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The impact of domestic water on household enterprises: evidence from Vietnam

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Abstract

A number of rural household-based productive activities, such as kitchen gardens, livestock rearing and micro enterprises, are dependent on adequate supplies of domestic water to operate. This paper examines whether improved access to piped water can facilitate these types of activities, particularly for poor households. Using data from rural Vietnam, we find that most household enterprises use non-metered water and have very small profit margins. Thus, the evidence suggests that these enterprises may be better supported by a household-level water supply infrastructure, such as well pumps and rainwater catchment tanks, rather than by piped systems in rural areas. We also found an unanticipated link between operating small-scale food production businesses and raising livestock: for many households, waste products from food-based micro enterprises were used for rearing pigs, and this enabled business owners to expand their pork production, a significant source of income and prosperity in rural Vietnam.

Keywords: Asia; Domestic water supply; Micro enterprise; Vietnam

1. Introduction

Household-based productive activities using water have been increasingly recognized as important to the poor (Moriarty & Butterworth, 2003; Pérez de Mendiguren, 2004; van Koppen *et al.*, 2006). The most common of these activities is the growing of food products and the rearing of livestock, both occurring in and around the household. A smaller number of rural households also run micro enterprises out of their homes. All three of these activities are of interest from a poverty alleviation perspective: with minimal start-up costs, even the poorest households can often undertake these activities. Another advantage to the poor is that home-based enterprises are typically flexible in terms of labour input, with

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family members participating as their domestic duties, work or school schedules permit. Many of these businesses are run primarily or entirely by the female members of the household, who fit these activities into their childcare and other household responsibilities, and the generation of income streams through these activities can empower women, both within the household and also in the community. As these activities increase, the potential for local-level development multiplies. Such activities can also have a positive impact at a broader scale: country-level evidence shows that growth in the rural sector lowers both urban and rural poverty (Ravallion & Datt, 1996) and is more pro-poor than urban growth (Woden, 1999, cited in Thirtle *et al.*, 2001; Thorbecke & Jung, 1996).

In rural Vietnam, domestic water supplies play an important role in many types of household-based enterprises. The cultivation of vegetables and fruit trees on household grounds is very common, as is the raising of pigs and, to a lesser extent, cattle. Micro enterprises are also found in rural areas, with those producing food items the most popular, particularly rice-based items such as wine, noodles, paper, and cakes. Produce from gardens can provide the raw material for food production enterprises, and the production of these can provide both water and food by-products used to rear livestock. Thus, household cultivation and animal husbandry must be a part of the analysis of water-dependent household enterprise. Other household-based micro enterprises include service businesses that utilize water; the most frequently found water-dependent micro enterprises are restaurants of various types, including small eateries, drink stands, and tea shops. Also common are motorbike washing businesses and hairdressers. All of these activities serve an important function, providing food security through increased income generation and the possibility of income diversification.

In researching these activities (micro enterprises, household gardens, and livestock rearing) our hypothesis was that an insufficient source of domestic water would be a major constraint to their undertaking. Focusing on household businesses but taking into consideration possible interactions with the other two activities, the research question selected was: does improved access to household water via piped water systems promote household-based water-dependent micro enterprises? Thus the paper is organized as follows: first we review the relevant literature on rural household-based enterprises; next we outline the design and methodology of our research in rural Vietnam to investigate which types of water supply systems best facilitate household productive activities; finally, we discuss the results and consider the policy implications of our study.

2. Literature review

Most of the literature on rural household-based enterprises focuses on the use of domestic water sources in household gardens and livestock rearing, and details how increasing the level of water availability positively impacts rural livelihoods. For instance, water obtained from collector wells in Masvingo Province, Zimbabwe, enabled increased production in community gardens, yielding average gross financial returns of US$38.00 per scheme member over one winter season, versus US$6.90 per member for winter vegetables recorded the previous year in traditional stream bank vegetable gardens (Waughray *et al.*, 1998). In Marondera District in Zimbabwe, improved access to water from wells through the use of rope pumps shifted the responsibility for watering household gardens from the females and children in the household to the male members, thus freeing women to concentrate on marketing the produce (Proudfoot, 2003). In the Bikita district of Zimbabwe, community members indicated the importance of community gardens grown with well water to their livelihoods through a

pocket voting exercise, which demonstrated that the gardens were more important to poorer households, and also of increased importance to all households during drought years; the value of yearly production per scheme member in different wards ranged from US$630 to US$2,091 (Mathew, 2003). Increased water availability through the use of rope pumps contributed in part to higher income streams from vegetable cultivation and livestock rearing in 'patios' (areas around a family farmhouse, comparable to kitchen gardens) in Nicaragua (Alberts & van der Zee, 2003). In Syria, households used small quantities of very scarce well water to cultivate vegetable gardens and rear livestock, thus supplementing their diets and incomes (Waughray & Rodríguez, 1998).

