Step by Step!

Livelihoods, Social Institutions and Treadle Pump Adoption, Kasungu District, Malawi

By Anna Handrina Lwesya and Paul Vedeld

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Department of International Environment and Development Studies
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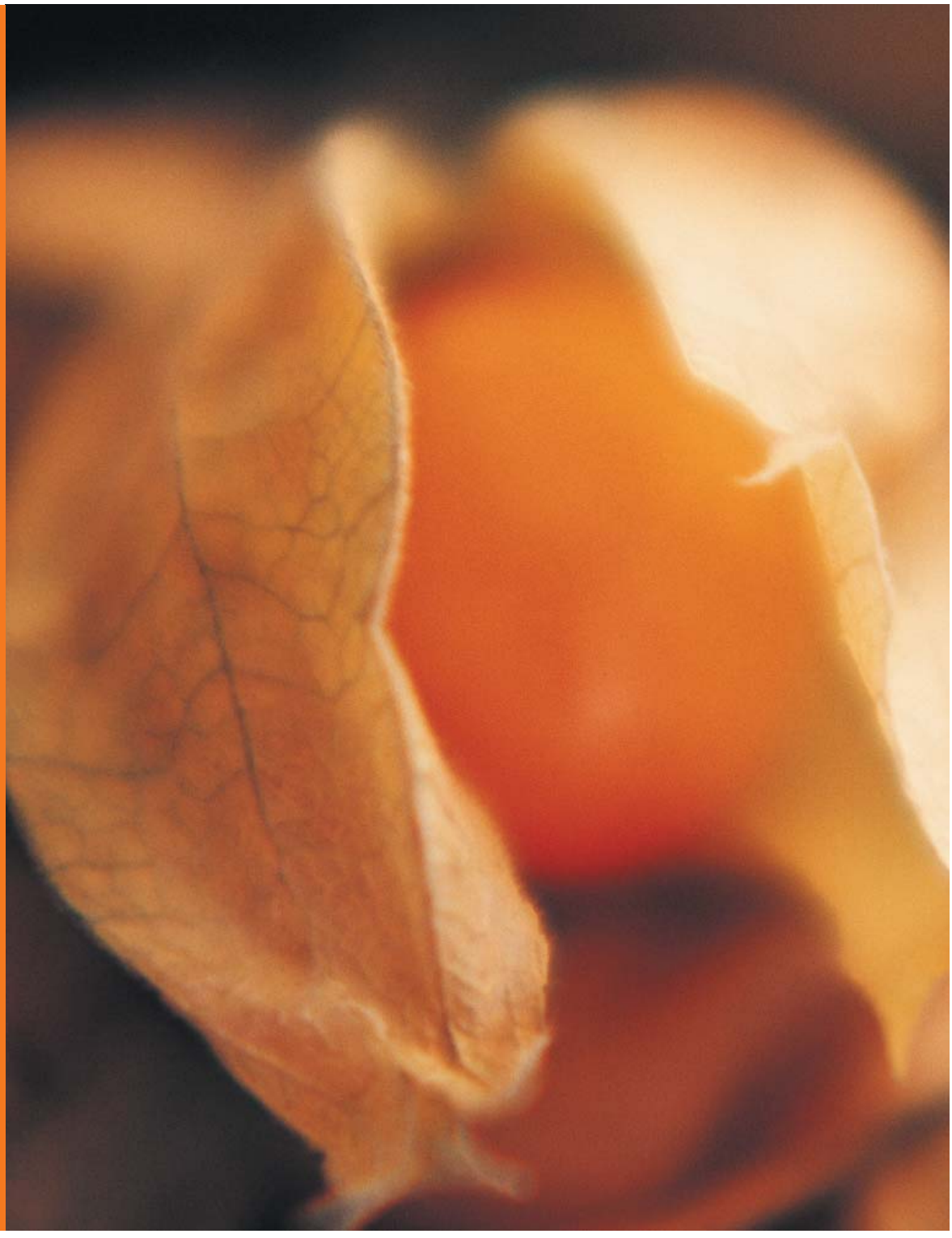

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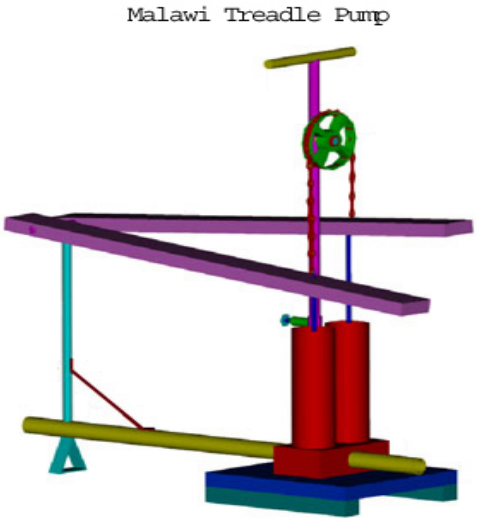

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ABSTRACT

Malawi is among the poorest countries in the world, and looks for ways to increase land productivity in agriculture. In a case study from Kasungu District, Malawi, this study investigates introduction of treadle pumps among poor small-scale farmers and effects of adoption on livelihoods and productivity.

