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Financing Domestic Rainwater Harvesting in the Caribbean

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Abstract

Domestic rainwater harvesting (DRWH), an old technology, is playing a key role in meeting some objectives of the UN "2030 Agenda for Sustainable Development" and building resilience to climate change, particularly in the Caribbean. DRWH projects can be implemented through self-financing, government subsidies, and micro-financing or by external agencies. Most recent promotion initiatives of DRWH have emphasized funding by external agencies, often ignoring the potential financial contributions of beneficiaries. Regional experiences have shown that, generally, the high initial capital costs for DRWH systems is a major constraint. However, in some cases, success in DRWH is possible through self-financing. This study reviews the experiences of some DRWH projects or by external agencies to determine a suitable financing mechanism. This paper shows that households can self-finance DRWH systems if payments are based on 5% of household income and interest rates are less than 5%, It concludes that the product/business cycle pattern of development adequately describes the development of DRWH in some parts of the Caribbean. It is recommended that such a model should be considered in designing DRWH projects through strategic partnerships of the beneficiaries with between local and international NGOs, community based organisations and domestic financial institutions like credit unions.

1. Introduction

Domestic rainwater harvesting (DRWH), an old technology, is playing a key role in meeting some objectives of the UN "2030 Agenda for Sustainable Development" (UN Sustainable Development, 2015) and building resilience to climate change. It is a viable alternative to increase water supply and improve quality of life in developing countries. In the small island developing states (SIDS) of the Caribbean, DRWH is seen as one of the means of building resilience to climate change. Therefore, efforts are being made to promote DRWH through increasing public awareness and implementing small scale projects that can demonstrate the potential of DRWH.

A number of initiatives including the hosting of workshops for experts and development of training manuals, have been undertaken to promote DRWH (Burke, 1999; CEHI, 2006b; CEHI, 2009). Notwithstanding, the widespread uptake of RWH technology has been slow partly due to the inability of the poor to finance the systems. Consequently, support for the development of DRWH has been based on funding from external sources. However, as observed by Cain (2014), the overall funding available from NGOs and international finance organisations for DRWH is limited.

People are usually willing to build their DRWH supply, in part or totally by themselves, if suitable financing mechanisms are available (Hartung and Rwabambari, 2007). Such financing mechanisms must be sustainable and take into consideration the budgetary constraints of households. Further, government and donor agencies should view DRWH development in a business context, preferably in a framework of a product/business cycle.

This paper reports on the self-financing approaches used in financing DRWH in three Caribbean islands. In so doing, it shows the application of a product/business cycle model to the development of DRWH, based on the experiences from Carriacou and Petite Martinique (C&PM). C&PM is used since DRWH is well established there and has been transformed from rudimentary to highly developed applications. This paper draws heavily from the previous work of the author with emphasis on 3 projects that were aimed at promoting the use of DRWH. It is hoped that such a pattern of development, along with the McPhail's (1993) rule of 5% of household income can guide sponsors in financing future projects, improve project implementation and ultimately enhance the up-scaling and sustainability of DRWH projects in the Eastern Caribbean.

2. Background

DRWH has the potential to provide environmental, social and economic benefits when addressed on a community wide scale (National League of Cities, 2014) and can be an important element in the promotion of green infrastructure (EPA, 2014). In the Caribbean, it is being promoted as an augmentation of potable water supplies to be used for emergencies in the aftermath of disasters and as a means of building climate change resilience.

Financing water and sanitation improvements for the poor remains a major challenge across large areas of the globe (Norman *et al.*, 2012). In analyzing the success of DRWH projects in the Caribbean, Peters (2016) identified the economic factors, particularly, the capital costs of DRWH systems as of highest importance. In Australia, DBais *et al*. (2007) reported that the capital cost of DRWH was 66.27% of the life cycle costs (LCC) at an interest rate of 5%.

Although in some cases, local people can easily be trained to build DRWH systems, which reduces costs, encourages more participation, ownership and sustainability at the community level (Hatum & Worm, 2006), low-income households often depend on donor and government programmes to finance DRWH systems. The capital cost component of the LCC of DRWH projects is relevant in developing a model for its promotion and expansion, particularly for low income households. Consequently, a financing mechanisms that requires significant financial input from low income households can be unrealistic as recovery of investment is likely to be very slow.

