supply system is sure to reduce sustainability (Moriarty, 2004; Perez de Mendiguren and Carlos, 2003).

Human Capital

Foremost among the benefits of productive water are benefits that accrue to household health. This happens primarily in three ways: 1) adapting Irrigation Plus systems for domestic use, i.e. improving water quality; 2) increased access to livestock products such as dairy and meat; and 3) increased access to fruits and vegetable for consumption from micro-irrigated areas (Robinson, 2003). In addition, increased access and available quantities of water are known to significantly increase hygiene and health (Esrey et al., 1985; Cairncross, 1987; Hoddinott, 1997).

Human capital also accrues to those who have access to productive water in the form of diversified and strengthened livelihoods, i.e. more livelihood activities undertaken or increases in herd size or farming area. There is also evidence that access to productive water improves the ability of farmers to mitigate drought by increasing the availability of water over longer periods of time in the year (Robinson, 2003; Rockstrom, 2000; WaterAid, 2001).

Social Capital

Few studies look at the impact of productive water on social capital beyond increases in women's empowerment in the community. Women often participate in water committees when multiple-use approaches are used. They are key participants in

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[7] If those earning the benefit from the system are not paying the bill, they may be less likely to reinvest in the system. For example, if the bill is paid through remittances.

many of the productive activities that may be undertaken, and have been shown to have a great willingness to pay for productive water services (Perez de Mendiguren and Carlos, 2003; van Koppen et al., 2006; Bradford, 2003; Mulwafu, 2003; McKenzie et al., 2003). Furthermore, time-savings that accrue when productive water becomes available accrue mostly to women and girl children, as they are the drawers of water. This may allow more time for childcare and food preparation for women, and for girls a higher likelihood that they will be able to attend school (VanDear Hoek et al., 1999; James, 2003).

Additionally, a particularly interesting study done in Mauritania in 2002 suggests that provision of water for productive uses may prevent or slow the rural exodus that is happening in many parts of Africa (Mohammed Lemine, 2002).

Costs

Financial Capital

The most significant cost of providing water for multiple uses is the increase in funds needed to adapt or upgrade existing water supply equipment (Endamana et al., 2004; Lefebvre et al., 2005; Robinson, 2003). System costs are increased because of adaptations necessary to provide for multiple uses. For example, increased pipe size, adaptation of irrigation canals, double taps for drinking and irrigation, and troughs necessary to water animals, installation of new pumps (van Koppen et al., 2006; Moriarty et al., 2003; Polak, 2003; Soussan, 2003; Mahoo et al., 2003; Robinson, 2003). The degree of treatment necessary may also increase the costs and ultimately make planned multiple uses inappropriate. For example, the cost of treating drinking water is likely to increase the unit cost of water, making it too expensive to use for irrigation (Moriarty, 2003; Bustamante, 2003; Polak, 2003; Perez de Mendiguren and Carlos, 2003).

Along with the investment costs to increase the quantity of water produced, water extraction technology also requires significant operation and maintenance support for the pumps, motors and piping (Polak, 2003, Endamana et al., 2004). Increasingly, it is also recognized that in order to ensure provision of water above and beyond domestic needs, sighting for boreholes that produce enough water may require more surveys and more expensive excavation than necessary for domestic water alone due to the need to ensure a high flow well (Robinson, 2003; Proudfoot, 2003). Furthermore, better water supplies may result in loss of income for water vendors, and sellers of drugs and treatments are affected when health improves (Robinson, 2003).

On a household level, financial costs of beginning productive activities once productive water is available can be significant (Polak, 2003). For example, to begin productive activities households often need micro-loans to buy the necessary equipment and inputs. Furthermore, if the productive activity is agricultural production or livestock, households may need additional capital to pay for transporting their products to a market (Tawney, 2006; Soussan, 2003).

Governments and non-governmental organizations working in water supply also recognize that these increased system costs pose significant obstacles to implementation of multiple-use systems (Bustamente et al., 2003; van Koppen et al., 2006). Agricultural or rural development ministries cannot pay for systems designated for drinking water even if it is known that a significant portion of the water will go towards productive activities. Similarly, investments for small-scale household irrigation systems or for home-bound[8] livestock that supplement domestic systems cannot be funded through either water or health ministries or agricultural ministries. In addition to these structure barriers to cooperation in water supply, budgetary allocations are shrinking for rural water infrastructure across Africa, making justification of increased costs for water systems that much more difficult (Robinson, 2003).

Human Capital

Research on wastewater reuse systems and many Irrigation Plus systems highlights concerns regarding the health of those in contact with the untreated water. In India, wastewater is frequently used (untreated) for irrigation of peri-urban agriculture. Studies have shown that farmers irrigating from wastewater could loose up to 11 days of labor per year from health complications (Endamana et al., 2004). Additionally, those using irrigation canals for drinking water are inherently exposed to higher health risks from untreated water (Bradford, 2003; VanDear Hoek et al., 1999; VanDear Hoek et al., 2002).

Access to productive water does not automatically induce people to begin productive activities, as knowledge and the know-how are also essential to begin. Many of the most lucrative activities require both financial capital and human capital to begin and succeed (Polak, 2003). This is certainly the case for any small-enterprise that grows out of increased access to productive water; entrepreneurs must know how to manage the income and access markets and inputs in order for the activity to have a sustained impact on household income.

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[8] Home-bound refers to animals that are kept in and around the compound year round and not sent out to graze with the rest of the herd.

Natural Capital

Where ground water recharge is important, there is concern about multiple-use approaches drawing down the water table by seeking maximum flow at each source or by preventing recharge (Yoder, 1983). This concern originates from public health research that indicates different levels of service will increase water use. If a household has to travel between five to 30 minutes, or 100 to1000m, to collect water quantities consumed will remain low. However, consumption levels drastically increase when domestic or productive water systems are adapted to make water more accessible to the household or closer to the point of consumption (such as in the compound) (Cairncross, 1987; Cairncross and Feachem, 1993; Howard and Bartram, 2003; Polak, 2003; White et al., 1972).

Type of Supply	Avg Consumption (l/c/d)	Service Level
Traditional Sources	15.8	Communal
Public Taps	15.5	Communal
Yard Tap	50	In compound
House connection	155	Within house (multiple taps)

Table 2: Increase in consumption by type of supply

(Source: Howard and Bartram, 2003)

Social Capital

Use of domestic water for productive purposes also has created some worries that conflict could arise in communities where scarce drinking water is used for productive activities. If the system was built for drinking water, communities may feel that its use for productive purposes is a waste – particularly if water is scarce. Similarly, if farmers expect a certain amount of water from a system (reservoir for example) to be available for irrigation, diversion of this water for drinking water elsewhere (neighboring urban areas/towns) may cause friction (Bustamante et al., 2003; Endamana et al., 2004; McKenzie et al., 2003; Perez et al., 2003; Polak, 2003; Zuin, 2005). Another potential source of social conflict from productive use of excess drinking water could arise when farmers begin to expand their agricultural production into new areas of the community, which may not receive approval from the rest of the community (Polak, 2003).

Chapter 3: Case Study: Thidé, Mauritania

The Islamic Republic of Mauritania covers just over one million square-kilometers on the west coast of Africa, and is sparsely populated (2.9 million in 2006). It shares borders with Senegal, Mali, Algeria and the Western Sahara, and boasts a nearly untouched 754-kilometer coastline. The country is predominantly desert, as the Sahara stretches across two-thirds of the country, but its southern boundary includes the northern edge of the Sahel and the Senegal River Valley (Handloff, 1990). The south receives significantly more rain than the rest of the country at approximately 400-600mm of rain a year; the capital, Nouakchott receives 100mm, and the city of Atar in the center of the country receives 50mm (UN, 1982; NCDC, 2007). The village of Thidé is located 450 km southeast of Nouakchott in the southern region of the Brakna (see insert), and has a population of 1800.

The Islamic Republic of Mauritania became independent on November 28, 1960, and since then has been primarily ruled by two presidents: Moktar Ould Daddah from 1961 to 1976 and Colonel Maaouiya Ould Taya from 1984 to 2003. In August 2005, President Taya was deposed in a bloodless coup by the Military Council for Justice and Democracy (CMJD) headed by Colonel Ely Ould Mohamed Vall. Ely and the CMJD carried through with their promise of free democratic elections in March of 2007, and handed over power to the new president Sidi Mohamed Ould Cheikh Abdallahi on April 19, 2007.

Methodology

The primary data presented in this case study is a result of two field visits to Thidé in August 2006 and March 2007. The first visit in August served to orient the research team towards the characteristics of water consumption in the village; eight preliminary household surveys were conducted with families that had a private tap in their compound; a mixed-gender focus group helped the team understand the water resources in the village, and resulted in a hand-drawn village map (later used to finalize the GPS map); key informant interviews with village elders, the president of the water committee, and the pump manager completed the information on the village's water history.

This preliminary information was completed and expanded during the second field visit in March 2007. 55 household interviews were conducted: 45 with families who had a private tap in their compound and 10 who did not have a private tap. I developed the questionnaires with help from Winrock International prior to the field visit. The first day of surveying in March served as a pre-test of the survey, and questions were eliminated and adapted with field team members following review of the first day results. Key informant interviews were continued with the pump manager, the secretary general of the water committee, and the village chief. Billing information and system costs over the last year were collected from the village's official records. GPS points of all households interviewed were collected to facilitate spatial analysis of survey results.

The questionnaire was approximately 20 pages long for households with a private tap and 18 pages long for households without a tap. Interviews were mostly conducted in Pulaar with the female head of household, although given the diversity of activities investigated many interviews expanded to involve multiple members of the household. The length of the interviews ranged from 30 minutes to 1.5 hours depending on the level of activities in which the families were involved. Responses were recorded in French and Pulaar, and later translated by field team members and myself. Questions focused on four categories: 1) demographic information (age, # of family members, perception of wealth, family employment; 2) source, payment and use of water; 3) benefits of using water for various productive activities (i.e. results/impact/outcome of productive activities); 4) costs (in time and money) for using water for various productive activities; 5) health impacts and dietary trends given drinking water source.

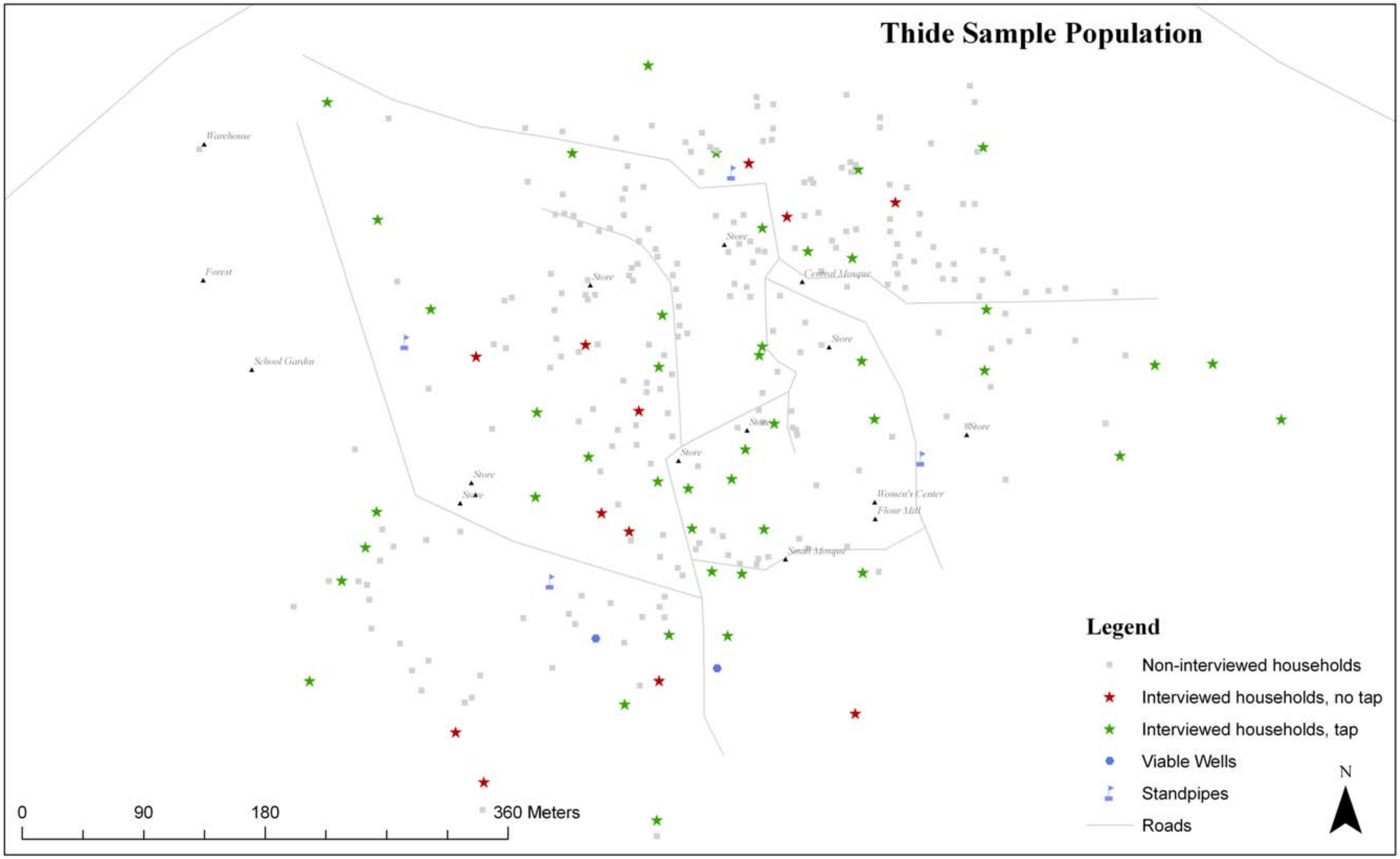

Figure 2: Map of Households Interviewed in Thidé

Description of the Study Area

The study population is the small village of Thidé, located in the Brakna Region of southern Mauritania. The estimated population of Thidé in 2007 is 1800, with an average compound size of two families and an average family size of 13 people (range 3 to 29 people).[9] The vast majority of Thidé is of Peul origin, with the exception of a few Hartani families, and the most common language spoken is Pulaar. The village is located in the Sahelo-Sudanean Zone of Mauritania, which receives approximately 400-600mm of rain per year from July to October, and has sparse tree cover, seasonal grasses and clay soils typical of alluvial flood plains.