Farmers in the area report an average daily household income of USD 0.84/capita. The Gini coefficient is 0.61, implying a very skewed distribution. Agriculture is more or less the only source of income, apart from some environmental resources, not valued in monetary terms. Major constraints to improved livelihoods relate to lack of land, especially irrigated land, labour and lack of access to reasonable credit. 33% of rural households have adopted treadle pumps in the study area over the last 10 years, in groups (60%) or as single households (40%). Adopting households control more land and labour, they have higher education levels and more access to credit, they are younger, they have higher incomes, especially on-farm and they are more organized, and are generally better off. Treadle pumps will not solve the problems of food security and secure household livelihoods among rural poor dwellers in Malawi but may contribute 15-20 % of incomes to adopting households.

Adoption also reveals a dynamic effect in that adopters increase land under cultivation. They cultivate 5 times more wetland irrigated -land than non-adopters. They also take more crops per year, report 4 times higher yields/ha and can secure production in the critical dry season and other distress periods, improving food security through this "safety net function" of the pump.

Adoption is a process of gradual social change, where skeptical farmers have become convinced through trial and errors that the technology carries merit. A majority of farmers adopt in groups, partly due to relatively high investment costs, but also due to promotion by extension officers. The intervention delivers through an interface in ways compatible with farmers' lifeworlds. Not without tensions, especially high costs and increased use of labour is a challenge, and there is general skepticism among non-adopters against new technology being alien to their present lifeworld and production system. It seems that using local institutions with their values, norms and social networks enhances adoption rates. The adoption is gradually internalised and becomes part of farmers' repertoire, as they increasingly report to maintain and repair pumps themselves, crucial in a long term sustainability of the adoption and preventing disadoption. The pronounced group adoption reflects social cohesion in the area and that socio-economic constraints can be overcome through joint efforts. "Step by step" we see that rural households are able to improve livelihoods through this kind of innovation.

1. INTRODUCTION

Malawi faces high food insecurity at national and local levels. The country has an agro-based economy with around 38.9% of GDP derived from agriculture in 2004 (World Bank, 2006). Almost 90% of the population reside in rural areas, basically working in agriculture. According to the 1998 Integrated Household Survey, agriculture accounted for 63.7% of total income for rural poor people. Agriculture is the sector with highest economic growth (estimated to be 7.1% in 2004). 90% of all export earnings are agriculturally based. In the National Development Plan for Malawi and in the PRSP (GOM 2002a), particular emphasis is put on agricultural development as a pathway to reduce poverty through poor targeted measures, and through "sustainable pro-poor growth measures".

Malawi has 12.6 million people and a high population growth (2.25%). With a total land area of 118 480 sq.km, the population density is around 100 people/km. The land size per rural household is around 0.2-3 ha, with 40% of the farms below 0.5 ha (World Bank, 2006). The general economic growth rates have been disappointingly low, with an average of 2.4% between 1981-1996, well below what is needed to avoid an increasing amount of poor people and achieve a general welfare increase per capita in the country (Orr and Mwale, 2001). Malawi has a GNI of USD 160/cap, an average life expectance of 40.2 years, and an adult literacy rate of 64.1% (lower for women). An estimated 14.1% of the population is HIV/AIDS infected (World Bank, 2006). Around 65% of the population is counted as poor. Malawi is among the poorest countries in the world, and ranks among the lowest on the HDI list (UNDP, 2001).

It is commonly assumed that a household with less than 0.5 ha of land cannot sustain its family for more than 3-4 months per year, and only 2-3 months more with improved hybrid varieties. There is thus widespread poverty in rural Malawi; maybe as much as 70% of the rural population is below the poverty line of USD 120/year. Malawi has tried various short-term relief strategies to reduce the chronic poverty such as food for work programs and various seed and fertilizer support programs, but with limited success.