Many DRWH projects can be implemented through self-financing mechanisms, government subsidies and micro financing. Self-financing or self-supply is a common financing mechanism where households have the financial capability to self-build their own RWH systems (Blanchard, 2012). In some of the small islands in the Caribbean where there is a long history of DRWH, self-supply financing was utilised. DRWH that were developed through self-supply, as observed in some Caribbean islands (Peters 2016), encouraged the incremental improvement of household and community DRWH supply through user investment in steps, which are easily replicable and with technologies which are affordable. In these islands people have responded naturally to the need to improve water supply, in the absence of private sector involvement and government advice and services, and with limited commercial financial resources (Peters, 2016).

Small-scale private-sector involvement in DRWH can be in the form of micro-finance. This can be through the provision of financial services by credit unions or special government programmes to low-income individuals and communities who otherwise would not have access to traditional commercial financial institutions. Thus, DRWH can be community driven and share common structural characteristics (UNEP, undated). Consequently, micro-finance institutions (MFIs) can play a key role in helping to up-scale existing RWH programmes among the poor (Lehmann *et al.* 2012; AGWater Solutions, 2012). Further, microfinance can enhance the sustainability of DRWH projects by reducing dependence on government subsidies and external agencies, therey creating a sense of ownership and developing a business 'Mindset' (Rain, 2014) which can encourage solutions led by communities and local entrepreneurs (Norman *et al.,* 2012).

Micro-financing mechanisms for DRWH in the Caribbean are not popular. However, they have been successful in financing water and sanitation for the poor in Africa and Asia (Hartung and Rwabambari, 2007; Davis *et al*., 2008; Nijhof and Shrestha, 2010 and Lehmann *et al*., 2012). Other forms of financing such as revolving loans or 'merry-go-round' schemes have been successfully utilised in the Pacific and Africa (Revolutionary Government of Zanzibar, 2007). Micro- financing, however is not a panacea for the development of DRWH, as there are challenges associated with the small size loans. Moreover, the increased need for follow-up by the creditors makes the costs of microfinance high (Netherlands Water Partnership, 2007).

Peters (2016) reported that in the Caribbean, there has not been much involvement of local entrepreneurs in the development of DRWH. This could be because DRWH projects do not generate enough profits to motivate investment by local entrepreneurs. Nonetheless, the International Rainwater Harvesting Alliance (2013) considers the private sector as being a vital component to increasing the use of RWH. Danert and Motts (2009) reported that there is enormous potential for promoting DRWH production and distribution chains on a commercial basis in rural areas.

Non-traditional forms of private sector funding also exist. Social entrepreneurship models (or social investment models) which creates ventures that use the power of commerce to sustainably meet social and/or environmental needs if used for DRWH development offers a strong alternative to financing by development agencies that mainly provide grants. These approaches are based on an emerging philosophy of many who aspire to "doing well while doing good" (Institute for Sustainable Futures, 2014). Grants can provide a catalyst and opportunities to grow the programs initiated by social entrepreneurship models (Amizade, 2010) and, depending on the context, returns on investment can be in an acceptable range.

3. Methodology

A review of three DRWH projects in St. Vincent, Grenada and Trinidad was carried out by analysing data obtained from previous studies undertaken by the author. The cases analysed were restricted to the operational aspects of DRWH systems. The analysis determined the amount that households are willing to invest in DRWH systems. In the case of Green Hill in St. Vincent, the information for expenditure on DRWH systems obtained from Peters and Mandeville (2012) was confirmed by surveying a sample of participants who were surveyed for that study. The other cases considered were Matelot -Toco, Trinidad (Peters and Monrose, 2015) and the St. Vincent DePaul project in Carriacou and Petite Martinique. The information for the St. Vincent DePaul project was obtained by surveying the beneficiaries of the project in this study.

Costs for different elements of the DRWH systems were obtained from the project records of the project sponsors where available, such as the Catholic Church in Grenada. This information was complemented by information on installation costs obtained through a survey of construction contractors at the research sites and building material suppliers. Capital and operating costs for the installation were estimated from the collected information.

LCC analysis of the DRWH systems for the different projects were carried out. LCC means the sum of the present values of the total investment costs; capital costs, installation costs, operating and maintenance (O&M) costs, and disposal costs over the lifetime of a system. The useful lives of Polyethylene RWH tanks and concrete cisterns were taken as 20 years and 40 years respectively. To determine under what financial conditions households would be able to meet the costs of DRWH systems, McPhail's (1993) rule of 5% of household income for water supply was considered.