While the above studies focus on the use of non-metered domestic water supplies in household gardens and livestock rearing, few studies have considered the relationship between piped water sources and these activities, or the use of piped water in household-based micro enterprises. In one such study in Gujarat, India, the unreliability of water from public standpipes was one of three factors negatively influencing the performance of micro enterprises run by women, and micro enterprises in villages with a poor water supply had more problems than those operating with better supplies of water (Verhagen *et al.*, 2004). A study on the productive uses of domestic water in Bushbuckridge, South Africa, which employed a treatment ('best case' villages) and control ('worse case' villages) research design, reported that beer brewing businesses in treatment villages averaged annual gross margins 1.8 times higher than control villages; this study also calculated that in the treatment villages the annual average gross margins on gardens were almost 11 times higher, while for fruit tree cultivation the margins were 6 times higher (Pérez de Mendiguren & Mabelane, 2001). Another study used a similar approach, examining two towns in Uganda, one of which had a piped system whilst the other had no improved source of water, instead relying on vendor-supplied water or water collected from local springs. The objective of this research was to investigate the demand for piped water as an input into micro enterprises (the majority of which had 1–2 regular employees); the results of the study indicated that most of the enterprises (75 out of 89) in the treatment town chose to access water from kiosks rather than private connections. In analyzing willingness to pay for improved water services in the control village, the demand by enterprises for private connections was also low, despite the fact that the micro enterprises' owners in the control village cited water as a major constraint. Interestingly, the research determined that profit margins for enterprises in both villages to be quite low, calculating that median monthly profits were actually negative, based on owners' rough estimates of costs and revenues (Davis *et al.*, 2001).

In this study, we take an holistic approach to rural livelihoods, considering not only the more common activities of household gardens and livestock raising but also the frequency of small-scale household businesses. Using pairs, in which one village has access to piped water supplies and the other utilizes well and rainwater, and holding other factors constant as much as possible, we explore the impact of different options for the supply of household water on productive uses and the interactions amongst these activities.

3. Study sites and data collection

The study took place in March 2006 in the provinces of Quang Nam and Ninh Thuan in Vietnam. As the research aimed to isolate the impacts of domestic water sources on small-scale household-based enterprises, the study design was to utilize pairs of field sites, with one site in each pair having received some type of water source improvement in the last 3–6 years and the other site serving as the control. With one exception (a village in Ninh Thuan province, Phuoc Nhon, was populated by the ethnic Cham

Table 1. Demographic details of study villages.

Province	District	Commune	Village	Ethnicity	Population	Number of households	Percentage of poor households	Treatment or control village?
Quang Nam	Thang Binh	Binh Dao	Tra Doa 1	Kinh	1,700	405	32.0%	Treatment
			Tra Doa 2	Kinh	2,215	543	22.6%	Treatment
		Binh Giang	Village 4	Kinh	2,915	1,716	29.5%	Control
Ninh Thuan	Ninh Hai	Nhon Hai	Khanh Phuoc	Kinh	2,065	357	10.9%	Control
			My Tuong 1	Kinh	3,352	701	14.9%	Control
		Xuan Hai	Phuoc Nhon	Cham	5,658	1,048	12.3%	Treatment
			An Xuan	Kinh	4,572	1,012	24.4%	Control

minority, whereas all other villages constituted members of the majority (Kinh) group) the pairs were selected to be as similar as possible in terms of size, demographics, non-water infrastructure (roads, electricity, etc.) and distance from nearest city, enabling a comparison of livelihood patterns to be made between the two areas.

After preparatory fieldwork to identify villages with a variety of water sources and small-scale water-dependent enterprises, seven villages were chosen for the study. Three villages had a piped water system and served as the treatment villages, and four relied on well water and were designated the control villages. The village pairs were located near each other in the same district, and in all cases shared similar rainfall patterns, topography, and other characteristics. Table 1 provides demographic details on each village.