Strategies for rural development involve various types of agricultural intensification, facilitating off-farm diversification and also non-farm activities, such as seasonal and more permanent migration. In Malawi, one has discussed four activity areas within agricultural development that involve intensification and agricultural diversification (Deverux, 1999 , Orr and Mwale 2001, Kutengule, 2000):

- Increase maize output through spreading maize hybrid varieties
- Improve food security by promoting food crops: cassava, beans, sweet potatoes, groundnuts
- Promote cash crops: burley tobacco, cotton, paprika, soybean
- Promote off-farm, agricultural related activities and diversify rural opportunities

One promising potential lies in small-scale irrigation that involves all four above mentioned strategies. According to Malawi's PRSP (GOM 2002a), there is a potential to substantially expand acreage under irrigation from present day 62 000 ha to 200 000 ha, potentially increasing agricultural production in Malawi by as much as 20-30%. Only 14 000 ha are at present managed by small-scale farmers. In the National Irrigation Policy and Development Strategy from 2000, one ambition is to increase smallholder irrigation by 100 000 ha within 8 years (Mangisoni, 2006).

Irrigation and treadle pumps in particular have been identified as important measures to achieve goals of higher and more stable yield levels and to improve agricultural land productivity. Treadle pumps are water-lifting devices for irrigation purposes for small-scale farmers. Irrigation does not only raise crop yields, but also secures more stable yields in dry years ("the insurance effect of irrigation"). It also prolongs the effective crop growing period, as it facilitates multiple cropping. However, as with any ingenious innovation, long time experience has taught us that adoption is complex. Farmers' decision-making processes imply careful considerations of economic, agro-ecological, climatic and technical conditions, involve social relationships and cultural values and norms, experience-based knowledge and other factors prior to potential adoption.

This paper addresses present livelihoods and studies possible reasons why only some households adopt the treadle pump. We also look at reasons given by farmers for adoption, constraints for and effects of adoption on survival and livelihood strategies and outcomes through a case study from Kasungu District in Malawi. The paper also discusses the present and future roles of the extension service in improving rural livelihoods with reference to the same case.

2. THEORETICAL PERSPECTIVES

2.1. INTRODUCTION

The livelihood approach offers tempting, broad and encompassing analytical frameworks for studying rural development and change at household and community levels (Scoones, 1998). The approach seems useful in analysing how different actors respond to external factors impacting their abilities and willingness to create and re-create their livelihoods. Its openness and broadness and its genuine eclecticness is, however, also its weakness, in the sense that it does not offer the rigour or seemingly clarity of less "ambitious" or more reductionistic models such as the household economic model in its various forms.

The livelihood approach is used by practitioners from a variety of schools of thought. It is first of all used much by people working in the development field, in project design, in short term consultancies for assessment, monitoring and evaluation tasks, often complimented by PRAs, RRAs etc. Tacitly underlying such ventures are often found rational choice assumptions of actors' behaviour. Also economists have started using livelihood approaches; and Ellis (2000) demonstrates how economists can benefit from the broader perspectives offered, still within an underlying rational choice perspective. The sustainable livelihood approach, is however, also used by anthropologists and sociologists utilizing the broad framework and frequently applying social constructivist perspectives to the analysis of individual household and community level issues.

There are clearly underlying tensions between theories assuming that the farmer is an individual, atomistic actor choosing to adopt new technology from rational calculations,

with given sets of ranked preferences and full or optimal information access, and on the other hand, social constructivist perspectives assuming that farmers' ways to see the world (and the object for adoption), explain, understand, learn, apply skills and make choices about adoption, are basically social and not atomistic. In this perspective, socialization processes become focal, as farmers grow up within social environments forming their lifeworld and making social choices in collaboration with and under the influence of other family members, extension officers, fellow farmers and other actors in the local community (see Vedeld et al, 2003).

We think that it is both possible and sensible to combine economic perspectives and broader social constructivist perspectives *if* this is done in coherent and theoretically sound ways. We believe that elements of (household) economic approaches to describe relationships between access to resources, resource outputs and broader patterns of adaptation and also key constraints for improved economic livelihood can be combined with social constructivist perspectives that ambition to *contextualize*, *explain* and *understand* farmers' adaptations. We believe in particular that the processes around adoption and relationships between farmers, the farming communities and the extension service system are important to see in such a context.

We present a perspective on adoption and innovation that combines a household economic model with a social constructivist perspective on adoption. The approach is applied to the case of treadle pump adoption in Malawi.

2.2. FARMERS' DECISION-MAKING AND ADOPTION – CONVENTIONAL PERSPECTIVES

From a household economic approach, households achieve their objectives by allocating resources in cost-effective ways. Access to land, labour and capital provide opportunities and limitations that constrain or enable and to a large extent determine decision-making and resource allocation (Sijm, 1997). Also factors outside households' direct control affect farmers' basis for decision-making when they enter as arguments into farmers' consumption and/or production functions.

Traditional farmers' adoption theories compatible with neoclassical economic theory can be classified as the diffusion-innovation model, the economic constraint model and the technology characteristics model (Negatu and Parikh, 1999).