A business cycle model was used to map the development pattern and financing mechanisms for DRWH systems, using the experiences from in the Carriacou and Petite Martinique. Data on the number, size and costs of DRWH storage facilities and the sources of funding obtained Peters (2013) were updated through a survey of local building contractors in Carriacou and Petite Martinique. Further, a survey of household DRWH facilities was conducted in 2016. It questioned participants on household income, sources of income, source of funds for the construction of DRWH systems, motivation for system improvements, age and type of DRWH storage systems, household plumbing systems and water-consuming facilities. There were 182 participants (heads of household) from a total of 1950 households in Carriacou and Petite Martinique, with a population of about 6900. This sample size of 9.3%s is adequate for reliability of the results (United Nations, 2005).

4. Results and Discussions

4.1 The Green Hill Case

In a study of DRWH at Green Hill, St. Vincent, Peters and Mandeville (2012) found that 33% of households used RWH to supplement public water supplies and 25% used it to reduce their water bill. Based on the study, 75% of households considered that DRWH was a good method for providing supplementary water supply but only 31% of households were willing to invest 1% to 1.6% of households' income in DRWH systems. The others, 44 % of the households were willing to invest an additional amount equivalent to the savings of the 5% of average annual household income (US$4050.00) that would have been spent on obtaining water from public water supplies in the absence of DRWH. The Green Hill case also shows that the bill from public water supply could be reduced by 20% to 35% by using DRWH. Residents considered that incentives like direct subsidies, tax rebates and concession on property taxes as appropriate financial supporting mechanisms. Peters and Mandeville (2012) recommended the use of micro-credit organisations for the sustainable development of DRWH in communities like Green Hill. The DRWH systems used in Green Hill required a capital investment of about US$1000.00. If the savings on the public water supply bill and the amounts that residents are willing to invest were capitalised, a significant portion of the capital investment of US$1000.00 could be recovered. Based on a savings on the water bill of 20% on an average water bill of US$120.00 plus the lowest amount that a household is willing to invest, i.e. 1.0% of average annual household income (US$4050.00), a household is capable of meeting 88% of the cost of the DRWH system at 5% interest rate and meeting the full cost when the interest rate is reduced to 3.1%.

4.2 The St. Vincent De Paul's Case

A local chapter of the St. Vincent de Paul of the Catholic Church undertook a DRWH project in C&PM. The project targeted the 'vulnerable' by constructing water cisterns with storage capacity of $57m^3$ at a cost of US$11,200.00 and distributing rainwater storage tanks with capacities of $1.7m^3$ and $3.8m^3$ at a cost of

US$280.00 and US$852.00 respectively. There was no financial consideration for determining beneficiaries of the project. Instead, the number of persons in the household and opportunities for using the water for improving subsistence agricultural and livestock rearing formed the basis for identifying the beneficiaries. Nonetheless, beneficiaries were required to contribute amounts, which were not based on any established criteria, of US$936.00 for the concrete cisterns, US$150.00 for the 3.8m^3 tanks and nothing for the 1.7m^3 tanks.

In formalising a contribution for recouping the costs of the DRWH systems, based on the 5% rule (McPhail 1993) of household's annual income, a small operating and maintenance cost of 5% capital cost is applied for PVC systems due to the absence of pumping in these systems. The beneficiaries would be able to cover the total cost of the PVC systems as shown in Table 1. In the case of concrete cisterns, operating and maintenance costs are estimated at 15% based on the work of Peters (2006). The analysis shows that beneficiaries could only meet the LCC of the concrete cisterns when the annual interest rate is less than 3.65% with no contribution or down payment and at 4% with the contribution that was provided. From the analysis it was found that at 5% interest rate with no down payment, the beneficiaries in the project would have been able to meet only 79% LCC and 86% of LCC with the required down payment. Based on the McPhail's 5% rule, the interest rate that would allow for households to meet the full cost of DRWH needs to be less than 3.1%.

It is noteworthy that in a similar type tank programme in Ghana, the Presbyterian Church transitioned the DRWH system from a fully subsidised tank to a paid for tank, by using a revolving fund scheme (Barnes, 2009). Although, the payments were small, the revolving scheme has proven to be efficient.