Primarily small-scale vegetable gardening, rice cultivation and animal husbandry make up the local village economy. Many males in the community also earn money as day laborers (mostly masons), cart drivers, and civil servants; some women also earn income as petty market vendors in addition to their agriculture projects. The vast majority of households have at least one working family member (80%), and just under half receive remittances from male family members living in Nouakchott or abroad (42%). A family in Thidé has an average of 1.5 employed[10] members, and 36% of adults in the each household are employed.[11] The level of formal employment in the village is one of the factors impacting water use, as consumption from the public or private tap requires cash payments.

[9] Mauritania's 2000 Census reports Thidé's population as 1371. However, if there are 115 households connected to the water system and approximately 20 (author's estimation) who are not connected, at an average of 13 people per household the population would be at least 1755 people.
[10] "Employed" refers to someone earning formal or informal income.
[11] This ratio exceeds 100% in rare circumstances due to employment of youth.

The male head of household and the sons in each family, are the most important income earners. In 47% of Thidé families the male head of household[12] is employed, of whom the majority earn a salary from labor jobs, and a quarter have state employment (Table 3). The average monthly salary for these working heads of household is 21,690 UM ($81.80).[13] Sons are an important source of income for the household: not only do 37% of households have at least one son who works, but also the average salary for a son that works is three times that of a male head of household, 61,863 UM ($233) per month. An additional 15% of households have two sons that work whose income is half that of the first son, 33,500 UM ($126), and still more than the male head of household. A few families in the sample population had five and six sons that contributed some income to the household. The most typical job for sons is also as a laborer or a state worker. Brothers of interviewees or their brothers-in-law also contribute income to a small number of Thidé families; they tend to be laborers or farmers and contribute 6,000 UM ($23) and 10,000UM ($38) per month respectively to household income. The average daily wage for men in labor jobs is 500 UM ($1.85) per day or 15,000UM ($57) per month; most male heads of household and their sons in Thidé are contributing on average more than this each month to household income.

[12] This study defines male heads of household as the father or husband of the interviewee, who may or may not live in the village.

[13] I have some significant concerns with the income data. Most interviewees (57%) did not know their husband's or father's salary, they simply knew that he did earn a salary (or sent money home) that paid for family needs. If a son's work was known his salary, or what he sent home to the family, was known by the interviewee. However, household income is a very taboo subject in Mauritania, and thus the validity of responses to income questions are suspect, and income was not used in the statistical regressions.

Family Member	% of households	most common job	% of group	second most common job	% of group
Male Head of Household	47%	laborer	43%	state worker	23%
Sons (1)	37%	laborer	31%	state worker	26%
Sons (2)	15%	merchants	57%	state worker; ex-patriot; laborer***	14%
Mothers	24%	merchants	53%	laborer; farmer	23%
Brothers	5%	laborer	67%	farmer	33%
Brother-in-laws	11%	laborer	40%	state worker; truck driver; farmer	20%

* A laborer could work as a mason, bread maker, tailor or black smith
** State workers are mostly teachers, police officers, nurses or army officers
***Colons indicate equal prevelance of each type of job

Table 3: Family members contributing to household income

Women in Thidé are involved extensively in agriculture both in the village gardening cooperatives and in family rice fields, but only 24% of those interviewed consider themselves employed. Working mothers make an average of 6,155 UM ($23) per month as vendors, which is nearly double than average daily labor pay for women of 3,400UM ($13.20).[14]

Overall, Thidé's households are representative of slightly below average Mauritanian incomes. All members of the average family make less than the national GDP per capita average of $2,600 (2006 est.) except for the first working son ($2,676 per year). However, all working members discussed here make more than $1 per day except for the mothers and brothers of the family, suggesting that Thidé households are not living in severe poverty (Table 4).[15]

[14] There are three different well-accepted payments for women's day labor in Mauritania. 2000-2500 UM ($7.50-$9.40) per month for a female water porter (2 trips per day); 5000 UM ($18.80) per month for a women to cook lunch each day; and, 3000 UM ($11.32) per month for a woman to wash laundry three times a week. The average of these costs is approximately 116 UM ($0.44) per day and 3500 UM ($13.20) per month.
[15] See also Appendix A for local prices of basic goods for comparison. NB. All income numbers reported come from March 2007 household survey.

Family Member	Income	
	($/year)	*$/day*
Son (1)	2,676	7.33
Son (2)	1,512	4.14
Father	982	2.69
Mother	276	0.76
Brother	276	0.76
Brother-in-law	456	1.25

Table 4: Thidé Incomes

Water Consumption and Management Patterns

Thidé has had a gravity fed reticulation system for 10 years; the government of Mauritania and the Japanese Embassy financed the system without consultation with the village, and with no village contribution required (Village Elder, 2006; Village Chief, 2007; see Appendix B for pictures). Before the system was built the village acquired drinking water from a series of 15 hand-dug wells. However, when the piped system was put in place the village filled in or covered up most of them for fear that children would fall in, or because as they were not using the water its quality decreased. Only two family-owned wells and the three garden wells remain viable.

Today, the village uses on average 1462 m^3 of water per month, or 27.1 liters per capita per day (l/c/d), but consumption varies by season. In the dry season, this monthly average increases to 1648 m^3 (30.5 l/c/d), and in the rainy season and the cold season it decreases to 1306 m^3 (24.2 l/c/d). 115 households have metered private taps in their compound; approximately 20 do not, and they get their water the public taps or the two private wells (see village map, Figure 2).

Initially, the Mauritanian government managed the Thidé water system. However, in 2000, in accordance with national water policies all such systems in Mauritania were privatized, with government involvement reduced to repairs and maintenance quality checks only (Village Chief, 2007; Plumber, 2007; Pump Manager, 2007; El Hacen, 2002; Abba, 2006). For Thidé, this meant that the village would have to begin managing its own funds and maintenance. A pump manager from the village was hired to manage all equipment, organize and oversee the filling of the water tower each day, record water use per household and standpipe, collect monthly bills and deposit payments in the local bank account, make payments to the *Agence National de l'Eau Potable et Assainissement* (ANEPA), pay for and transport gasoline and other maintenance incidentals, and contact ANEPA if technical problems arose. These duties proved too much for the untrained pump manager, and over the period of 2000-2006, the village incurred between 300,000UM (~$1200) and 460,000UM (~$1840) of debt to ANEPA.[16] During this time, although the price of diesel rose, the cost of water in the village did not.

Consequently, in 2006 the village took action to begin repaying their debt (at a rate of $38 per month), increase water costs, and better manage their system. A water committee was created, which would oversee all future finances of the system, take responsibility for disconnecting delinquent households, and communicate with ANEPA regarding payments. On the 10th of each month the committee meets, verifies with the pump manager who has paid their bill, and then shuts off those families that have not paid.[17] The pump manager is now simply responsible for maintenance of the system, distribution of bills and collection of payments. Everyday he turns on the diesel pump in the morning, and lets it run until the water tower has filled to 50% capacity ($10m^3$). When

[16] The village and ANEPA report different amounts.
[17] Bills are distributed on the 1st of the month, and families are given until the 10th (the day of the meeting) to pay. Only 24% of connected households have ever been disconnected, and of these household 45% were disconnected for only one day. The average number of days they remained disconnected was 9 days.

he suspects a problem with the motor or submerged water pump, he immediately calls ANEPA and they send a technician to the village to investigate the problem.

The village's attempts at cost-recovery have lead to an increase in the cost of water and a decrease in per household consumption of water. As gas prices rose 9.5% over the course of this past year, the cost of water from a private tap rose 26%, from 100UM ($0.39) per m^3 in February of 2006 to 140UM ($0.49) per m^3 today. This led to a corresponding reduction in demand of 28% over the same time period (Figure 4). Water from the public tap is 2.14 times as expensive as water from the private tap, and has double in cost since August 2006 when a 30L bucket was 5UM ($0.019); 30L now costs 10UM ($0.037).

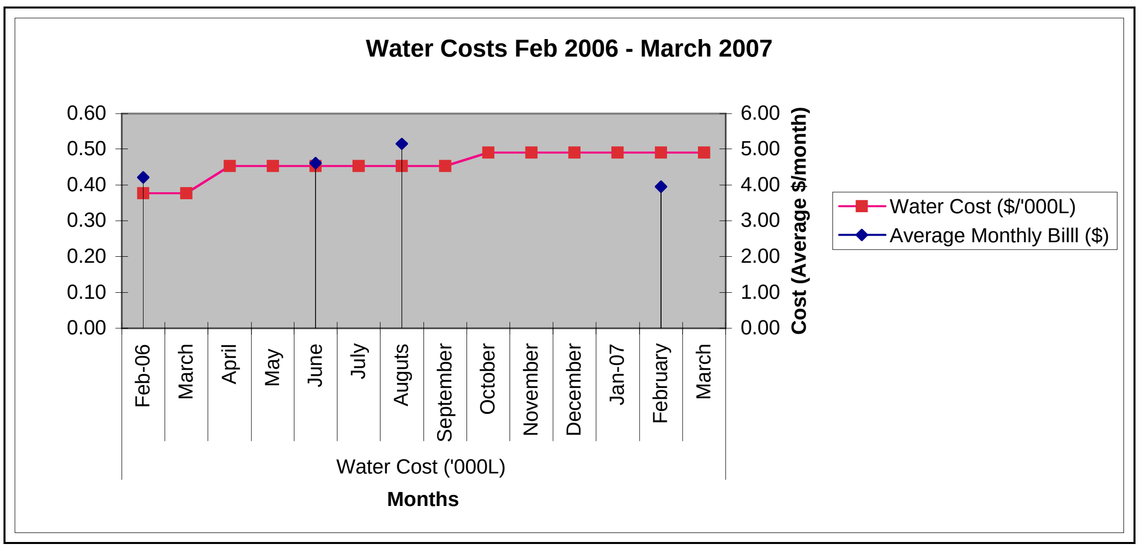

Figure 3: Household Water Costs and Water Price 2006-2007

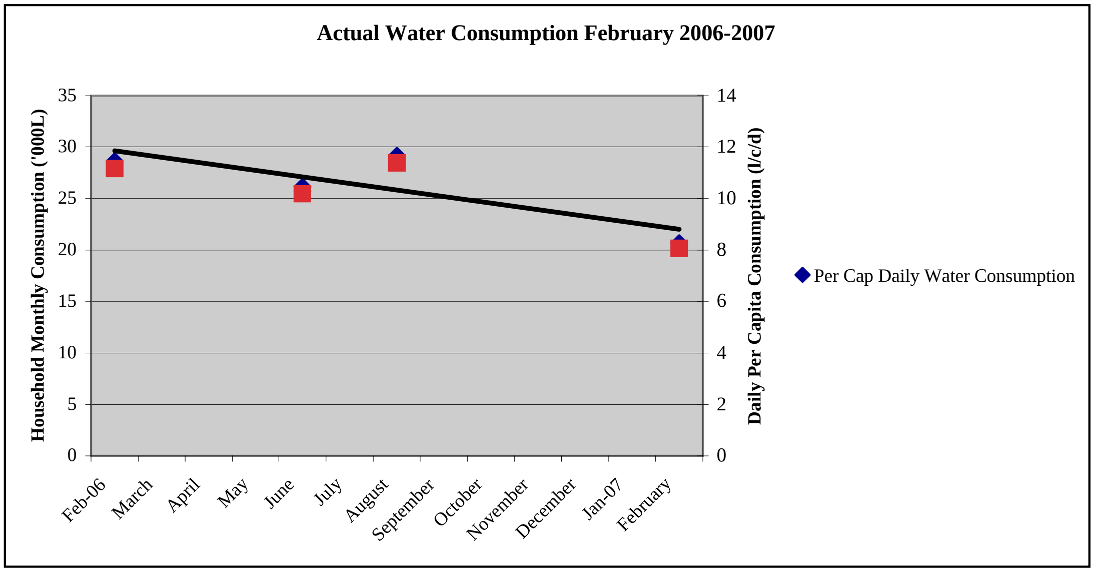

Figure 4: Actual Water Consumption 2006-2007

Nevertheless, households have continued to invest in the installation of a private tap. Since the beginning of August 2006, 14 new households have connected primarily for reasons of convenience and health. Health reasons mentioned for the investment included ease of fetching water, reduced distance to carry water and a perception of improved water quality. These reasons have changed only slightly over time; families who connected more recently indicate that the reason to connect was "because the whole village has them" or "because of problems taking water from the neighbors."

In general, households feel they have sufficient water to meet all their needs in both the wet and the dry season. However, there were some households who felt they did not have enough water in the dry season. Their reasons for insufficient water included: wells drying up for periods of the day, not having enough water to wash clothes or bath at the house due to increased consumption needs, public tap closed in the morning, lack of money to pay for water, increased water temperature from piped water in the dry season, and neighbors ask for too much water. Figure 5 shows the difference between tap and non-tap households' perceptions of water sufficiency; households with a tap feel they have more sufficient availability year round than those without.