The costs of the piped water systems in the treatment villages varied between the two provinces. In Tra Doa Villages 1 and 2[1] in Quang Nam, residents paid a one-time fee of approximately US$7.50 for connection, and usage charges of US$0.16 per m^3. In Phuoc Nhon in Ninh Thuan, the connection fee varied depending on the length of pipe needed to connect individual households, with the range of cost being US$19–64; the water tariff was US$0.19 per m^3. Residents of these villages indicated that water charges were being collected, although it was not clear if these tariffs were sufficient for full recovery of operations and maintenance expenses.

In terms of investment requirements for wells, costs varied from US$22 for drilled wells (0.2–0.3 m in diameter, depth of 70–80 m) with a hand pump to US$64 for a drilled well with an electric pump. Hand dug wells (1.0–1.5 m in diameter, depth of 6–7 m) were US$32–51, and pumps to access hand dug wells cost US$10–20 for hand pumps and US$15–30 for electric pumps.

4. Methods

The overall approach was based on conventional rapid participatory appraisal techniques. Information was collected through the following methods:

(a) observation of the local landscape, land use arrangements, local livelihood activities, agricultural crops, water resource and household water supply facilities;

[1] The villages are identified as Tra Doa 1 and Tra Doa 2 by local government officials.

(b) interviews with commune officers, including heads of people's committees, health workers and women's union officers;
(c) in-depth interviews with hamlet/village leaders on topics such as: (i) types of water supply at the household level; (ii) local use of water for productive activities; (iii) common livelihood activities; (iv) Vietnam's recent Poor Household Survey and the percentage of poor households in the hamlet; and (v) wealth ranking criteria;
(d) interviews with other key local informants, including village health care workers, heads of village-level women's groups, and directors and staff of local water supply schemes;
(e) household surveys, focusing on: (i) number of members, gender, age, education level, health; (ii) type and current capacity of household water supply facility, including quality and changes over time, and information on household sanitation facilities; (iii) household sources of income and livelihood activities, with a particular emphasis on water-dependent income generating activities (IGAs) and their associated costs and benefits; and (iv) additional qualitative questions (e.g. What would the household do if they had access to more water? What constraints are there to specific IGAs? Has their household's financial situation improved or worsened over time and, if so, why?). For households engaged in productive activities, researchers conducted an extended interview that included detailed questions on quantities produced seasonally, revenues, costs, and net profits;
(f) focus group discussions on: (i) the water supply situation in the community, including quality and changes over time, the amount of household income spent purchasing water and time spent collecting water; (ii) the health situation, with an emphasis on water-borne illnesses, including number of incidences, frequency and associated cost; (iii) livelihood activities, with specific attention to small-scale productive activities using water and constraints other than water (skills, equipment, access to capital or credit, assistance from government agencies or mass organizations, etc.); and (iv) wealth ranking, including differences between the government classification and community concepts of poor households;
(g) researchers first randomly selected households in each area to visit and then went to households engaged in micro enterprise activities, with village leaders providing data on the number of micro enterprises operating in their village and details on type and location of household enterprises to assist researchers in visiting an illustrative range of those households.

A total of 144 household interviews (68 in Quang Nam and 76 in Ninh Thuan) were completed, of which 21 were engaged in water-dependent micro enterprises. Key informant meetings were also held in each village and focus group discussions took place in each province.

Table 2. Quang Nam Province: types and numbers of micro enterprises.

Village Treatment or control?	Tra Doa 1 Treatment	Tra Doa 2 Treatment	Village 4 Control
Type of business			
Rice wine	10	10	10
Rice noodle	1	3	0
Tofu	3	0	0
Restaurant/eatery	0	3	0
Hairdressing shop	1	5	0
Motorbike washing shop	0	2	0

Table 3. Ninh Thuan: types and numbers of micro enterprises.

Village Treatment or control?	Khanh Phuoc Control	My Tuong Control	Phuoc Nhon Treatment	An Xuan Control
Type of business				
Rice wine	6	3	0	20–30
Rice noodle	0	1	0	1
Tofu	0	0	0	0
Restaurant/eatery	0	1	1	20–30
Hairdressing shop	0	4	0	6

5. Results

The major types of water-dependent goods found were rice-based wine and noodles, and tofu-based items (cake and juice). The most common service businesses were small eateries, hairdressers, and motorbike washing shops. The frequency of each type of business, as reported by the village chairmen, is provided for each province (Tables 2 and 3).