Table 1. LCC analysis of DRWH (PVC =polyethylene: CC= Concrete Cistern)

Project site	System Type	Storage size (m^3)	Capital investment	O&M plus PCS	Present value	RWH system useful life	Interest rate	Estimated Annuity	Household income	One time contribution	Annual household contribution required	% Cost recovery
		m^3	(US$)	% of Capital	(US$)	Years	%	(US$)	(US$)	(US$)	(US$)	%
Green Hill, St. Vincent and the Grenadines	PVC	4.0	1000	30	1300.00	20	5	104.00	4050	NA	88.80	85
	PVC	4.0	1000	30	1300.00	20	2	79.50	4050	NA	88.80	110
	PVC	4.0	1000	30	1300.00	20	3.1	79.50	4050	NA	88.80	100
SVDP, Carriacou, Grenada	PVC	3.8	852	5	895.00	20	5	71.08	3600	150.00	180.00*	250
	PVC	1.7	280	5	294.00	20	5	23.60	1200	0.00	60.00*	260
	CC	57	11,200	15	12880.00	50	5	705.50	11,880	936.00	560.00*	79
	CC	57	11,200	15	12880.00	50	2	410.00	11,880	936.00	560.00*	136
	CC	57	11,200	15	12880.00	50	3.56	560.50	11,880	936.00	560.00*	100
Matelot-Toco, Trinidad and Tobago	PVC	7.6	1200	15	1380.00	20	5	110.70	3840	NA	192.00	174
	PVC	7.6	1200	15	1380.00	20	2	85	3840	NA	192.00	225
	PVC	7.6	1200	15	1380.00	20	12.73	192	3840	NA	192	100
	PVC	16	2000	15	2300.00	20	5	184.60	11,400	NA	570.00	309
	PVC	16	2000	15	2300.00	20	2	140	11,400	NA	570.00	407
	PVC	16	2000	15	2300.00	20	24.7	570.00	11,400	NA	570.00	100

4.3 Matelot-Toco

In the Matelot-Toco district in Trinidad, the absence of a steady supply of pipe-borne water to households has resulted in the development of RWH technology (Peters and Monrose, 2015). RWH systems have been fully self-financed in the past. In 2012, the Toco Foundation signed the Memorandum of Agreement with the Government of Trinidad and Tobago to receive US$2.7 million from the Green Fund, to be disbursed over a four-year period to support the rainwater harvesting project (GWP-C 2012). An analysis of two types of systems in the district shows that based on the 5% rule (McPhail 1993) of household's contribution for financing household water, that DRWH can be totally financed by households. It was also found that under current conditions, 2.8% and 1.6% of annual incomes can support DRWH systems in the lower and middle income households respectively, if interest rates were 5%.

4.4 The General Case of Funding and Growth of RWH Systems in C&PM

In C&PM, DRWH is at mature stage of development. Almost 80% of the households using concrete cisterns with an average capacity of $57m^3$ while about 6% of households depend on polyvinyl chloride (PVC) and high density polyethylene (HDPE) tanks with minimum capacity of 1.5 m^3. The remainder of the households are using drums and other smaller containers to harvest rain (Peters, 2006). DRWH developed in step-like phases, starting with simple systems of 170L drums, which were predominant during 1950s to 1960s, to cisterns with capacity of over $100m^3$ and averaging about $90m^3$ (Figure 1). Over time, the sophistication of DRWH systems increased such that middle income households have installed technology driven plumbing and purification systems and water is in sufficient quantities to satisfy the upkeep of swimming pools and the irrigation of ornamental gardens.

The growth and improvement of household DRWH systems have been exclusively self-financed. When the development of DRWH is traced back to the 1960s, it is observed that the stock of storage facilities (cisterns) grew step-wise (Figure 1) and followed a path similar to that of a product/business cycle as summarised in Figure 2. Up to the late 1970s, a typical residence was constructed in phases. First, the main building excluding a cistern was constructed and the main water supply was from a communal source or from neighbours with cisterns. A few years afterwards households would construct concrete cisterns detached from the main building.

In later years, as mortgages became available for the construction of dwelling houses, RWH systems became part of the initial home construction project. With improved availability of commercial loans and increased financial remittances from the diaspora, there was a noticeable growth of improved DRWH systems (numbers and capacities), particularly during the 1990s and 2000s (Figure 1). Ultimately, household owned and improved DRWH systems became an accepted feature in residential buildings and reached a mature stage of development.