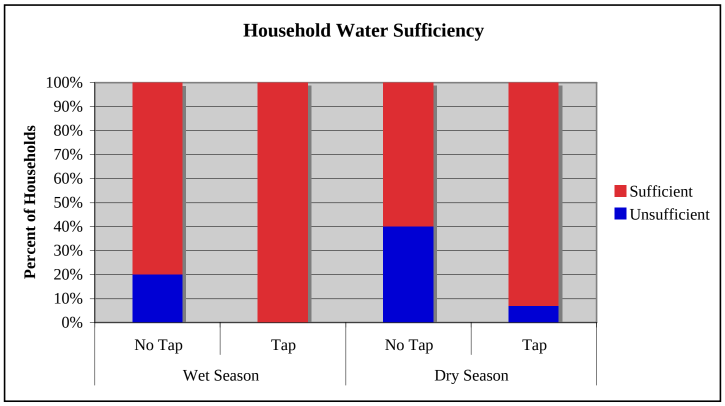

Figure 5: Water Sufficiency by Season and Tap

While the system has not had significant problems in any of the last 10 years, the village water committee is worried that as more and more parts are replaced with non-original pieces there is a high likelihood of a significant motor breakdown. Simultaneously, they are worried about the sustainability of the current well. Until 2000, there was enough water pressure to fill the tower to 50% capacity in one hour. It now takes almost five hours to fill it to the same level. The pump manager, local plumber (who installs all household connections) and secretary general feel there are two possible options for avoiding disaster: 1) buy a second motor and keep it at the ready; 2) dig a second well as a reserve incase the first dries up. Further study of Thidé should investigate the financial and environmental feasibility of these two options.

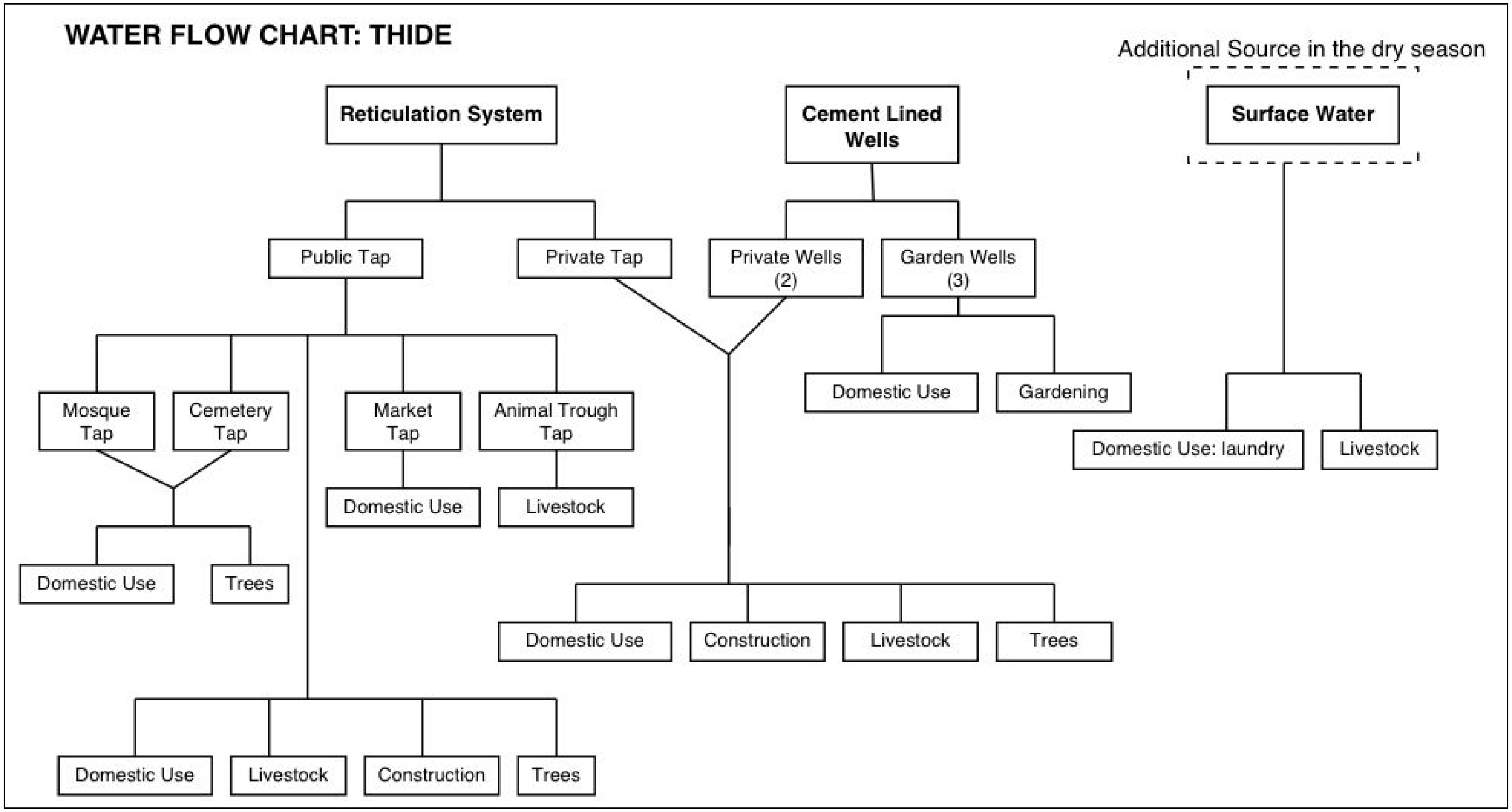

Figure 6: Water sources and uses in Thidé

Water Use in Thidé

In Thidé, water is used for a variety of purposes beyond domestic uses; households keep cows, sheep, goats, poultry, donkeys and horses in their compound year round, and feed and water these animals from the household's resources. Water is also used for trees and construction (Figure 6).

Households in Thidé keep an average of 2 cows, 7 sheep or goats, 4 poultry and one donkey or horse in their compound year round. However, the averages are not particularly relevant to the reality: only 27% of households keep cows, 85% keep sheep or goats, 35% keep donkeys and 40% keep poultry (of which all are households with a tap) (Figure 7).[18] The home-bound ruminants represent a characteristically different asset from those ruminants in the family's main herd. The main herd is kept outside the village, sometimes thousands of kilometers away, grazing for most of the year. In the short rainy season families bring primarily those heifers expecting calves, and goats and sheep expecting kids back to the village to consume or sell the milk they produce. The larger herd serves as a bank account for the family, and is not often culled for consumption or sale.

[18] Qualitative observations indicate that poultry are owned by most households not simply households with a tap, and that the small sample size for non-tap households may have randomly excluded the population of households without a tap that have poultry.

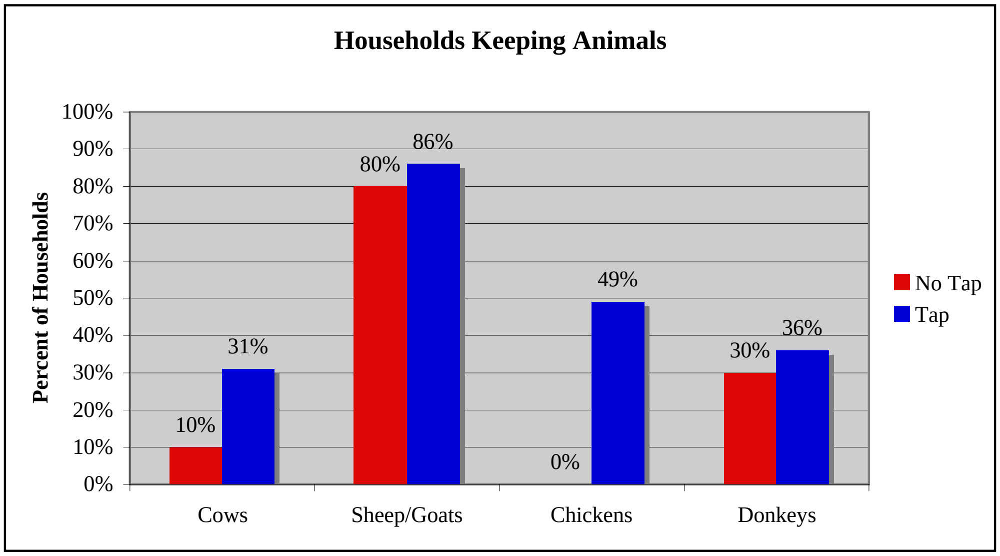

Figure 7: Percent of Households keeping animals

Sources of water for the animals change by season and household water supply infrastructure (Figure 6). Availability of surface water depends entirely on frequency and strength of seasonal rains for 90 days from early-July to late-October. Rainwater accumulates in ponds approximately 100 meters to the north and south of the village, and most families use these ponds to water their animals in the rainy season. In the dry season, households with a tap exclusively use the tap for their animals, and those without use the private cement wells. Of households with a tap that keep sheep or goats, 52% water them exclusively from the tap year round.

Water use per animal in Thidé is not particularly typical of recognized quantities for animals in dryland climates. Oxfam, UK estimates that 20-30 liters of water is appropriate for a large or a medium sized animal per day, and 5 liters per small animal (Oxfam, 2004). Table 5 shows sheep, goats, donkeys and horses are given significantly more water per day than suggested by Oxfam. Given these estimates and the average number of animals kept in a household, household use an average of approximately 150L a day to water their livestock.

Animal	Water Consumption (L per day)
Cows	19.7
Sheep/Goats	9.4
Poultry	0.87
Donkeys or Horses	41.6

Table 5: Average water consumption per animal in the dry season (L)

Water is also used to grow trees, make bricks and repair houses in many households. Thirty percent of sampled households water trees with an average of 13.4 liters per day in the dry season; the rain waters the trees in the wet season.[19] Similarly, 25% of households use water for construction of bricks or house repairs, however, it was impossible to measure the amount of water used because they do not keep track; either they allow the tap to run constantly until the mason is finished with the construction, or they and their neighbors bring bucket after bucket to the construction site filling 150L barrels until the work is done.

Wealth, employment and productive water use

In a household with a tap, on average 38% of the adults[20] are employed, and of those households without a tap, only 27% (Figure 8). Interestingly, households without a tap have a higher percentage of sons and a significantly lower percentage of male heads of household who work than those with a tap. Brothers of the interviewee were also much more likely to be contributing to household income for households without a tap. In families where the head of household does not have *"travail fixe"* or regular work, the

[19] The sustainability of this activity is not known. World Vision International recently provided the fruit trees to the village, and my experience in Mauritania would lead me to imagine that the majority of trees will not survive to the point of production.
[20] An adult is someone older than 16 years. Only in rare cases is this percentage greater than 100 due to youth who work.

youth and extended family are more likely to work and contribute money to the household indicating the relatively greater importance of extended family labor in households without a tap.

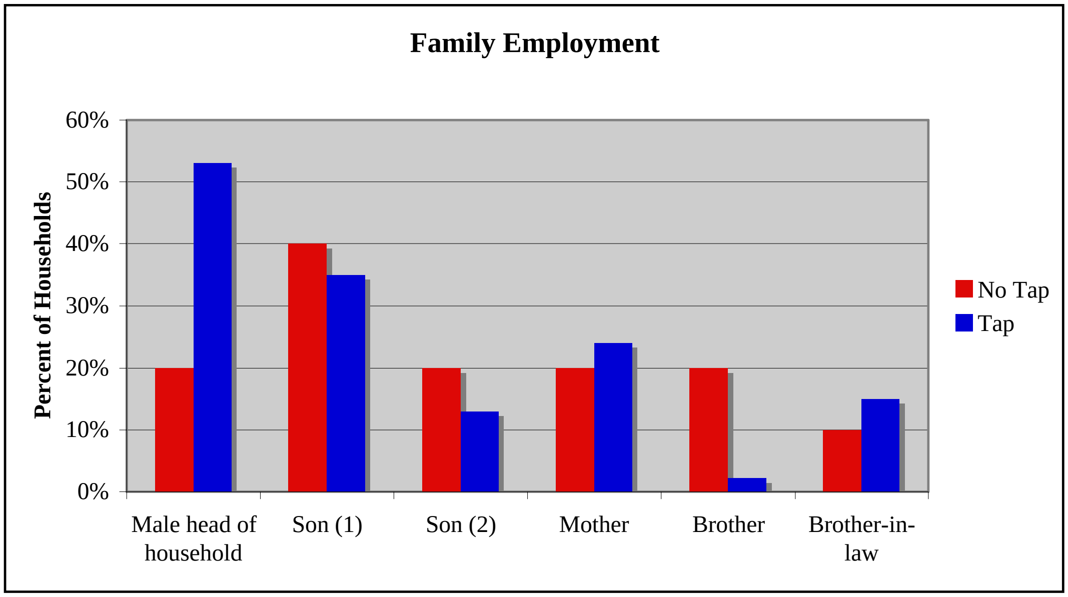

Figure 8: Family Employment Summary

Remittances are equally important to households with and without a tap, and 46% of population relies to some extent on external income. Of non-tap households who pay for water at the public tap, 50% receive assistance from outside the village to pay for this water, and 46% of households with a tap receive external assistance to pay their monthly water bills. The impact that remittances have on water consumption and the sustainability of self-sustaining water systems could be measured by the percentage of household income derived from them; unfortunately, given the difficulties of collecting income data in Thidé, it was not possible to collect this information. However, this study was able to estimate the percentage of household income going towards water using the average monthly water bill 1,187UM and the average family income 17,117UM.[21] The average household in Thidé is paying approximately 6.58% of their monthly income for water. This is significantly higher than the generally accepted maximum of 5% of household income that the poor are willing to pay for water (McPhail, 1993), and the observed 1.7% spent on water in Haiti, reported by Whittington (1990).