The "diffusion-innovation" model ('transfer of technology') implies that technology is transferred from researchers to farmers through competent extension services and that farmers have lacked information and knowledge about the innovation (Rogers, 1995). The "economic constraint model" assumes that households' access to resources influence critically on the ability and willingness to adopt a technological innovation (Vedeld, 1990). The "technology characteristics model" assumes that characteristics of the innovation itself (cost/return ratio, labour needs, complexity, culture etc.) play important roles in decision-making of adoption and diffusion process (Scoones and Thomson, 1994; Vedeld et al, 2003). These models are not incompatible, but offer emphasis on different factors important for farmers and their decision-making, factors that often have different relative importance under different empirical conditions and that can be tested through field surveys. The models are compatible with a household economic approach in that they can be described as arguments affecting farmers' consumption and production decisions. They also hold similar basic assumptions on rational choice, methodological individualism and to the extent they address institutional perspectives it would be within the new institutional economics, accepting missing or imperfect information and markets, transaction costs etc.

2.3. CONTRASTING CONSTRUCTIVIST AND NEOCLASSICAL ECONOMIC PERSPECTIVES

A more comprehensive understanding of farmers' behaviour and how farmers "really" assess new technology and consider adoption, would require, in our view, a different type of analysis to integrate deeper and broader concepts of social and cultural capital also referred to within the livelihood analysis approach.

A livelihood approach assumes that a household accesses *a set of assets* or endowments, where access is modified by social relations (gender, class, ethnic group, age), legal, economic and social institutions and also physical organisations. Also *contextual factors* beyond the direct control of the households are important; demographic, technological, economic, legal, political and administrative factors (often emanating from SAPs and PRSPs), in addition to environmental vagaries of various types. Given these livelihood conditions, households involve themselves in a variety of natural resource (NR) and non-NR based *strategies* to produce outputs for survival and livelihoods. Such strategies encompass various diversification strategies, dynamic in time and space, and between different groups of households. Such adaptive strategies by households- and communities- also have economic, socio-cultural and environmental *external effects*.

Often we find a particular focus on the *livelihood platform*; the resources or assets controlled by the household that form a crucial foundation for decision-making. There is also substantial emphasis on substitution mechanisms between different types of capitals. In the livelihood approach, the different types of capital are seen as pools of resources for different groups of households that may enable or constrain them relative to taking advantage of the new technology.

Different types of capital can be converted in ways that promote adoption to further enhance capital formation and accumulation. If there are constraints in term of labour or land for irrigation, such factors can be hired by using financial capital.

Such conversions will typically be more frequent and fluid among wealthier households. Wealthy households often control more social and cultural capital and this can often be linked to credit systems and extension workers access. In economic terms, wealthier household also have more production possibilities. Poorer households typically have less options and often convert their main asset, labour, into other types of capital. Patterns for conversions of capital thus typically vary systematically between household groups with differential access to various capital forms. In a long run perspective, the different ability to accumulate various types of capital, and maybe in particular financial capital, has

implications for community level patterns of differentiation, where particular focus must be put on crucial forms of real capital, such as land and livestock.

Households' willingness to adopt new technology must be understood relative to initial assets access and how the access is modified or controlled through social relations, institutions and organisations. Adoption will also be contingent upon broader contextual factors and shifts in policies and trends such as demographics, other technological developments, macro-level legal and economic policies to mention some. In addition come natural vagaries of various types that can actually promote or discourage the adoption of technologies.

2.4. SOCIO-CULTURAL AND PHENOMENOLOGICAL CONTEXTUALIZATION OF ADAPTATION AND ADOPTION

A conventional livelihood approach, based on rationalist assumptions, departs from a social constructivist approach in the ambitions to understand and contextualize human adaptation and adoption. This requires a deeper analysis of concepts of social and human capital; of social relations, institutions and organisations that constitute, create and recreate households' willingness and ability to access and transform various forms of capital into livelihood outcomes.

Rural communities and subgroups within them often have different attitudes, values and norms related to the particular adoption object, precisely because they have been exposed to and lived through different socialization processes and practical experiences. Group attitudes, values and norms are not only related to wealth groups and scale of operation, but to gender, ethnicity, social groups, kinship etc. where belonging to a social group should not only be seen as a variable or a property of the individual, but as socially constructed institutions that constitute people and their adaptation and their adoption repertoire (knowledge and experienced based actions) in a more comprehensive way, also forming their perceptions of innovations. Such understanding is difficult to merge with traditional rational choice perspectives and perceptions of universal rationality, where one

assumes that given sufficient information, actors basically perceive, explain and understand phenomena in the same way.