While the improving standard of living in C&PM has resulting in increasing per capita use of water, the per capita use is limited to climatic conditions and the size of houses and cisterns (Peters, 2006). However, there comes a time when increased per capita uses cannot be matched by the increased house sizes and storage capacities. As a result, there is a deficit between amounts available through DRWH and the demand. Consequently, to satisfy any further increases in per capita water use at the household that may be driven by improved standard of living, other sources of water such as desalination would be required. This would be an indication of the decline/intervention stage of the DRWH development cycle. This is the current situation in which solar desalination is being introduced in C&PM (Figure 2).

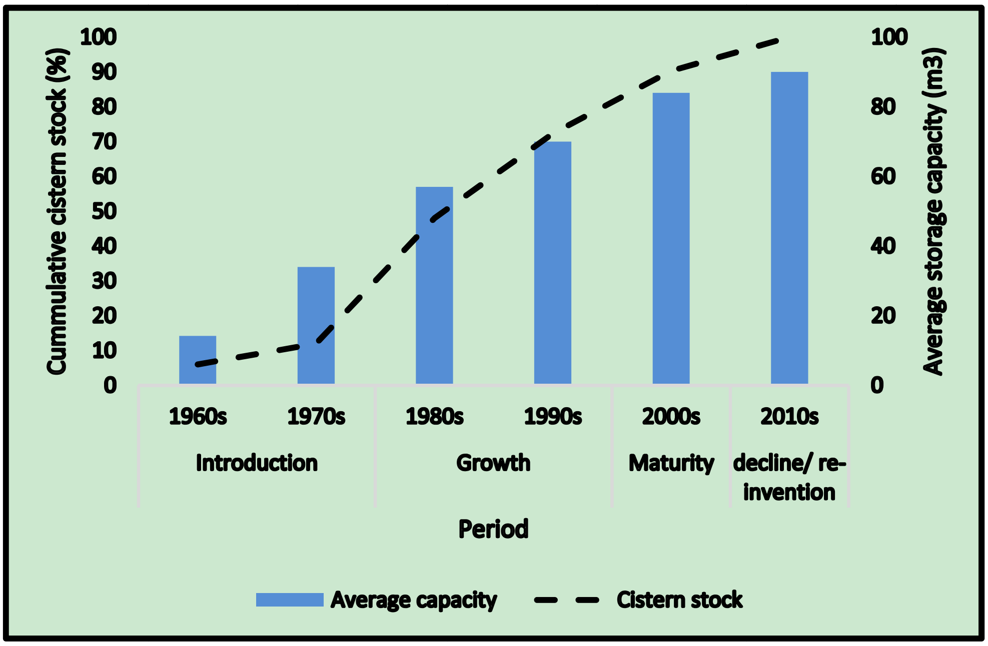
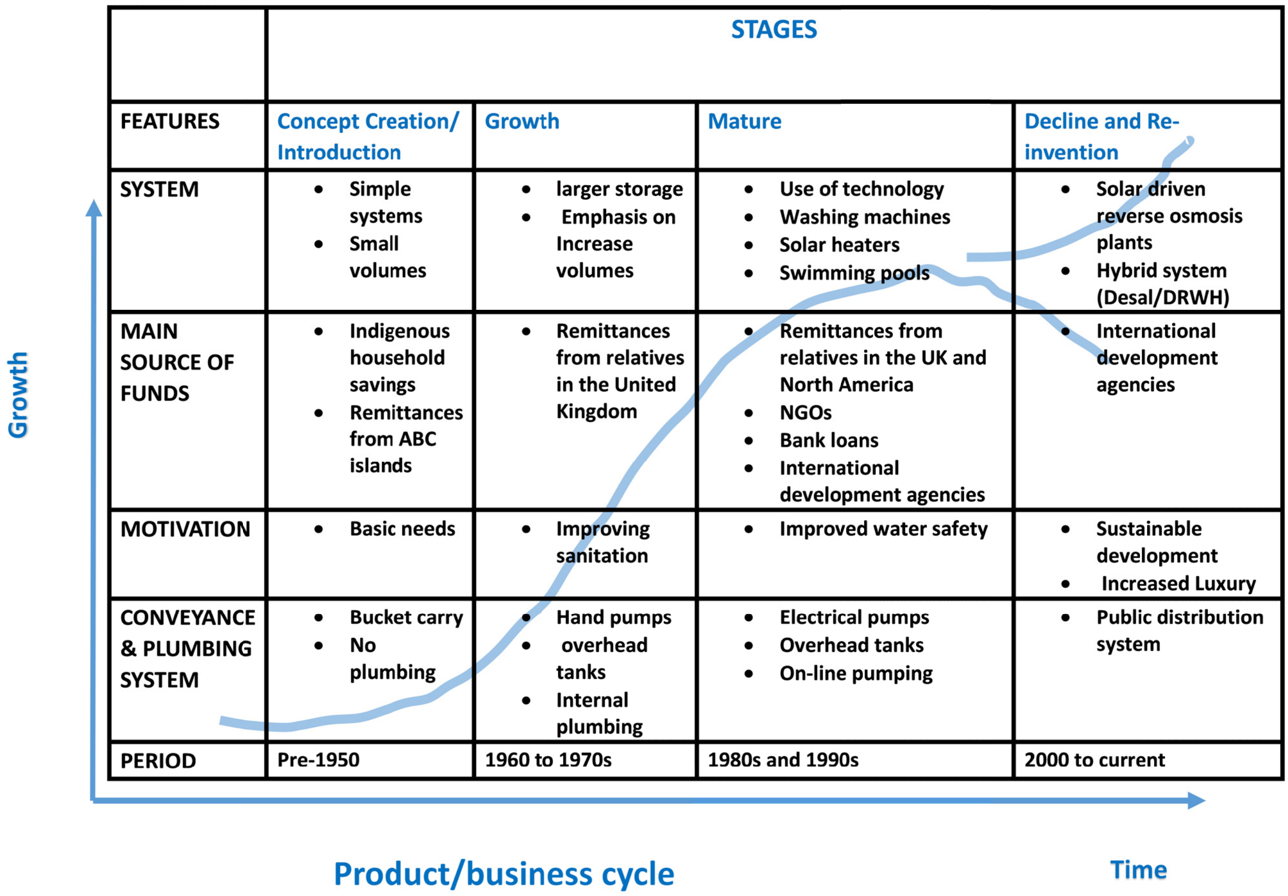