Finally, perceptions of wealth in Thidé provide insight into the difference between tap and non-tap households because un-served households are twice as likely to see themselves as worse off than those with a tap (Figure 9). Despite the fact that this is a qualitative comparison, it has serious practical importance. If self-paying systems are not serving those who see themselves as worse off, they may not be an appropriate tool for strengthening livelihoods and reducing poverty.

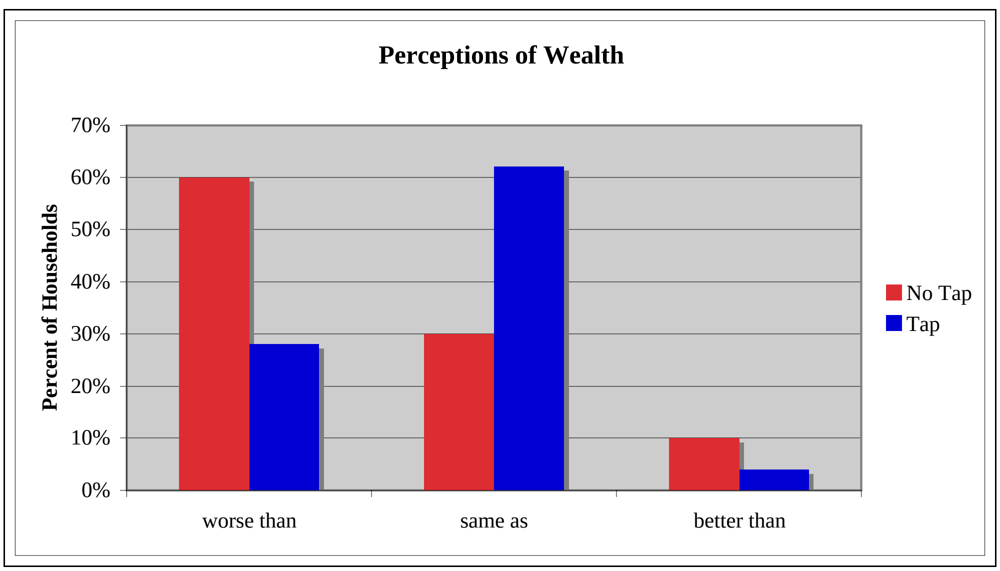

Figure 9: Perceptions of Wealth

[21] Family income was calculated by summing the reported salaries for each family member, and the averaging across the sample population. 21 households did not know how much their working family members made; these households were not included in the calculation of family income.

Chapter 4: Results and Discussion of Costs and Benefits to productive water

The following discussion is based exclusively on estimates from the March 2007 survey. As in the literature review, the framework for analysis is a livelihood approach that looks at the various forms of "capital" that together make up all a household's livelihood assets. Each sub-section analyzes the particular costs and benefits for each type of capital.

Unfortunately, this dataset is missing certain explanatory variables that because of time and cultural taboos were not possible to collect. Ideally, the survey would have included measures of ethnicity, housing type, income and household education levels. Instead certain proxies were chosen: dummy variables for the types of latrine (*dlatx*) as a proxy for housing. Households with both are shower room and a pit latrine are better off than those with only a pit latrine, and those with only a pit latrine are better off than those with only a shower room.[22] Percent of employed adults (*percadultemp*) and dummy variable for perceived wealth (*dwlthx*) is used as a proxy for income.[23] Ethnicity was not included because everyone in Thidé is of the same ethnicity, and there was insufficient time to collect education data. One additional socio-economic variable was included, the number of people in the family (*pplfam*), along with a water supply variable indicating the presence of a household tap (*tap*) (Table 6).

Various dependent variables were tested against the above explanatory variables in an attempt to tease out the effect of having a tap on various aspects of Thidé livelihoods. These include: the number of animals of each kind a household keeps; the

[22] This ranking is based on the cost to a household of building each of these latrines.
[23] See page 12for explanation of why collected income data was not used.

number of trees in the compound; the likelihood of a household keeping animals at all; the frequency with which a household eats dairy, meat, grains other than rice, and peanuts or beans[24]; and, a dietary diversity index.

This discussion falls short of a true cost-benefit analysis because of the missing socio-economic and financial data, but it does thoroughly describe the current trends and relationship, and provides a basis for further study of multiple-use systems in this area of the world.

Variable Definition		
Indicator	**Description**	**Value**
tap	Presence of a tap in the compound	1 = yes, households has a private tap 0 = no, households does not have a private tap
dwlth1	Household sees itself as worse off than other Thidˇ households	1 = yes, households sees itself as worse off 0 = otherwise
dwlth2	Household sees itself as the same as other Thidˇ households	1 = yes, households sees itself as the same as 0 = otherwise
dwlth3	Household sees itself as better off than other Thidˇ households	1 = yes, households sees itself as better than 0 = otherwise
dlat1	Household has a pit latrine only	1 = yes, pit latrine only 0 = otherwise
dlat2	Household has a shower room only	1 = yes, shower room only 0 = otherwise
dlat3	Household has both a pit latrine and a shower room	1 = yes, both pit latrine and shower room 0 = otherwise
pplfam	Family Size	Number of people in the familyinterviewed
percadultemp	Employed Adults	Percent of adults (older than 16) employed in the family

Table 6: Definition of Variables

[24] These foods were chosen because bivariate estimates showed that the means of these variables for both types of households were significantly different.

Benefits

Physical Capital: Livestock and Trees

Physical capital is generally thought of as the infrastructure and changes to the physical environment that help people meet their basic needs, but it can also include the "producer goods" necessary to function productively (DFID, 1999). In Thidé, the presence of the piped water system, and in particular, productive water seems to have had a positive impact on physical capital. It directly provides the village with an extremely accessible high quality drinking water supply (one of the core aspects of physical capital), and indirectly assists households in their ability to keep more animals year round, and to plant trees by providing the water to sustain these physical assets.[25]

Proportionally greater benefits in physical capital have accrued to households with a tap. These benefits can be seen in the likelihood that a household keeps animals year round, the number of animals that households with a tap keep year round, as well as the likelihood that they have trees. Eighty-eight percent of households with a tap keep an animal in their compound (cow, sheep/goat, poultry, donkey) as compared to 80% for households without a tap.[26] For each category of animal (as seen in Figure 7 above) a higher percentage of households with have a tap keep the animal year round. Similarly, of those tap households keeping cows they have on average six cows, while those without a tap have only two. Those keeping sheep or goats also have more on average than those without a tap, 8.8 and 5.5 respectively. In this dataset only households with a tap keep

[25] Water quality testing was not done, but the gravity system is considered a protected source, which is significantly better than the cement wells or surface water used previously for drinking water (WHO/UNICEF, 2004).
[26] This difference in means is statistically insignificant (t=0.75).

poultry, and both categories of households keep approximately one donkey or horse.[27] On average, one or two trees are grown in 31% of households.

These assets are not only in and of themselves physical capital, but they are capable of generating more physical capital. Donkeys and horses kept by Thidé households also provide an important means of transportation for families to and from the nearby market and irrigated rice perimeter where many families farm. Qualitative questions on the household survey also indicate that the vast majority of both household subsets recognize that one of the primary advantages of keeping animals in the compound year round is the possibility to increase their herd size.[28] Similarly, the primary advantage of having a tree is for its fruit and shade (Figure 10). Shade in Mauritania is practically a physical asset, as it serves as shelter for people and animals during the hot sunlight hours, and buffers the strong desert winds (see Appendix B for pictures).

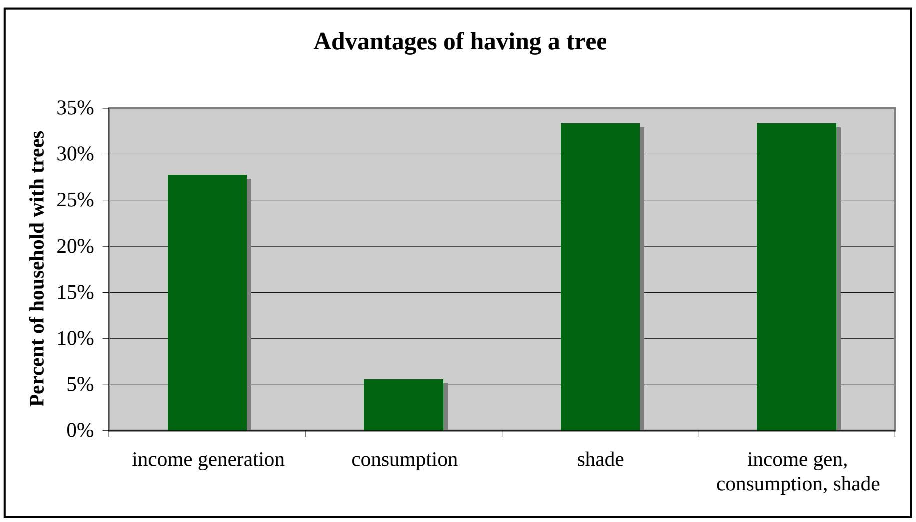

Figure 10: Advantages of Having a Tree

[27] Donkeys and horses were aggregated in this dataset, but it is important to note that in Mauritania horses are used almost exclusively to pull transportation carts that earn the owner money. Donkeys are more frequently simply beasts of burden for the family, and do not earn an income. In the future these two types of animals should be disaggregated.
[28] Other advantages include: revenue generation, consumption and the fact that the animal can be sold when needed, which will be discussed below.

Linear regressions show that having a tap is positively correlated with whether or not a household keeps animals year round and the number of cows, sheep or goats and poultry that a household has (See Table 7 on next page for regression estimates). However, the explanatory variable *tap* is insignificant for each regression. Furthermore, none of the chosen explanatory variables are significant for the quantity of cows kept, or the likelihood that a household keeps animals at all. The percentage of employed adults in the family is significant and positively correlated to the number of sheep or goats, and the number of poultry kept, but in practical terms barely so. For example, for every one percent increase in the percent of working adults in the family, the family can expect to gain 7/100 of a goat and 2/100 of a chicken. While this does not seem practically important, if we consider that the average family size is 13 people, and the average number of working adults is approximately seven, then the employment of one additional adult in the family would be a 8% increase, leading to an increase of half (0.56) a goat. Two additional adults would need to find employment[29] to increase the number of goats kept in the compound year round by one.

Similarly, the number of people in the family (*pplfam*) is significant and positively correlated to the number of poultry and donkeys or horses in the compound, but not practically so. Having only a shower room (*dlat2*) or both a shower room and a pit latrine (*dlat3*) is only significant and again positive for the number of trees in a compound. All else equal, the number of trees in a compound will be larger by three if a household has both a pit latrine and a shower than if it only has a shower room. The

[29] The idea of employment here should be understood to mean an additional adult in the family begins earning some cash in a relatively consistent way.

implications of these differences is that while there is clearly a positive relationship between having a private tap and increased physical assets (larger herd size, shade, transportation, etc.) it does not seem likely that having a tap is the strongest indicator of physical capital.

Variable	Explanatory Variables					
	Physical Capital					
	# of Cows	**# of Sheep or Goats**	**# of Chickens**	**# of Donkeys**	**Animal Kept (Yes/NO)**	**# of trees**
tap	0.75	0.08	4.70	-0.35	0.17	0.14
	2.09	3.55	3.47	0.61	0.16	0.36
dwlth1	-1.91	-3.61	-4.85	-0.23	0.14	0.03
	2.74	4.66	4.54	0.79	0.21	0.41
dwlth2	0.39	-0.23	-3.32	-0.71	0.36	0.19
	2.68	4.55	4.44	0.78	0.21	0.39
dwlth3	-1.22	1.98	-3.74	-0.41	0.57	NA
	4.24	7.20	7.03	1.23	0.33	NA
dlat1	0.27	4.35	0.26	0.30	0.55	NA
	3.46	5.87	5.73	1.00	0.27	NA
dlat2	1.44	-0.11	-5.56	-0.54	0.22	0.77
	3.95	6.70	6.53	1.14	0.31	0.60
dlat3	-0.20	2.91	-2.18	0.47	0.26	0.51
	2.93	4.97	4.85	0.85	0.23	0.37
pplfam	0.08	0.27	0.47	0.08	0.01	-0.01
	0.11	0.19	0.19**	0.03**	0.01	0.02
percadultemp	0.02	0.07	0.02	0.00	0.00	0.00
	0.02	0.04**	0.03**	0.01	0.00	0.00
R-squared	0.20	0.54	0.41	0.37	0.86	0.33
n	55	55	55	55	55	55

** Significant at the 0.05 level

Table 7: Physical Capital Benefits of access to productive water

Financial Capital: Revenue generation

The existence of productive water in the compound does not itself hold financial benefits to household in Thidé.[30] In fact, there are direct costs of having a tap in the compound (see section on Costs below). Nevertheless, the physical assets that are sustained in part by this water do provide the household with the opportunity to increase its financial capital through revenue generation from sales and expenditure saving consumption.

The village has two markets for its livestock and livestock products, one in the village itself (see village map), and a larger one 7km away in the departmental capital, Boghé. Animals tend to be sold outside the village, in the Boghé market, while animal products (dairy and meat) are sold in the village, if at all. Sheep and goats are the items most often sold, although many households with a tap also sell cow dairy products (Figure 11). In general, a higher percentage of households with a tap earn income from their animals than those without. These households make up all those that sell cows or cow dairy products; all those that earn revenue from their donkeys or horses; 92% of those that sell goats, and 85% of those selling goat or sheep dairy products. Conversely, households without a tap noted consumption as the single most important advantage of having sheep, goats or cows. They also only use their donkeys and horses for personal (i.e. non-revenue generating) transportation. Even if these differences are a result of the larger herd size in households with a tap (as discussed above), they indicate that financial capital benefits of productive water are greater for tap households.

[30] In many multiple-use systems, water is sold directly, or made into ice or drinks to sell, and thus financial capital is generated directly from the water itself.