The percentage of households engaged in water-dependent micro enterprises was between 0.1% and 6% in all villages, which was not statistically significantly between 'control' and 'treatment' villages (Table 4).

Comparing the control village of An Xuan and the treatment village of Phuoc Nhon, located in the same commune, is particularly interesting. These two villages are roughly the same size: 1,102 households in An Xuan versus 1,048 in Phuoc Nuon; however, due to a higher average number of members per household, Phuoc Nuon has the larger population, with over 1,000 more people than An Xuan. In Phuoc Nhon, residents reported that the piped water was of very poor quality and not significantly better than water from the village canal; in An Xuan, villagers relied on well water to meet their domestic needs, the quality of which they felt was reasonably good. The difference in participation in micro enterprises in the two villages is striking: there were 61 businesses operating in An Xuan, and only one, a restaurant, in Phuoc Nhon.

Cultural factors are also important to consider, particularly in the case of Phuoc Nhon, the only village in the study area populated by the Cham minority. Because the Cham are Muslim, this village would not have any rice wine businesses regardless of the water supply situation, but there were also no businesses producing other rice products (noodles, cakes, or paper). There are also no service-based businesses, such as hairdressing shops and motorbike washing businesses, as found in An Xuan; the factor limiting

Table 4. Incidence of water-dependent businesses.

Province	Study Area	Treatment or control?	Percentage of water-dependent businesses, excluding water vending
Quang Nam	Tra Doa Village 1	Treatment	3.7% (15 out of 405)
	Tra Doa Village 2	Treatment	4.2% (23 of 543)
	Village 4	Control	0.15% (11 out of 716)
Ninh Thuan	Khanh Phuoc	Control	1.7% (6 out of 357)
	My Tuong 1 Village NT)	Control	1.6% (11 out of 701)
	Phuoc Nhon	Treatment	0.10% (1 out of 1,048)
	An Xuan Village	Control	6.0% (61 out of 1,012)

micro enterprise activity may be the lack of an adequate alternative source of water, such as the wells found in An Xuan, or may be related to the village's cultural (ethnic and religious) characteristics. Residents of Phuoc Nhon also reported much higher incidences of water-borne illness, which could also impact residents' capacity to undertake household enterprises.

In further analyzing the patterns of water usage in the study areas, it became clear that the definition of control versus treatment villages did not accurately reflect the sources of water being employed for productive uses. In Ninh Thuan province, 15 households out of 76 interviewed were engaged in water-dependent micro enterprises; all of these were using non-piped sources of water for those activities. In Quang Nam, 7 of the 68 households interviewed had micro enterprises, and only 3 of those 7 were utilizing piped water. Thus, with the 3 exceptions in Quang Nam, piped water was not the factor enabling micro enterprises: it was the presence of an alternative water source that was accessible and reliable, providing sufficient quantities, and not charged by units used. The sources of water employed in these businesses were wells (accessed through both hand pumps and electric pumps), rainwater catchment tanks, and ecosystem water, including lakes, streams, and rivers.

This result was not driven by differential access to a water source, as the physical location of piped water and alternative water sources was roughly similar for households. Families with piped water supplies accessed it through yard taps. Families operating micro enterprises using well water had wells located within their household plot; rainwater catchment tanks were also located in the area around the house. In those instances in which ecosystem water was being used for businesses, the water body was also typically very close; for example, the household would be located next to the river or lake being utilized as the water source.

Although geographic access to a water source was similar in the villages with piped water when compared to those relying on well water, there was a significant difference in terms of service levels. For the piped systems, residents noted that they did not consider the water safe for drinking and routinely boiled it before use, emphasizing that the quality of the piped water was no better than that of alternative water sources. Reliability of piped systems was also an issue, with community members reporting that water was not always available throughout the day due to operational problems. In one of the study areas in Quang Nam province, Tra Doa Village 1 and 2, the piped system had been inoperable for 18 months out of its 5 years of existence. Although it had been repaired 4 months before the research took place, community members repeatedly expressed concern about its reliability.

Therefore, in view of the issues concerning water quality and reliability in the piped systems studied, along with cost issues, the designation of villages with piped systems as 'treatment' villages and those using non-piped sources as 'control' villages does not appear to capture the complexity of water requirements for livelihood activities in the study villages.