Figure 1. Growth of DRWH cisterns in C&PM



	STAGES			
FEATURES	Concept Creation/ Introduction	Growth	Mature	Decline and Re-invention
SYSTEM	• Simple systems • Small volumes	• larger storage • Emphasis on Increase volumes	• Use of technology • Washing machines • Solar heaters • Swimming pools	• Solar driven reverse osmosis plants • Hybrid system (Desal/DRWH)
MAIN SOURCE OF FUNDS	• Indigenous household savings • Remittances from ABC islands	• Remittances from relatives in the United Kingdom	• Remittances from relatives in the UK and North America • NGOs • Bank loans • International development agencies	• International development agencies
MOTIVATION	• Basic needs	• Improving sanitation	• Improved water safety	• Sustainable development • Increased Luxury
CONVEYANCE & PLUMBING SYSTEM	• Bucket carry • No plumbing	• Hand pumps • overhead tanks • Internal plumbing	• Electrical pumps • Overhead tanks • On-line pumping	• Public distribution system
PERIOD	Pre-1950	1960 to 1970s	1980s and 1990s	2000 to current

Figure 2. Business cycle model of DRWH development

5. Conclusions and Recommendations

DRWH has developed in some of the islands in the Caribbean through self-financing or self-supply. Specifically, as seen in the case of C&PM, enhancements in DRWH systems have been driven by improvement in household finances from remittances and the availability of funds from financial institutions. This, however, is not the case in other parts of the Caribbean. This study, shows that for three case study projects, households can self-finance DRWH systems if payments are based on 5% of household income and interest rates are less than 5%. Therefore, in the case where DRWH projects are financed by NGOs or from government grants, households should be asked to contribute in line with the criteria of self-financing. Accordingly, sponsors of DRWH projects should analyse the financial capabilities of beneficiaries to self- finance DRWH projects with the aim of reducing the grant components and as such increasing the number of beneficiaries

While there appears to be a limited role for commercial banks in financing DRWH, greater impact is possible through the collaboration of local and international NGOs, community based organisations, government and financial institutions, including credit unions, with due consideration of the potential for self-financing. In this way the constraints to the development of DRWH can be overcome in partnership with of key stakeholders through the combination of commercial discipline with concessionary financing arrangements. Thus, it is concluded that based on the experiences from C&PM, a financing development model for DRWH can be formulated in the context of a product/business cycle model. Knowledge of the stage of development of DRWH has implications for financing DRWH.

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