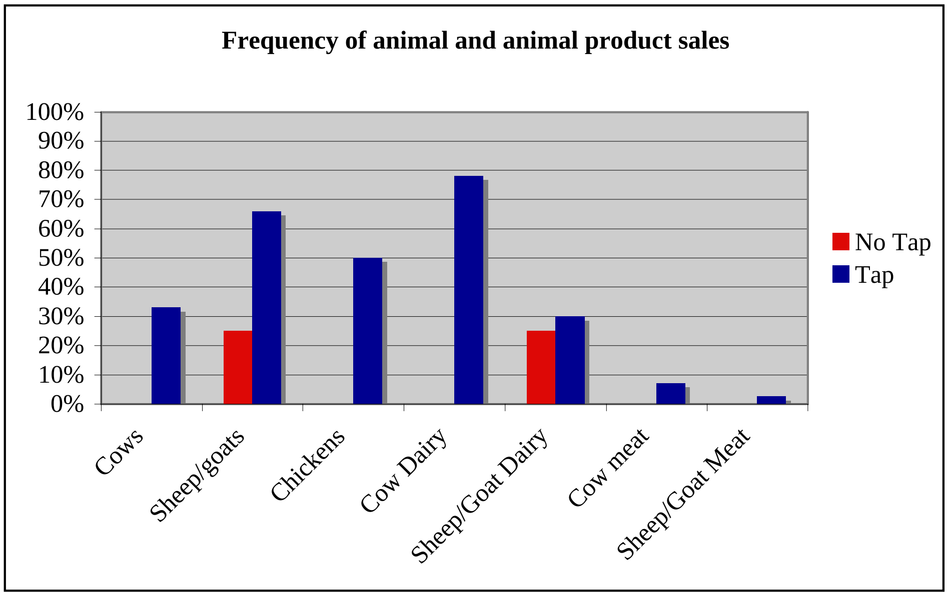

Figure 11: Frequency of livestock and livestock product sales

In order to understand more fully the impact of revenue earned from animals, households were asked to describe the most common uses of revenue from animals. Overall, approximately 80% of households use some of the revenue to buy food, and 33% exclusively so; clothes, shoes and animal feed are also an important use of the revenue. Households with a tap spend money earned from their animals on a diverse range of products while households without a tap have a narrower range of uses for animal revenue (Figure 12). As to be expected given the below average income levels in this village, both subsets spend most of the revenue earned from animals on essentials such as food, clothes and shoes. However, non-tap households more often reinvest their animal earned revenue back into their animals and into the cost of water than tap households.

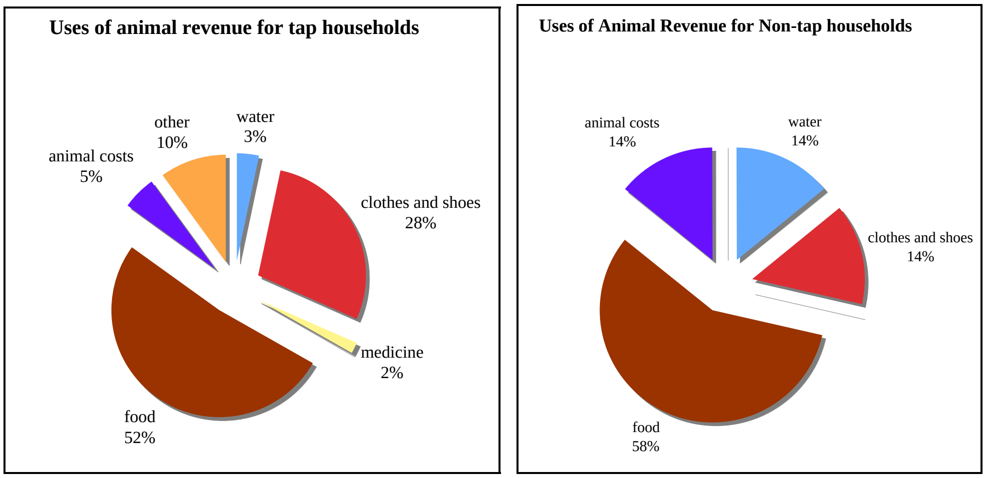

Figure 12: Uses of Animal Revenue

While this diversity may simply be an indication of a disparity in levels and sources of wealth between the groups, it also suggests that remittances may play a significant role in a household’s willingness and ability to pay for water in Thidé. Considering that 25% of households without a tap use revenue from animals to pay for water, as compared to only 6% of households with a tap, one might assume this self-financing system is better sustained by non-tap households who reinvest income in the system once they have benefited from it. However, the dependence of households with a tap on remittances complicates this picture; in 46% of households with a tap the water payer lives outside the village, and these households do not have the need to reinvest locally earned income from livestock back into their water bill. Conversely, only two out of 10 non-tap households have water paid for by someone outside the village, and thus depend more often on the income they earn from local water related activities to continue paying for water. This is an important aspect of the financial benefits and the sustainability of multiple-use systems that has yet to fully investigated.

Social Capital: Uphold Cultural and Religious Customs

An unexpected outcome of this study has been the realization that the benefits gained from productive water activities such as livestock are less financial than they are social. Mauritania has a very strong tradition of hospitality and sharing of household goods that has its origins both in Islam and in the country's pastoralist history. Religious traditions dictate that households should give charity regularly, share meat from a butchered animal, and make every effort to provide livestock and their products for any village baptisms (naming ceremonies), marriages, deaths or holidays (Quran, Surah 9, Verse 60*)*. Cultural traditions include slaughtering or preparing a dairy drink for a guest, responding to a request from a neighbor or family member for meat, and giving to an intimate friend as a gift (Figure 13).

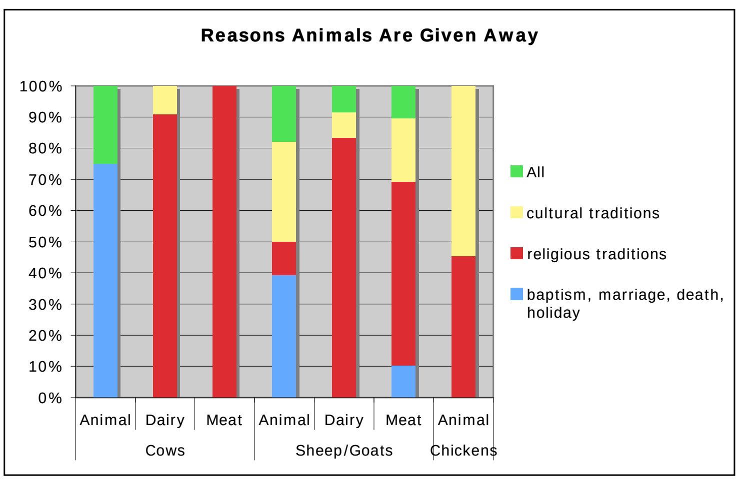

Figure 13: Reasons for giving away animals

This study looked specifically at the frequency with which households gave away the whole animal, the animal's meat, and cow and goat dairy products[31] and skins. Among households that do give away livestock and livestock products, goat meat and

[31] Dairy products are *lait caillait* (sour milk or yogurt), fresh milk, butter and *idhin* (a rancid oil from the buttermilk used as a condiment on rice dishes).

goat-skins are the most common products given away, and cows, cow meat and poultry are the least frequently given.

Again there is a difference between the sample subsets. Those without a tap are more likely to give away goat meat and skins than those with a tap (Figure 15 and Figure 14), while those with a tap give away the whole animal and its dairy products more frequently (Figure 16 and Figure 17). The reason for this difference is unclear. It may indicate that those households without a tap only have the resources to share meat when an animal is slaughtered, while tap households have a large enough herd to give away an animal. Potentially, households without a tap may give away goat-skins more frequently because they are linked into a network of people who transform the skins into various products such as mats, pillows, harnesses, prayer mats and containers. Differences in income between the two groups may affect the likelihood that a household uses the animal skins, just as it may be more able to share dairy products instead of consuming or selling them.