If we instead re-define treatment villages as having a source of good quality water, whether from a piped system or from alternative non-metered source, such as well water, then the last two villages change their classification, with Phuoc Nhon (the village with piped water of poor quality) becoming a control village and An Xuan (the village in the same district with no piped system but well water of good quality) shifting from a control village to a treatment village. Under this classification, the participation in micro enterprises in the treatment villages ranged from 3.7% to 6.0%, whereas participation in the control villages was between 0.1% and 1.7% (Table 5).

In examining two of the three households that used piped water and for which more comprehensive interviews were completed, it appears that these were middle income or wealthy households with significant financial and human capital assets that facilitated their businesses. A hairdressing business in

Table 5. Villages categorized by source of water supply and percentage of water-dependent businesses.

Study area	Treatment or control?	Piped water		Other water source		Percentage of water-dependent businesses, excluding water vending
		Yes/No	Quality	Type	Quality	
Tra Doa Village 1 (QN)	Treatment	Yes	Good	Well	Good	3.7% (15 out of 405)
Tra Doa Village 2 (QN)	Treatment	Yes	Good	Well	Poor	4.2%(23 of 543)
Village 4 (QN)	Control	No	Not applicable	Well	Poor	0.15% (11 out of 716)
Khanh Phuoc (NT)	Control	No	Not applicable	Well	Poor	1.7% (6 out of 357)
My Tuong 1 Village (NT)	Control	No	Not applicable	Well	Poor	1.6% (11 out of 701)
Phuoc Nhon (NT)	Control	Yes	Poor	Canal	Poor	0.1% (1 out of 1,048)
An Xuan Village (NT)	Treatment	No	Not applicable	Yes	Good	6.0% (61 out of 1,012)

QN: Quang Nam Province; NT: Ninh Thuan Province.

Tra Doa 1, for example, required an initial investment in shop equipment of US$637; the two women running the shop had also each paid US$191 to take a training course in the nearby city of Da Nang. In the same village, another family was using pipe water to produce rice wine, for which they reported annual profits of US$1,800. The business owner, however, explained that his wife worked at the commune's farmers' union and thus provided a steady stream of income; previously, she had engaged in buying rice and re-selling to other villages, making the household wealthy before the male head of household began the rice wine business. In both these cases, therefore, it appears the business owners were atypical in that they had significant access to capital and credit, as well as high levels of human capital.

Other than these exceptions, households undertaking micro enterprises were either poor or middle income and used non-metered sources of water for their businesses. In interviews, family members noted they undertook the micro enterprises as a supplement to their income and food from other activities, primarily rice cultivation and some wage labour.

The analysis of interviews with households undertaking micro enterprises also raised another issue: it emerged that the majority of these activities had very small profit margins. In fact, in some cases, after taking into account the labour utilized using the minimum labour wage rate, some of the micro enterprises actually operated at a small loss. This suggests that some micro enterprises utilize labour that would otherwise be idle, and explains why these businesses tend to be self-selecting to the poor. It must be noted that low profit margins are common in most other livelihood activities occurring in the rural sector, in particular smallholder farming, and many of these activities also operate at a net loss when the value of labour is considered.

Also of interest is the pattern of water usage for household gardens and animal husbandry; 49 households interviewed were engaged in the activities, and 26 of these had both gardens and livestock. However, no households were watering gardens with piped water, and only one household was using it to raise livestock (a wealthy household in Phuoc Nhon, which had multiple water taps installed around the household grounds for watering its livestock).

This is particularly significant because many interviewees pointed to the synergies in running a micro enterprise and engaging in other household enterprises. The strongest connection that emerged was between raising pigs and undertaking food production household businesses. Although, as related above, many food production businesses operated at a low—or even negative—profit margin, in interviews it

became evident that many food production businesses served only to provide a low-cost source of water and food for pigs. All seven households with food production businesses were also raising pigs. Calculating costs and revenues (but excluding labour costs), a household in Tra Doa Village 2, which was using piped water to produce rice wine and using the waste products of the production to raise pigs, was earning US$620 per year from the combined businesses. Also noteworthy: the household head told researchers that his family had previously been counted as a poor household, but due to the increased income from his two businesses, the household was now classified as middle income. Similarly, in a village in Thai Binh province, interviewed during the 2005 fieldwork, a family involved in producing rice wine reported it was able to produce 300–400 kilograms of pork a year from the business' waste, and the women running a micro enterprise in tofu products in the same province estimated they were earning more income from pork raised on the tofu by-products than on the tofu business itself; both businesses utilized well water, and the tofu business also used rainwater from catchment tanks during the rainy season.