Furthermore, the attributes of the adoption item itself are also important. Is the item compatible with different farmers' life modes, basic values, norms, experience, knowledge and perceptions? (Vedeld et al 2003). The innovation should be compatible with farmer's asset access, budgets, not too demanding on family labour relative to other forms of capital, if it is efficient also for small holdings etc. may make it relatively speaking more interesting for poor households. Do different actors have realistic abilities to choose whether to adopt or not at all? Pannel et al, (2006) talk about the relative advantage of the new innovation compared to present practices and highlights; short and long term investment and running costs and incomes, also compared to present technology, effects on other parts of the production system (e.g. labour demand), adjustment costs of the innovation, impact on risk situation, compatibility with existing sets of technology, practices and resources and competence/skills, the complexity of the innovation, compatibility with present beliefs and practices, social self-image and status.

In a phenomenological perspective the adoption item should be simple, easy to access, use and maintain, results should come swift and be visible and practical, facilitating rather short-term tangible benefits for poor households in order to be more likely to be adopted and it should fall in well with present production systems.

The implementation and decision processes themselves are also important; in what social and cultural contexts are adoption items introduced; by whom, for whom etc. In this lies also an expansion of theories for decision-making; seeing farmers' (rational) choices as "conscious, consistent and consequential" is quite different from seeing them as "contextual, rule-based and interpretative" (March, 1994). The latter seems to form a more fertile ground for comprehensive studies of adoption. It also means less emphasis on particular physical criteria; profitability, constraints etc. and more focus on applying an interpretational context for farmers' adaptation and adoption processes. Norman Long (1989) uses the concepts of interventions, life modes and interface, to describe how an

intervention such as the treadlepump is seen as attempts from outside to alter the system (farming). People "negotiate and transform" this technology to fit into their own lifeworld, defined as "realities that people adaptively construct for themselves". Lifeworlds are also what people are born into, create and re-create in reciprocal ways. People may not be explicitly aware of their lifeworlds - and their limitations. A crucial realization of the lifeworld concept is that "people have different realities and makes understanding these realities a primary research activity. This is very different from more traditional approaches that put a premium on the scientist's understanding of problems and solutions" (Douthwaite et al, 2001). The *interfaces* link lifeworld and intervention in that different lifeworlds meet and interpret the interventions in different ways. What these encounters are and how they develop and are interpreted by different actors becomes crucial in understanding success or failures of outcomes of such encounters (Long, 1989 and 1992).

Factors to look for when assessing adoption success, would be linked to the degree of social cohesion and trust, social institutions, values and norms, organisations, historical relationships, the relationships to implementing private and public agents and the extension service, ethnic, cultural and gender relations.

3. ADOPTION OF TREADLE PUMPS- FIELD EXPERIENCES FROM RELATED STUDIES

3.1. GENERAL EFFECTS OF ADOPTIONS

There are two major impact assessments from Malawi (Wiyo et al. 2002, and Mangisoni, 2006), as well as a general report on treadle pumps in Africa (Kay and Brabben, 2000).

3.2. AGRONOMIC IMPACTS

Kay and Brabben (2000) report that treadle pumps impact on land use, farming practices and cropping patterns. The total area and share of cultivated land is often found to

increase due to more irrigation. Farmers are able to grow more crops/year, more yields/ha and a wider menu of crops, also outside the rainy season.

Treadle pumps are easy to operate and reduce time spent on irrigating crops compared to more traditional manual irrigation devices. Farmers achieve higher yields and increase land and farm productivity levels, total food production and availability throughout the year. The adoption may sometimes lead to changes in the overall farming systems. Some farmers may be reluctant to adopt for such reasons (Pannell et al, 2006).

Cropping intensity has increased with adoption. The average number of yields for treadle pump fields is 2.3 crops/year. Farmers report an average of 0.26 ha land/household under treadle pump irrigation. The irrigated area/household has increased on average by 156% for Malawi since the introduction of the pumps (Wiyo et al, 2002).

Pumps may lift water 7 metres and produce around 1.6 litres/second. Preferred crops for irrigation are maize and vegetables. Almost 79% of the farmers use inorganic fertilizers and 48% use manure in these fields. The pump is mainly used in the dry season. A main maintenance problem is lack of spare parts (65%). Many farmers, given the rather simple technology, report a variety of ways to improve the system and display a number of such modifications (Wiyo et al, 2002).

3.3. ECONOMIC EFFECTS

Treadle pumps enable farmers to raise total income levels directly through increased crop yields, more crops/year and through improved land productivity. Furthermore, as farmers are able to utilise irrigation water, they also try out new crops. Treadle pumps also increase employment opportunities for local artisans manufacturing pumps, carpenters producing the treadles, and rural workforce to cover increased labour demand (Kay and Brabben, 2000).