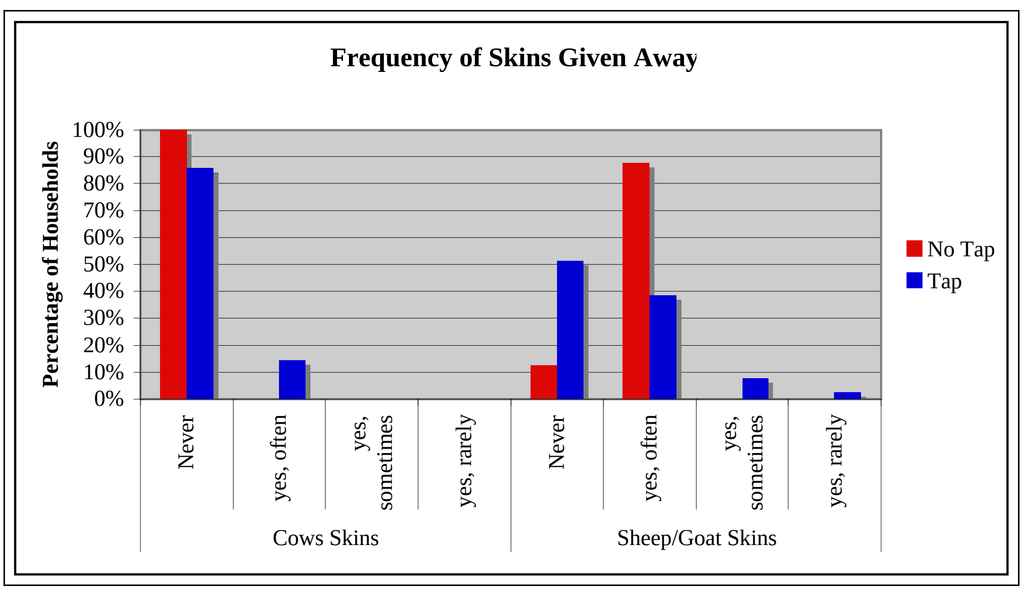

Figure 14: Frequency with which households give away animals skins

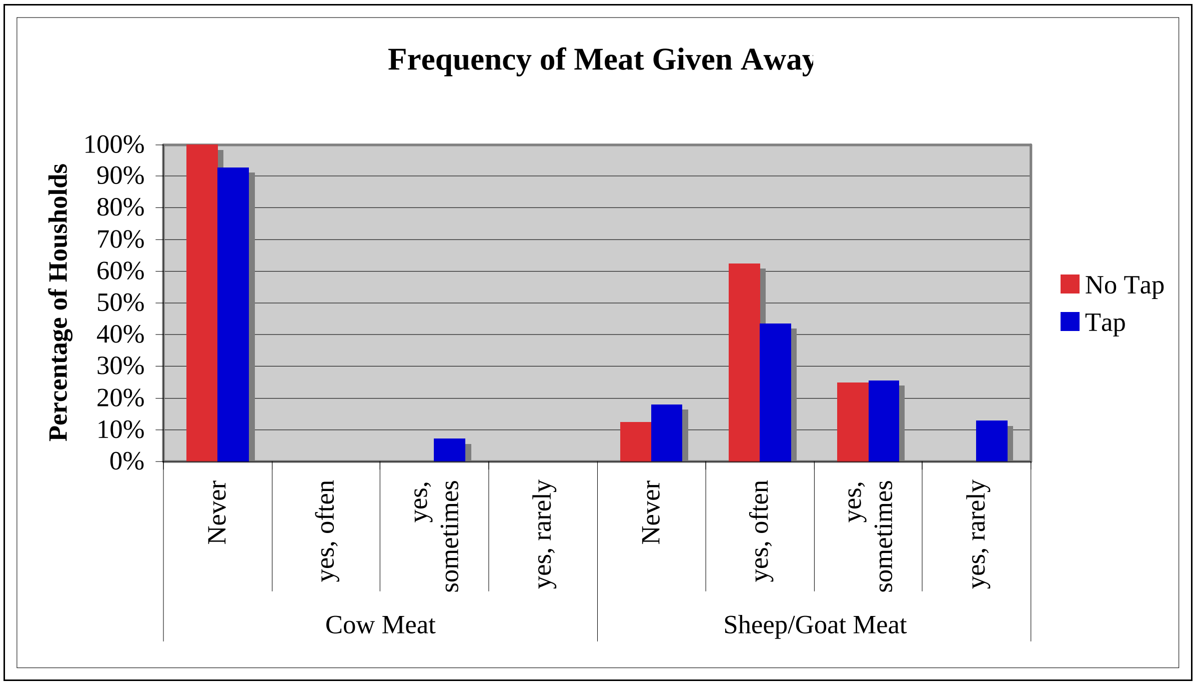

Figure 15: Frequency with which households give away meat

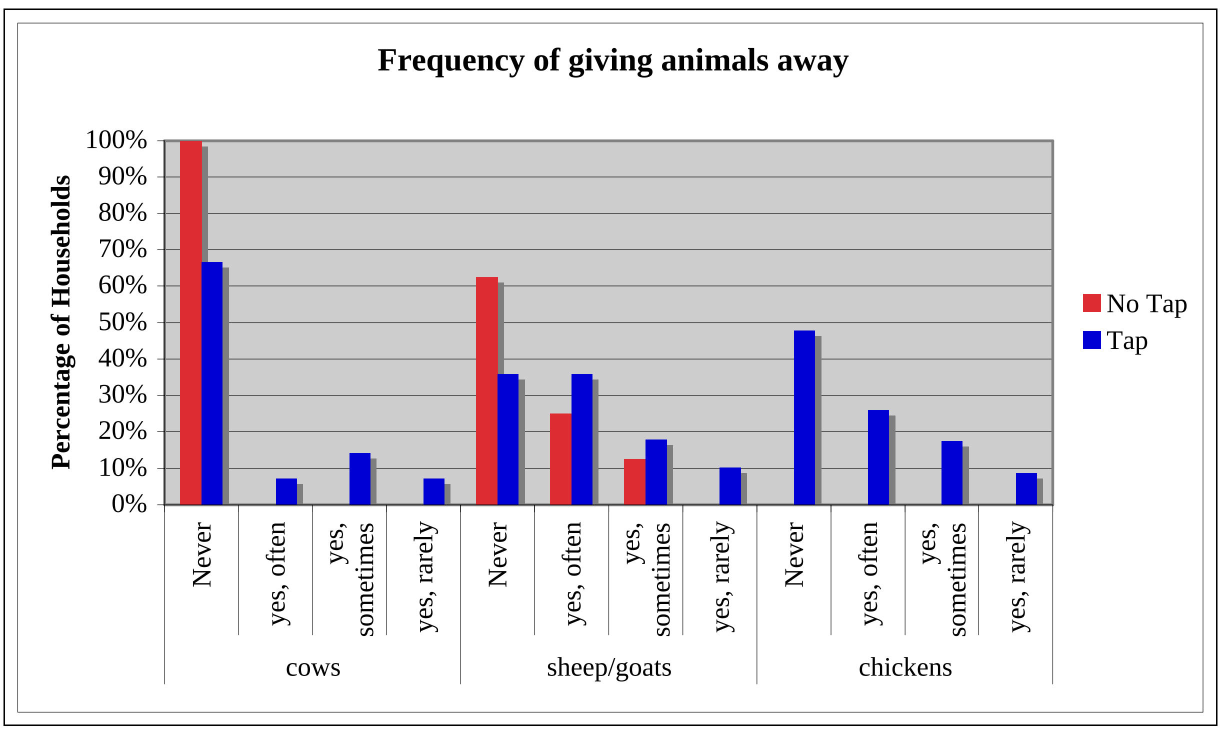

Figure 16: Frequency with which households give away animals

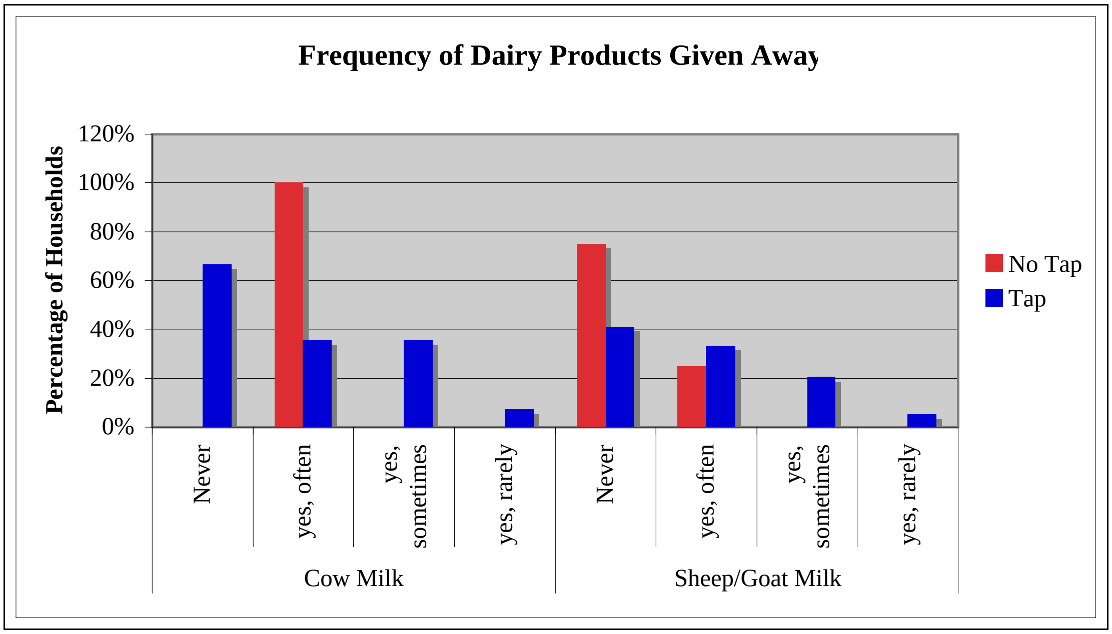

Figure 17: Frequency with which households give away dairy products

Human Capital: Health and Time Savings

In Thidé, it seems that the availability of productive water improves human health in three ways. First, assuming that there is a positive relationship between having a tap and increased physical capital in the form of livestock, productive water should increase a household and the village's access to livestock products.[32] However, results from the study indicate that this may only be true at the village level because at the household level the majority of those eating dairy and meat (63% and 78%) do not consume products produced from the family animals kept in the compound year round. Instead they get their animal products from the local market or the Boghé market; unfortunately, we do not know from exactly where people buy their dairy and meat products, but we do know where Thidé households sell their locally produced dairy and meat. As discussed briefly above and in more detail in Table 8: Location of Livestock Product Sales, meat is not sold frequently, but when it is the market is within the village. Similarly, the majority

[32] As discussed above, animals provide an important source of dietary supplementation; dairy products and poultry meat are frequently consumed in Thidé.

of dairy products that come from animals kept in the compound are sold at the village market. Assuming those purchasing animal products at the local market are primarily those who live in the village,[33] the majority of the milk consuming population buys it from the village. Ultimately, at the household level it is not clear if productive water improves access animal products, but location of sales indicates that access, and simultaneously human capital, is improved at the village level.

Animal and Product		Location of Sale		
		inside village	**outside village**	**both**
Cows	**Dairy**	81%	0%	18%
	Meat*	100%	0%	0%
Sheep/ Goats	**Dairy**	64%	28%	7%
	Meat*	100%	0%	0%
Chickens	**Meat**	54%	18%	27%

*only one observation

Table 8: Location of Livestock Product Sales

The second way that households may improve its human capital from productive water is through increased consumption and dietary diversity (again assuming the positive relationship between having a tap and increased household assets such as livestock). Bivariate comparisons indicate that the mean frequency with which a household eats dairy products, fruit, other grains (in addition to rice), peanuts or beans differs significantly across households with and without a tap (Figure 18 and Table 9). It is important to consider that the household itself could produce dairy, grains, peanuts and beans, and production levels would depend on size of family land holdings. However, this sample population procured these products almost entirely from outside the household.[34]

[33] This is a valid assuming considering that every small village in the vicinity has its own market or is located closer to Boghé, and is not likely to frequent Thidé's market.
[34] Results from the dietary recall portion of the questionnaire indicate of those consuming these food items 97% bought other grains; 100% bought beans, peanuts and fruit; and, 63% bought dairy. Note that March

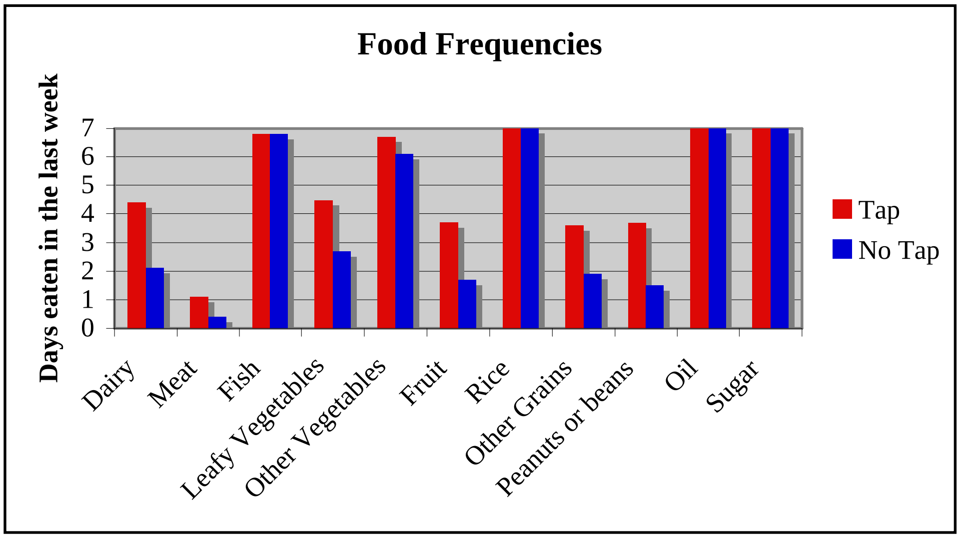

Figure 18: Food Frequencies

Health Indicator	**Average Incidence**		**Reject/ Fail to reject null**
	Tap	**No Tap**	
Days Eatten in last week			
Dairy	4.4	2.1	R
Meat	1.1	0.4	F
Fish	6.8	6.8	F
Leafy Vegetables	4.48	2.7	F
Other Vegetables	6.7	6.1	F
Fruit	3.7	1.7	R
Rice	7	7	NA
Other Grains	3.6	1.9	R
Peanuts or beans	3.68	1.5	R
Oil	7	7	NA
Sugar	7	7	NA

Table 9: Dietary Differences between sample subsets

Given these differences the question then becomes whether the same significance exists when explanatory variables are held constant. Unfortunately, this is not the case; having a tap is not significant to the frequency of consumption for any of these foods (Table 10). Other explanatory variables, however, are significant: if a household sees itself as the same as other households (*dwlth2*) it is likely to eat dairy products nearly

is the beginning of the "hungry" season in this part of Africa; household produced grains and legumes have run out, and families are buying food now until harvesting again in November.

three more times in a week than a household that sees itself as worse off (*dwlth1*). Perception of wealth is also statistically significant for meat: households that see themselves as better off (*dwlth3*) are more likely to eat meat approximately 2.5 more times in a week than a household that sees itself as worse off. However, the sensitivity of this income dummy variable is questionable, and these results should be understood to indicate a generally positive relationship between income and food frequencies.

The most interesting aspect of these relationships is that having a tap is significant to a household's dietary diversity. Dietary diversity is measured as "diverse" if a household eats more than three types of foods in a week, and "not diverse" if it eats less than three. Not a single non-tap households has a diverse diet, but 40% of tap households do (Figure 19). If a household has a tap it is likely to eat slightly more than one food type in a week more than a household without a tap, all else equal (Table 10). The implications of this finding are significant, and in line with current literature on the subject. Should households have access to productive water in their compound versus from a public tap, they are more likely to have a diverse (i.e., healthy) diet, and a corresponding increase in human capital.

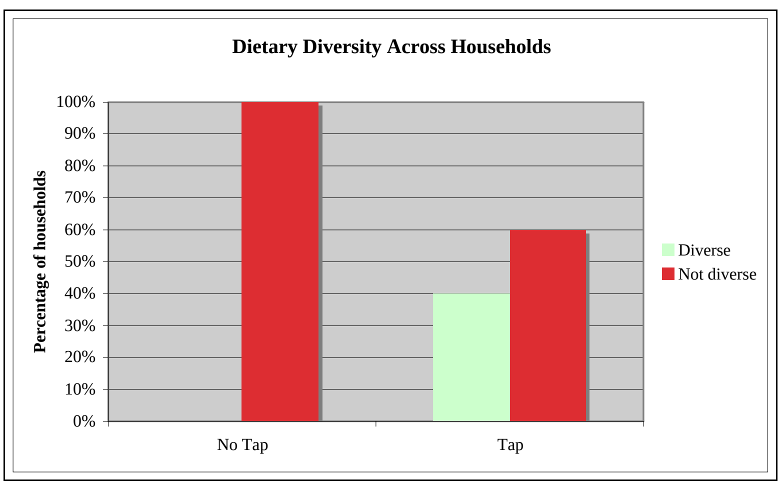

Figure 19: Dietary Diversity Across Households

Variable	Explanatory Variables					
	By Human Capital					
	dietary diversity	dairy	meat	fruit	peanuts/ beans	cereals
tap	1.21	1.87	0.55	1.68	1.86	1.51
	0.59**	1.06	0.66	1.18	1.01	1.02
dwlth1	0.45	2.14	0.27	1.66	-0.53	-1.76
	0.78	1.40	0.86	1.55	1.32	1.34
dwlth2	0.96	2.76	0.28	1.37	-0.42	-0.54
	0.76	1.36**	0.85	1.52	1.29	1.31
dwlth3	0.91	1.43	2.61	-1.10	1.68	0.78
	1.20	2.16	1.34**	2.40	2.04	2.08
dlat1	0.72	-0.48	0.09	0.21	0.56	-1.10
	0.98	1.76	1.09	1.96	1.66	1.69
dlat2	1.33	0.33	-0.79	-1.86	1.93	1.54
	1.12	2.01	1.24	2.23	1.90	1.93
dlat3	1.15	-0.08	0.07	-0.60	0.47	0.64
	0.83	1.49	0.92	1.66	1.41	1.43
pplfam	0.01	-0.05	0.01	0.07	0.09	0.14
	0.03	0.06	0.04	0.06	0.05	0.06**
percadultemp	0.01	0.02	0.00	0.02	0.01	0.02
	0.01	0.01**	0.01	0.01	0.01	0.01
R-squared	0.88	0.78	0.37	0.70	0.73	0.72
n	55	55	55	55	55	55

** Significant at the 0.05 level

Table 10: Human Capital Benefits from productive water

Finally, human capital also refers to the knowledge and skills acquired by individual members of the household that support the family's current and future livelihood opportunities. School attendance rates are one type of social capital that has significant future benefits for rural livelihoods. The literature on water supply states that one benefit of having a yard tap is that it frees up not only women's time, but also that of school age children who normally collect water. However, in Thidé school children are statistically just as likely to be the primary collectors of water in households with a tap as those without.[35] Furthermore, estimates of subset collection time means are not statistically different. This suggests that the presence of a tap in the compound does not liberate children from the task of collecting water. Despite these negative statistical outcomes, there may still be practical importance. In both cases- children as collectors and time to collect water – means are higher for households without a tap (Table 11).