Other households engaged in food production IGAs also drew similar conclusions, stating that the production of items such as rice noodles or rice wine was undertaken more as a food and water source for their pigs than for the income produced from selling the item itself. This connection between raising pigs and running food micro enterprises was well-established, even among households not making food items: when families with 1–3 pigs were asked if they would raise more pigs if they had an inexpensive water source, they often replied that they didn't make anything and therefore would have nothing for the extra pigs to eat. This may also be a reason why the Muslim village of Phuoc Nhon had no food production micro enterprises: with no use for the by-products, such businesses may not have been viable.

6. Discussion

Although much attention has been given to the importance of domestic water improvements in helping to meet health goals, domestic water through its use in home-based micro enterprises also has a critical and less widely recognised role to play in meeting income, food security and other poverty reduction targets. In economic terms, such activities can constitute a significant part of the rural economy, and one that is too often ignored in data collection and rural income assessments. The full poverty reduction significance of these activities is even greater, as they provide the livelihood diversification opportunities that can be the basis for families moving out of poverty, and they also provide a high level of livelihood security for families who are otherwise threatened by the impacts of factors beyond their control (such as floods, droughts or market price collapses) on their dominant livelihoods. In food security terms, the cultivation of vegetables, tree crops and livestock is the means through which a healthier, more balanced diet is achieved, as well as the basis for ensuring minimum quantities of food are available even in pre-harvest "hungry" seasons or when field crops fail.

In poverty reduction terms, an additional advantage to supporting these home-based activities is that they are self-selecting to the poor: offering small income streams, they are not as attractive to middle income and wealthy families, but can be essential to those living in poverty. As the poor are the ones who rely on these activities the most and are affected most when water shortages influences their viability, national planners need to recognise and make use of the pro-poor nature of domestic water supply improvements in their development strategies.

These small home-based businesses also have positive gender impacts. In most cases, the females of the household had significant responsibilities in the business's operations, and some of the businesses

were run entirely by the women of the extended household. The labour flexibility that owning a business offered was particularly important to women: mothers, daughters and daughters-in-law, and sisters working together as a team could produce food items for sale from their homes while still meeting their time requirements for the family's children and other household domestic needs.

The findings of this research further indicate the need for policy makers to take into consideration the full range of uses of household water in considering water delivery options: promoting access to water supplies through household-level infrastructure may in some cases be more effective in supporting household-based enterprises than water provision through piped systems. The literature reviewed above also points towards this conclusion. In all but one of the studies cited, the water utilized in micro enterprises came from non-metered sources. In most cases, water was drawn from wells and accessed via hand or rope pumps (Waughray & Rodríguez, 1998; Waughray, *et al.*, 1998; Alberts & van der Zee, 2003; Mathew, 2003; Proudfoot, 2003) and fees were not charged according to quantity used. In two of the other three studies, water was drawn from public or private standpipes but users did not pay per cubic meter (Pérez de Mendiguren & Mabelane, 2001; Verhagen *et al.*, 2004). In all of the studies cited above, it appears there were either minimal or flat tariff charges for the water used and in no cases was water charged according to usage. The one study that that looked at metered piped water and considered small and micro enterprises' willingness to pay for private water taps found demand was low (Davis *et al.*, 2001).

However, a case study of the community of Challacaba, in the municipality of Cochabamba, Bolivia, offers an interesting example of a demand-driven and community-financed small-scale piped water system that effectively supports productive activities such as livestock rearing (Heredia, 2005). The Challacaba system is a deep borehole, upgraded from a manual pump to a hydro-tower, which supports 60 households. The community's willingness to invest in water infrastructure seems to be directly related to the system's service level: it offers water 24 hours a day, whereas the nearby city water supply only provides water for 2 hours a day.

These findings, taken together with the present study, suggest policy implications in terms of the types of rural water supply systems that facilitate small-scale household enterprise. As indicated above and in Davis *et al.* (2001), the profit margins of these enterprises are very small; it may be the case that profits would vanish entirely in the face of any type of metered charges. Given the study findings that even the poorest households were able to invest in wells and pumps, household-level infrastructure may also be more sustainable than traditional piped systems in rural areas. Government and/or donor assistance could thus focus on developing supply chains for appropriate household-level technologies. Alternatively, small-scale demand-driven piped systems (e.g. the Challacaba model) that deliver reliable water supplies of adequate quality may also be a workable solution for promoting small-scale household-based enterprises.

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