Wiyo et al, (2002) report that treadle pump farmers have on average 59% higher income than watercan farmers and 20% higher incomes from *dimba* land. They further find that 44% of treadle pump farmers report to be food secure throughout the year, while only 23% of watercan farmers report the same. Many households manage to have access to maize throughout the year by means of the treadle pump and they take two irrigated crops/year. In response to crises, the treadle pump farmers report to buy or to use *dimba* maize, whereas non-*dimba* farmers to much larger extent report to work for others (Ganyu). One treadlepump may be used to irrigate around 0.3 ha. The treadle pump seems to be economically viable for up to 5 ha farms. Beyond this, motorized pumps are competitive, despite high fuel costs. (Mangisoni, 2006).

Land under irrigation is found to double for households adopting treadle pumps. In a financial analysis, Wiyo et al. 2002 find that a farmer is able to repay a pump after one year through two crops of maize. (The cost of the pump was MAK 8750 (USD 78) in 2004). The profitability of investing in a pump thus seems robust. Many farmers (21%) also report to hire out the pump to other farmers.

Other properties of the pump however, may constrain adoption for particular households. Even if many state that pumps have a major advantage in the ease of operation and low costs of maintenance, the pumps demand substantial labour; constraining households with little family labour access and or access to capital for hiring labour (see e.g. Shah et al., 2000). Wiyo et al. (2002) find that 75% is family labour, while 25% is hired labour during the season. Hired labour is partly permanent (67%) and partly temporary piecework (Ganyu). Children and men in the family typically operate the pump; treading 3-4 hours/day 2-3 days /week in the now expanded growing season. Three people are needed to operate one pump; two pumping and one directing the water (Mangisoni, 2006).

The treadle pump adoption is also constrained by high purchasing costs relative to the low incomes. The lack of local artisan suppliers is also mentioned as a problem (Wiyo et al., 2002). The distance to suppliers often not staying in rural areas also discourages

farmers from buying pumps. Many smallholder farmers also have problems meeting maintenance costs, even if they seem small.

Irrigation can cause damage to downstream ecosystems due to reduced water quantity and quality, salinization, water logging, erosion as well as soil acidification (Dougherty and Hall, 1995). This may in the long term deteriorate the productivity of soils and reduce crop yields. Still, from an environmental perspective, the pumps tend to reduce pressures on land expansion onto more marginal lands as land productivity on cultivated land increases. The pump also offers a substitute in terms of muscle power for fossil fuels.

3.4. SOCIO-CULTURAL IMPACTS

Shah et al. (2000) in studies from South Asia, find a high proportion of rural poor people adopting the treadle pump improving their livelihoods, including abilities to improve health, education and other social concerns.

Many (50%) of the adopters in Malawi use treadle pumps in groups of 10-20 people. Such group adoptions, often quite stable, may strengthen social cohesion, trust and security in local communities (Wiyo et al. 2002).

In a study of two districts in Malawi (Blantyre and Mchinji), households with higher education levels, more labour access, more land and higher net farm incomes are more frequent adopters. They report higher incomes, increased food security, reduced poverty (headcount number, depth, severity) and less loans sought from neighbours (Mangisoni, 2006).

Some negative effects are also present. Mangisoni, 2006 finds that the increased labour input, and also pumps needing service and repairs, in addition to lack of knowledge about irrigation techniques and culture can become a source of conflicts. There are also conflicts over (contested) rights to communal resources, access to water, to the small capacity of pumps and the distribution of costs. Reduced water access for downstream communities also generates conflicts. Irrigation can also enhance the spread of

waterborne diseases to communities using the same water point source (Dougherty and Hall, 1995).

Irrigation may also enhance inequity (Dougherty and Hall, 1995). In some cultures, women do not feel comfortable using the pump, as they feel "exposed and undignified". For female-headed households, this could entail facing relatively speaking lower food production. Women are also disadvantaged as (male) extension workers tend to concentrate on male farmers. Female-headed households thus face constraints both relative to physical capital (labour) and to cultural capital (self-esteem related to the type of work involved, no contact with external actors such as extension system or NGOs). Wiyo et al. (2002) stress that both men, women and children treadle. Men and women work the same in *dimba* lands, and the claims that women do over 70% of the work is a substantial "exaggeration for Malawi, even in upland fields". A main constraint mentioned is that it is labour intensive and that it is "tiring" to treadle.

3.5. OVERALL EXPERIENCES

The main impression from other studies is thus that the treadle pump technology seems to be of interest to many farmers and that it indeed delivers. Many farmers have adopted the treadle pump. Initial assessment results, although scant and superficial, indicate both higher incomes and improved food security. But the results come at costs; more labour input in the farming system, and rather substantial cash layouts. The social effects seem to be both positive and negative.