Activity	Tap/No Tap	Collectors of H20	% of time child is the collector	Reject/ Fail to Reject Null*	time spent (mins)	Reject/ Fail to Reject Null*
Domestic Water	No Tap	Mother, female child	90%	F	12.5	F
	Tap		69%			
Cows	No Tap	Father	0	F	10	NA, one observation
	Tap	Father, mother, male and female children, no one	43%		21	
Sheep/Goats	No Tap	father, mother, female child	88%	F	53	R
	Tap	Father, mother, female and male child, shepherd	44%		17	
Chickens	No Tap	NA	NA	NA	NA	NA
	Tap	Mother, female and male child, no one	50%		6	
Donkeys	No Tap	father, female and male child	67%	F	18	F
	Tap	father, mother, female and male child	75%		16	
Trees	No Tap	female child	100	F	15	NA, one observation
	Tap	Mother, female and male child	31%		9	

*Null Hypothesis is difference in means equal to zero

Table 11: Likelihood that children are collecting water and time it takes them to collect.

[35] P-values are all insignificant, and thus we fail to reject the null hypothesis that the difference in means is zero.

Costs

Financial Capital: Productive Water Expenses

There are quite a few household costs related directly to obtaining productive water as well as sustaining the activities this water supports. Most fundamentally, or course, is the cost of any water obtained from the gravity fed system. In addition there are costs for animal feed, vaccines, materials for animal enclosures, equipment for transportation animals such as horses and donkeys, salary for shepherds and the cost of the animal itself. The household survey focused on three of these expenses: water, feed and materials for animal enclosures. There was not sufficient time nor man-power to collect information on the other costs: in particular the cost for livestock is extremely variable by season and by place. Appendix A lists relevant current prices; estimates are based on these costs.

The cost of water used for animals depends on the amount of water given to them each day, and on whether this water comes from a private tap, a public tap or one of the cement wells. Because so many households did not know how much their animals drink in the rainy season, water costs estimates are based on quantities consumed in the dry season.[36] Unfortunately, because non-tap households did not specify how much water they buy from the public tap versus how much they take for free from a neighbor's tap or the cement well, it is impossible to calculate how much this subset pays for water for their animals. Table 12 shows the costs per animal and tree for both subsets in the dry season; non-tap households pay more than tap households to water their trees and their cows, however, for both these categories there is only one observation, which may bias

[36] The dry season is estimated at 120 days long from early-March to early-July. The wet season is estimated at 90 days long from early-July to early-October.

the estimates. It is significant, however, that non-tap households use less water on cows, yet pay more; this is a result of using the more expensive public tap water. Donkeys and horses consume the most water, and therefore households pay the most in water costs for these animals.

		Water Costs per Animal				
		L/Day	**UM/day**	**$/day**	**UM/season**	**$/season**
Cows	**No Tap***	15	5	0.02	600	2.26
	Tap	20	2.8	0.01	336	1.27
Sheep/ Goats	**No Tap**	10.1	NA**	NA	NA	NA
	Tap	9.26	1.30	0.005	156	0.59
Poultry	**No Tap**	NA	NA	NA	NA	NA
	Tap	0.88	0.12	0.0005	15	0.06
Donkeys	**No Tap**	20	NA**	NA	NA	NA
	Tap	44.3	6.2	0.023	744	2.81
Trees	**No Tap***	20	6.67	0.025	800	3.02
	Tap	16.5	2.3	0.009	207.9	0.78

*one observation

**majority use the ciment well, which is free

Table 12: Water Costs

The cost of animal feed to a household can be estimated from the time it takes to collect the feed (usually crop residues) from the fields, or from the cash that is spent to buy feed in the market. Purchased feed includes *rakal* (a machine made pellet with a base of rice hulls or millet residue - see picture in Appendix B), millet and rice hulls. Families can also buy millet and rice crop residue by the hectare. Traditionally, in the rainy season animals graze around the village once pasture grasses have grown; less than a quarter of households buys feed and only 10% collects feed in the wet season, and only 4 out of 45 households with a tap both collect and buy feed in the wet season. In fact, non-tap households never buy feed in the wet season, and in general feed costs are slightly less (Table 13). Poultry is never bought food, but thrown scraps at meal times or left to scavenge.

In the dry season, however, the percentage of households buying feed increases significantly to more than two-thirds of all animal-owning households, 38% of whom also collect feed. Non-tap households collect feed more often than tap households (50% versus 38%); they spend three hours per day collecting feed, but pay on average significantly less per animal with the exception of cows (Table 13). Feed costs are more than ten times the cost of water per season, and donkeys, horses and cows are consistently the most expensive.

		Feed Costs per Animal and Season							
		UM/day		$/day		UM/Season		$/season	
		wet	dry	wet	dry	wet	dry	wet	dry
Cow	**No Tap***	0	100	0	0.38	0	9000	0	33.96
	Tap	60	59	0.22	0.22	5355	5310	20.21	20.04
Sheep/ Goats	**No Tap**	0	16	0	0.06	0	1463	0	5.52
	Tap	34	65	0.13	0.24	3049	5812	11.50	21.93
Donkeys	**No Tap**	0	50	0	0.19	0	4500	0	16.98
	Tap	291	270	1.10	1.02	26154	24291	98.69	91.66

*one observation

Table 13: Feed Costs

Vaccines for animals are traditionally given once during the dry season (90% of those with cows and 71% of those with sheep or goats), and only cows, sheep and goats are vaccinated. In the dry season, households with a tap pay more than three times as much per cow, sheep or goat for vaccinations than households without, which could indicate that they buy higher quality vaccinations[37] Households without a tap are also less likely to give vaccines at all.

[37] These costs include the cost of the veterinarian if relevant.

		Vaccination Costs			
		UM/season		$/season	
		wet	dry	wet	dry
Cow	No Tap*	0	100	0	0.38
	Tap	436.4	388.6	1.65	1.47
Sheep/ Goats	No Tap	166	91	0.63	0.34
	Tap	167.9	331	0.63	1.25

*One observation

Figure 20: Vaccination Costs

Table 14 summarizes how much households pay for each animal per item per season. Totals indicate that households without a tap pay understandably less per animal for nearly every item in every season. Using the average number of animals for each subset, households with a tap pay nearly four times as much per season on feed water and vaccinations for their animals as households without a tap (Table 15).

Animal	Tap/ No Tap	Feed		Water	Vaccines		Total (UM)	Total ($)
		wet	dry	dry	wet	dry	dry	dry
Cows	No Tap*	0	100	2700	0	100	2900.00	10.94
	Tap	59.5	59	252	436.4	388.6	699.60	2.64
Sheep/ Goats	No Tap	0	16.25	NA**	166	91	107.25	0.40
	Tap	33.875	64.58	116.676	167.9	331	512.26	1.93
Chickens	No Tap	Chickens are thrown a handful of food at meal times		NA	Chickens, Donkeys and Horses are not given vaccinations		NA	NA
	Tap			11.088			11.09	0.04
Donkeys	No Tap	0	50	NA**			50.00	0.19
	Tap	290.6	269.9	558.18			828.08	3.12

*one observation
**majority use the ciment well for free, except for cows

Table 14: Costs per animal per service level

	Total Average Dry Season Costs for Animals			
	No Tap		Tap	
	UM/season	$/season	UM/season	$/season
Cows	19400	73.21	36208	136.63
Sheep	8544	11.72	55429	209.17
Poultry	0	0	74	0.28
Donkeys	4500	16.98	25035	94.47
Total	32444	$ 101.91	116746	$ 440.55

Table 15: Average Dry Season Costs for Animals

Households also spend money and time on cages for their animals. Cages for animals more frequently cost a household the time it takes to build, than actual cash. None of the households without a tap that have a cage for their animals paid cash for the cage, instead they built them, which took on average 1.6 days. Of households with a tap 72% have a cage for their animals, but did not pay for it in cash. The average cost for fencing, posts and wire for those in this subset who did pay for the materials and/or labor to build the cage was 14,000UM ($52.80). Of these households 33% also spent on average 4.8 days building the cages for their animals. Children do most of the labor to build mud cages for chickens, sheep and goats while adults build the larger wire and fencing enclosures. The opportunity cost of the time spent on building these cages can be estimated from the average daily wage for men in the community, 500UM ($1.88). For households without a tap, the opportunity cost of the building the cage is 800UM ($3.01), and for those with a tap it is 2400UM ($9.05).

Some families also pay shepherds to take their goats to the nearby surface water in the rainy season. Households with a tap are only slightly more likely to pay a shepherd to take their goats, cows or donkeys to the nearby surface water in the rainy season (46% versus 40%). The average cost for a shepherd in the wet season was 387UM ($1.46) per month or 1161UM ($4.28) per season, however, most households did not know how much they paid the shepherd. Culturally it would be appropriate for a family to “pay” their shepherd in kind rather than in cash, which may explain why so many could not answer this question.

In total, the cost to feed, water, house and care for animals is enormous. Given our estimates for dry season costs it amounts to 133,146UM ($502) for a household with a tap, or just over two times the average family income over the same period for this group. The costs is slightly lower for households without a tap at 33244UM ($105), but is also two times the average family dry season income.[38]

Beyond the costs to sustain animals, there are additional connection costs for households that have a tap. These costs include labor and materials, but some families opted to use family labor to put in the pipes. A household with a tap paid an average of 25,800UM ($97.36) to connect. This is more than the average monthly income for the village 17117 ($65.59), and more than three times the non-tap household monthly family income of 5500 ($20.75).

Social Capital: Dependence on Remittances and Water Sharing Tension

This survey brings to light only two costs to social capital of productive water. First, there is the possibility that households may increasingly depend on remittances to pay larger and larger water bills. Already, 42% of the employed family members who pay for household water live and work outside the village, but send money home to pay the water bills. This will increasingly be the case if productive activities are not directly earning the household cash with which to pay the bill themselves. It is wonderful that productive activities are supporting cultural and religious traditions, however, in this self-paying system these traditions will not pay the monthly bill.

Second, tension between neighbors is growing as un-connected households continue to use water for free from their neighbor's tap. Many households without a private tap reported using water from their neighbor's tap frequently without payment until tensions were created, and then were forced to connect themselves or go back to

[38] Again, the reader should bear in mind the weaknesses of income data gathered from the survey. It is sure to be an underestimate, and to make truly meaningful comparisons income data must be much more accurate.

using the cement wells. In addition, households with a tap reported not having enough water at times because they were sharing with a neighbor at the same time as they were trying to limit their consumption to keep the bill low.

Conclusions

This household level analysis provides an explicit example of how the availability of productive water strengthens rural livelihoods and provides opportunities for asset accumulation in the form of livestock, trees, and revenue from livestock products. Yet it falls short of quantifying the net benefits of these opportunities and thus the extent to which productive uses of water form an important contribution to livelihoods remains unclear.

The statistical outcomes of the relationship between a tap and a household's physical capital (numbers of animals) are inconclusive, and do not help determine the exact impact of a tap on household assets. However, the significant relationship between a tap and a household's dietary diversity suggests that the benefits to human capital are a direct result of having a larger quantity of water at a higher quality, whereas benefits to physical capital from productive water may be more indirect.

The qualitative results regarding the benefits to social capital in the village indicate that cultural and religious customs, which have held this community together overtime, are clearly strengthened and supported by a household's ability to raise livestock. The ability to provide neighbors and extended family with animals on important social occasions, and to fulfill religious charity duties is extremely important to Thidé's social networks.

The financial costs of having a private tap, on the other hand, are clearly significant, and seem to outweigh the benefits. The magnitude of these direct and indirect costs is in some cases more than double the average family income. This is likely to prohibit many of the poorest people from undertaking these activities. However, in the case of Thidé, the weaknesses of the data should be taken into consideration. After all, 115 out of 135 households have invested in a connection, a true indication of the village's perception that there are net benefits to productive water.

The most significant obstacle in responding to the three research questions is the valididty of the income data collected, and the possibility that households without a tap are simply poorer than those with a tap. It is possible that all the differences between subsets described here are less a result of access to water, as they are a fundamental difference in the activities and resources of different income levels. If indeed, this is the case, the results presented here still have significant practical importance: this self-paying project is not providing water for the poorest in the village, who have the most need for the benefits to physical, human and financial capital. This finding goes against the current rhetoric that self-paying projects are the most effective way to implement long-lasting equitable water supply.

In the future, there are a number of issues that could be studied:

- The place of this system in the larger context of Mauritanian water supply development strategy and policy. A thorough study of the management and maintenance issues in this village could provide the *Ministere de l'Hyrdolique* with appropriate recommendations for future water supply development, and continued maintenance and cost recovery of existing systems.

- The determinants of sustainability in self-paying water supply systems. This system has survived for 10 years without serious problems, and the reasons for this success could shed light on certain previously unrecognized factors of sustainability. Such as for example, the fact that a significant proportion of this village pays for its water with remittances. How does this inflow of cash change the willingness to pay, to maintain and improve this system?
- A proper quantitative cost-benefit analysis of the financial capital gained and lost from the productive water related activities would truly demonstrate the extent to which productive uses of water contribute to rural livelihoods. This would be possible with comprehensive income and market data available locally.
- A comparison across villages of the extent to which cultural and religious customs are upheld when people have different levels of inputs necessary to support livestock. This would be particularly interesting in any country where pastoral traditions are common.