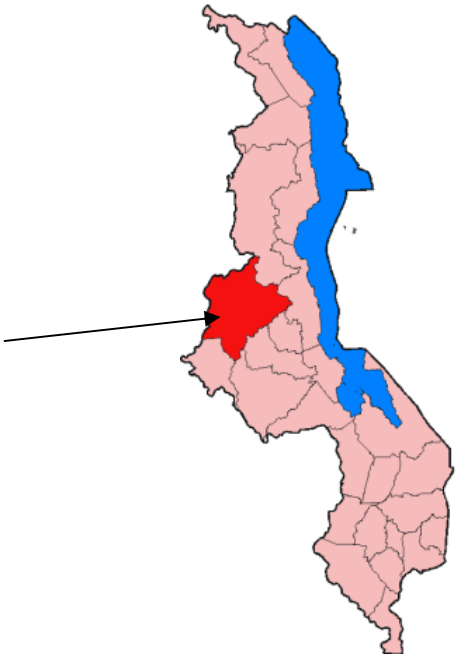
4. STUDY AREA, SURVEY METHODS AND MODELS

4.1. STUDY AREA

The study was conducted in three villages in Kasungu district, central Malawi (see Map 1). Agricultural activities are coordinated under the Kasungu Agricultural Development Division (KADD) agro-ecosystem. The district has a population of 569,581 and a population density of around 61 people/sq.km.

The sampled villages were Chioza village under Chulu EPA, Chikankheni and Mnduka villages under Kasungu-Chipala EPA.

Kasungu District has a warm tropical climate characterized by a unimodal rainfall pattern, receiving erratic rains (500-1200 mm per year). The district lies at an altitude of around 1300 meters, with undulating landscape and has a mean annual temperature of 19-23°C. Soils are predominantly oxisols, ultisols, and alfisols and reasonably fertile with substantial potential for agricultural development.



Map 1. Malawi and Kasungu District study area (in dark)

Agricultural production: Farming is the main livelihood activity. The average land holding is half a hectare. Tobacco is the main cash crop. Maize, beans and groundnuts are main food crops, in addition to vegetables. Crop farming is largely rain-fed. The district produced 198, 000 MT of maize in 2006, or some 8% of Malawi's total agricultural production. 72% were produced by small-scale farmers (USAID, 2006). The main livestock in the district is poultry, mostly chicken, followed by small ruminants

(goats). Livestock production is thus quite marginal, despite public efforts to enhance production (GOM, 2002b).

Major development challenges of the district. There is a high incidence of poverty and food insecurity (29% of population under risk in 2006) and a substantial degree of under- and malnutrition, 66, 000 people or 12% are HIV-positive among the adult population, there is a low agricultural productivity, high population densities, low education levels and a general lack of infrastructure and well-functioning markets and few job opportunities (USAID, 2006).

4.2. SURVEY METHODS

One village from Chulu EPA and two from Kasungu-Chipala EPA were selected based on the fact that at least some households in all villages had adopted treadle pumps. Eight extension workers involved in treadle pump promotion were interviewed.

Qualitative methods such as focus group discussions and participatory observation were applied. A quantitative survey was conducted using two structured questionnaires, one for households and one for extension workers. Household deliberations were held with household heads and/or their spouses. In some cases also older children or relatives within the household would participate. Remaining members of the household participated when present. 90 households were interviewed, 45 of whom were adopters. A stratified sampling procedure was thus used to select adopters' and non adopters' households.[2] In the villages in total some 33% of the farmers had adopted the treadle pump, implying that adopters are somewhat over-represented in our sample of 90 farmers (50% adopters).

Polygamous families were treated as separate households. Fifteen percent of the households were randomly selected from the two strata. The adopters' households were randomly selected from the total number of adopters. Non-adopters' households were randomly selected from the total number of non-adopters.

[2] A household is defined by local people as a group of individuals living together and eating from the same pot", joint production, consumption and reproduction functions" (Vedeld, 1990).

4.3. MODELS USED IN THE ANALYSIS

Adoption of treadle pumps is a dichotomous choice and a logistic multiple regression model was used to estimate factors affecting adoption of treadle pumps. The model is based on the cumulative logistic probability function and is given by:

$P_i = E(Y=1|X_i) = 1/(1+e^{-(\beta_1+\beta_2 X_i)}$ ……………………………………(1)

where P_i is the probability that an individual will make a certain choice (adopt, not adopt) given the knowledge of X_i. P_i ranges from 0 to 1 and it is non-linear. The dependent variables are dummy variables of either 0 or 1 (1 yes alternative). The more negative the log-likelihood, the better predictability (Gujarati, 2003).

β1 and β2 Xi explains how much parameter X_i affects the dependent variable. The more negative sign, the less the parameter affects the dependent variable. The explanatory variables hypothesized effect on adoption is outlined in Table 1.