APPENDIX A : Local Prices

Item	Unit	Cost (UM)	Cost($)
sheep	animal	12500	47.17
goat	animal	8000	30.19
cow (2 yrs)	animal	70000	264.15
cow (male,2 yrs)	animal	110000	415.09
donkey	animal	12000	45.28
horse	animal	120000	452.83
chicken	animal	700	2.64
Wheat	50kg sack	4700	17.74
Wheat	1kg	94	0.35
Rakal	50kg sack	3000	11.32
rakal	1kg	60	0.23
Millet	50kg sack	750	2.83
millet	1kg	15	0.06
Rice Hulls	50kg sack	1400	5.28
rice hulls	1kg	28	0.11
Rice crop residue	1ha	10000	37.74
Millet crop residue	1ha	15000	56.60
Crop residue	1 sack	100	0.38
Crop residue	1kg	20	0.08
butter/oil	5gm	10	0.04
curdled milk	1L	70	0.26
fresh milk	1L	200	0.75
Fresh meat	1kg	1000	3.77
Rice	50kg sack[39]	8000	$30.82
River Fish	1kg	250	0.94

[39] A 50kg sack of rice will feed a family of 5 for three to four weeks.

Appendix B: Photos of Thidé

Figure 21: Storage Tank for Gravity Fed Reticulation System

Figure 22: Animals Tied to tree roots for shade


Figure 23: Typical Horse drawn cart for transport

Figure 24: Rakal - a product of rice hulls and/or millet residues

Appendix C: Questionnaire

The following questionnaire is the English version asked to households with a private tap in March 2007. The questionnaires for non-tap household did not include questions #10-#19.

Winrock Multiple-Use Water Services
QUESTIONAIRE FOR HOUSEHOLDS WITH A PRIVATE TAP

Attached is a questionnaire about water services and demand for them in the village of Thidé, Brakna Region, Mauritania. The questionnaire will take **approximately 1.5-2 hours to complete**. Its goal is to answer the following questions:

1) Does the availability of productive water strengthen rural livelihoods?
2) If so, to what extent do productive uses of water form an important contribution to these livelihoods?
3) Does it provide opportunities for asset accumulation? (Is it a temporary coping strategy or a longer-term adaptive strategy?)

Directions: Complete the following questions for 30 households who have a private tap. Households should be selected randomly. Each of the two interviewers will begin in a different part of town and interview every other household that has a tap.
**Keep track of households interviewed on the community map by circling the house, and writing down the family name in the space provided below. Family name and household ID# are EXTREMELY important. Record the family name and household ID# on the bottom of each page.
PLEASE INTERVIEW THE FEMALE HEAD OF HOUSEHOLD. IF SHE IS NOT AVAILABLE, FIND OUT WHEN SHE WILL BE BACK. THEN GO ON TO THE NEXT HOUSE.
**Enter the answer to each question in the appropriate box.
****ENTER DK (DON'T KNOW) IF THE INTERVIEWEE DOES NOT KNOW THE ANSWER****
****ENTER NA IF THE INTERVIEWEE DOES NOT UNDERSTAND THE QUESTION****

Identification:

Interviewee Name:___________________________________

Household Name:___________________________________

Household ID#:_______________________________________

PART A: DEMOGRAPHIC AND SOURCE QUESTIONS

1) # of families in the household (circle)	1	2	3	4	5	6	
2) # of people in each household							
3) # of people younger than 16							
# of people older than 16 (line 2 – line 3)							

Household Income

4) List household sources of income by person (relationship to interviewee), type of work and salary:

	PERSON	TYPE OF WORK	MONTHLY SALARY
1			
2			
3			
4			
5			
6			
7			
8			

5) Compared to other households in the village, do you consider your household: *(circle one)*

a. Worse Off b. The Same c. Better off

Domestic water sources, labor and time

6) What sources do you use for drinking water? (Name the source location)

Source	Wet Season		Dry Season		Collector *(list collector ID#)*	Time to Collect (min/day)
	Y/N	**Pay (Y/N)**	**Y/N**	**Pay (Y/N)**		
Private Tap:						
Cement Well:						
Public Tap:						
Neighbor's Tap						
Surface Water						
Hand dug Wells						
Other:						

Collector ID#s:
(1) Father (2) Mother (3) Female Child (Age) (4) Male Child (Age) (5) Other

Quantity and Reliability

	Wet Season	Dry Season
7) Do you have sufficient water for all your needs? (Y/N)		

8) If you do not have sufficient water for all your needs what do you need more water for?

____

____

____

____

9) If water were cheaper what would you use if for?

____

____

____

10) Why did your household decide to connect to the piped system? (Y/N)

1. Convenience________________________________
2. Reliability________________________________
3. Health Concerns________________________________
4. Status________________________________
5. Modernization________________________________
6. Cheaper________________________________
7. Other________________________________

11) Who made the final decision to connect to the piped system?

____

____

12) Costs to connect to the piped system:

1. Fixed Service Fee? ________________________________
2. Labor Costs? ________________________________
3. Meter Cost?________________________________
4. Piping and other material Cost?___________________________
5. Fee for distance from the mainline? __________________

13) What was the source of payment for the connection costs?

1. Family member? Who? ________________________________

14) Who pays your monthly bill?

____

15) Since the time you got a tap in your compound, have you ever been disconnected? Why?

____

____

____

____

16) If so, how many times?_______________________________

17) If so, for how long (days)? ________________________________

18) If so, what was the re-connection cost? ______________________

19) How long does it take you to walk to the tap (min)?

____

____

PART B: PRODUCTIVE ACTIVITIES

Labor, Time, Consumption

20) Do you keep **COWS** in the compound? If yes, fill following chart including the source locations:

Water Source for COWS	**Wet Season**			**Dry Season**			**Collector *(list collector ID#)***	**Time to water COWS per day**
	USE (Y/N)	**L/day**	**# in compound**	**USE (Y/N)**	**L/day**	**# in compound**		
Private Tap								
Cement Well:								
Public Tap:								
Neighbor's Tap								
Surface Water								
Hand dug Well								
Other:								

Collector ID#s:
(1) Father (2) Mother (3) Female Child (Age) (4) Male Child (Age) (5) Other

21) Do you keep **SHEEP/GOATS** in the compound? If yes, fill following chart including the source locations:

Water Source for SHEEP/GOATS	**Wet Season**			**Dry Season**			**Collector *(list collector ID#)***	**Time to water SHEEP/ GOATS per day**
	USE (Y/N)	**L/day**	**# in compound**	**USE (Y/N)**	**L/day**	**# in compound**		
Private Tap								
Cement Well:								
Public Tap:								
Neighbor's Tap								
Surface Water								
Hand dug Well								
Other:								

Collector ID#s:
(1) Father (2) Mother (3) Female Child (Age) (4) Male Child (Age) (5) Other

22) Do you keep **OTHER** animals in your compound? What kind?____________________ Please include the source locations:

Water Source for OTHER	**Wet Season**			**Dry Season**			**Collector *(list collector ID#)***	**Time to water OTHER per day**
	USE (Y/N)	**L/day**	**# in compound**	**USE (Y/N)**	**L/day**	**# in compound**		
Private Tap								
Cement Well:								
Public Tap:								
Neighbor's Tap								
Surface Water								
Hand dug Well								
Other:								

Collector ID#s:
(1) Father (2) Mother (3) Female Child (Age) (4) Male Child (Age) (5) Other

23) Do you have additional expenses other than water for your **ANIMALS?**

		Type *(of feed or expense)*	**Wet Season**		**Dry Season**	
			Y/N	**Cost (per season)**	**Y/N**	**Cost (per season)**
COWS	**Feed**					
	Other expenses					
SHEEP/ GOATS	**Feed**					
	Other expenses					
OTHER						

24) Do you grow **TREES** in the compound? If yes, fill following chart including the source locations:

Water Source for TREES	**Wet Season**		**Dry Season**			**Collector *(list collector ID#)***	**Time to water TREES per day**
	USE (Y/N)	**L/day**	**USE (Y/N)**	**L/day**	**# in compound**		
Private Tap							
Cement Well:							
Public Tap:							
Neighbor's Tap							
Surface Water							
Hand dug Well							
Other:							

Collector ID#s:
(1) Father (2) Mother (3) Female Child (Age) (4) Male Child (Age) (5) Other

25) Do you grow a **GARDEN** in your compound? If yes, fill following chart including the source locations:

Water Source for GARDEN	Wet Season			Dry Season			Collector *(list collector ID#)*	Time to water GARDEN per day
	USE (Y/N)	L/day	m^2 in compound	USE (Y/N)	L/day	m^2 in compound		
Private Tap								
Cement Well:								
Public Tap:								
Neighbor's Tap								
Surface Water								
Hand dug Well								
Other:								

Collector ID#s:
(1) Father (2) Mother (3) Female Child (Age) (4) Male Child (Age) (5) Other

26) Do you have any additional costs for keeping **TREES** or a **GARDEN** in your compound?

ADDITIONAL COSTS	**Amount of Each Additional Cost**	
	Trees	**Garden**
Fencing		
Pesticide/Fertilizer		
Other		

27) Do you use water for any **OTHER** productive use in your compound? If yes, fill following chart including the source locations:

Water Source for OTHER	**Wet Season**			**Dry Season**			**Collector *(list collector ID#)***	**Time to water OTHER per day**
	USE (Y/N)	**L/day**	**Units**	**USE (Y/N)**	**L/day**	**Units**		
Private Tap								
Cement Well:								
Public Tap:								
Neighbor's Tap								
Surface Water								
Hand dug Well								
Other:								

Collector ID#s:
(1) Father (2) Mother (3) Female Child (Age) (4) Male Child (Age) (5) Other

PART C: INCOME GENERATION FROM PRODUCTIVE ACTIVITIES

ID CODES:

GIVEN AWAY	**PURPOSE OF GIFT**	**LOCATION SOLD**	**BENEFITS OF CARRYING OUT SAID ACTIVITES**
(1) YES, OFTEN (2) YES, SOMETIMES (3) YES, RARELY (4) NO, NEVER	(1) BAPTISM (2) WEDDING (3) FUNERAL (4) HOLIDAY (5) CHARITY (6) OTHER	(1) INSIDE (2) OUTSIDE VILLAGE	(1) INCOME GENERATION (2) CONSUMPTION (4) HEALTH BENEFITS (5) OTHER

28) Income from animals

	PRODUCT	**GIVEN AWAY**	**PURPOSE OF GIFT**	**INCOME FROM PRODUCT *(pick unit)***	**LOCATION SOLD**	**BENEFITS**
COWS	**Animal**					
	Dairy					
	Meat					
	Skins					
	Other					
Sheep /Goats	**Animal**					
	Dairy					
	Meat					
	Skins					
	Other					
Other						

****IF OTHER IS A RESPONSE, SEE NEXT PAGE****

PLEASE DESCRIBE:

29) Other products from "other" animal activities:

____

____

____

30) Other purposes of the gift:

____

____

____

31) Other benefits of having animals in the compound:

____

____

____

____

32) Income from Gardening

TREES	**CROPS**	
(1) Azidirachtica Indica (Neem)	(1) Tomato	(9) Bitter Tomato
(2) Citrus	(2) Hot Pepper	(10) Beets
(3) Mango	(3) Green pepper	(11) Garlic
(4) Prosopis juliflora	(4) Eggplant	(12) Beans
(5) Medicinal Tree	(5) Lettuce	(13) Corn
(6) Moringa oleifera	(6) Mint	(14) Melons
(7) OTHER	(7) Sweet Potato	(15) Squash
	(8) Carrot	(16) OTHER

ACTIVITY	**TYPES *(list numbers from Crop/Tree list)***		**GIVEN AWAY**	**PURPOSE OF GIFT**	**INCOME FROM EACH VEG**	**LOCATION SOLD**	**BENEFITS**
	Wet	**Dry**					
GARDENING							

****IF OTHER IS A RESPONSE, SEE NEXT PAGE****

PLEASE DESCRIBE:

33) Other garden item (#16):

34) Other purposes of the gift:

35) Other benefits of having a garden in the compound:

36) **Income from Trees**

ACTIVITY	TYPES *(list numbers from Crop/Tree list)*	INCOME EARNED FROM EACH TYPE		BENEFITS
TREES				

PLEASE DESCRIBE:

37) Other benefits of having a TREE in the compound:

___

___

___

38) What do you do with the income earned from these products? What do you spend it on?

PART D. PUBLIC HEALTH

39) How many children are there under 5 years old in your compound? ___________________________

40) In the last two weeks, how many of these children have had an incident of diarrhea?______________

41) In the last month, which of the following diseases did someone in your family have?

DISEASE	**# OF TIMES**
DIARRHEA	
EYE INFECTIONS	
SKIN INFECTIONS	
SCHISTOSOMIASIS	
TYPHOID	
OTHER	

42) What type of toilet does your household have?

1. PIT LATRINE
2. SHOWER ROOM ONLY
3. SHOWER AND PIT
4. NO TOILET
5. OTHER TYPE________________________________

43) Is the toilet used only by your household or do you share it?

1. THIS HOUSEHOLD ONLY
2. SHARED

44) Do you usually boil your water before drinking?

1. YES, ALWAYS
2. YES, MOST OF THE TIME
3. YES, SOMETIMES
4. YES, RARELY
5. NO, NEVER
6. DEPENDS ON THE SOURCE: (list sources boiled):

____

45) Hand washing (MARK THE APPROPRIATE BOXES):

FREQUENCY	**Washing Hands**	
	Before meals	
	Y/N	**Soap? (Y/N)**
YES, ALWAYS		
YES, MOST OF THE TIMES		
YES, SOMETIMES		
NO, NEVER		

Dietary Recall:

46) In the last week has your family consumed these foods? If so, how many times? Where did they get them? Did they pay?

Product	**Frequency**		**Source**	
	Y/N	**Times per**	**Inside**	**Outside household**

		week	household		
			Y/N	Y/N	Pay? (Y/N)
Dairy Products					
Meat					
Chicken or Fish					
Green Leafy Vegetables					
Other Vegetables					
Fruit					
Rice					
Other grain					
Pulses					
Fats/oils					
Sugar					

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