Table 1. Variables used for analysis of treadle pumps adoption

Variable	Description	Expected sign with adoption
Age hh.	Age of household head	-
Sex hh.	Sex of household head; 1 if female, 0 if male	-
Worker units	Total worker units of household	+
Educ. Hh.	Formal education of household head	+
Farm size	Total farm size of household	+
Inc gen. source	Income generating sources	+
Extension	Access to extension services; 1 if yes, 0 if no	+
Credit	Access to credit; 1 if yes, 0 if otherwise	+
Market distance	Distance to produce markets	-
Dimba	Access to *dimba* land; 1 if yes, 0 if no	+

A multiple linear regression model was used on maize yields and the total land under cultivation in order to test impact of adoption on changes in land productivity and production. Yields of maize/ha were used, as the crop was grown both in the upland and in *dimba* areas so one could compare the net effect of pumps used and not used for the same crop. Other *dimba* crops were grown in mixed patterns and were more difficult to quantify, and were therefore not used in the impact analysis. The model is estimated by:

$Y_i = \beta_i + \beta_1 X_{i1} + \ldots + \beta_n X_{in} + e_i$ ....(2)

Where Y is the independent variable (yields of maize/ total maize land under cultivation)

i=0 is maize yield from households without treadle pump adopted

i=1 is yield from households with treadle pumps

β_i is the constant,

$\beta_1 X_{i1} + \ldots + \beta_n X_{in}$ are the exploratory variables.

e_i are independent error terms $N(0,\delta)$.

Total household income (THI) was used to assess possible impacts of treadle pump on overall incomes. THI is the sum of values from different entitlements that households generate.

5. RESULTS AND DISCUSSION

5.1 SURVIVAL AND LIVELIHOOD IN THE STUDY AREA

5.1.1 Livelihood assets

People in the study area are poor, also by Malawian standards. They are small-scale farmers and even if they have farm sizes above average for Malawi, the climatic, agricultural and economic conditions frame a situation where land does not yield much.

Table 2. Household Characteristics, Kasungu District, Malawi 2003

Variables	Poor group (N=56)	Least poor group (N=8)	Mean total sample values (SD) (N=90)
Age of hh	46,4	36,8	45 years (10)
Sex head of hh	89% male	73% male	83.3% male
Household size	6.6	5.8	5.8 (2.0)
Consumer/worker units	2.5	1.7	2.6 (1.3)
Educatation level hhh	5.1	9.0	5.4 (3.4)
Farm size (ha)	3.9	8.3	5.2 (3.4)
- Upland	3,7	7.7	4.8
- Dimba land	0.2	0.6	0.4
Land tenure			
- Own land	95.5%	92,3%	93.3%
- Hired land	4.5%	7.7%	6.7%
Total TLU	0.9	3.1	2.0 (6.1)
Formal credit	16%	50%	23%
Fertilizer use	112 kg	226 kg	155 kg

Education levels are low. The size of households is on average 5.8 people. Most households are male-headed (83%). 81% of the household members are below 15 years,

indicating a substantial population growth and high dependency ratios (consumer/worker ratio= 2.6).

People keep livestock and cultivate land. It is mostly upland areas, but farmers do have some irrigated land (Table 2). The average land holding is 5.2 ha/household. Compared to Malawi in general, this is thus a sample with larger farms; most of the around 2 million farms in Malawi are 1-2 ha. 10% of the households in the sample had less than 2 ha. In general for Malawi, 40% are reported to have less than 0,5 ha. Some 23% report to access credit from formal sources through both commercial banks and particular fertilizer loans from MRFC. This is a high figure compared to what is commonly found in socio-economic field studies for Africa. The formal lending system institutions charge interest rates up to 50% per year, so many cannot afford this option. Most respondents do report access to informal lending institutions.

Livestock management is reported to be difficult; with substantial losses to theft and diseases. People keep livestock in small numbers; cattle (0.9 Tropical Livestock Units (TLU)), goats (0.4 TLU), pigs (0.4 TLU) and poultry (0.3 TLU). 27% keep cattle, 63% goats, 50% pigs and 91% keep poultry. Land is basically under customary tenure, but can be bought at MAK 8000 /ha. *Dimba* land (wetland areas) as potential irrigation land is important in an area with erratic rainfall, but it is scarce (6% of land). Most households in our sample still report to access and own both types of land. Some 28% report to keep some land under fallow, and use it for grazing livestock.

The main food-crops grown in the upland areas are maize and cassava, while tobacco and groundnuts are main cash crops. The *dimba* land is used for vegetables, potatoes, beans and maize in both subsistence and cash strategies. Water is derived from dams and from streams; but is scarce in supply for most farmland. Labour access is not seen as a major problem, even if some 40% of the population is below 15 years. People report to spend only some MAK 1977 (less than 1% of THI) on hired labour. There are surprisingly few reports of migration (3%).

Contextual factors impacting individual adaptation include population density and land scarcity, which are mounting in the area, but that not yet form immediate threats to livelihoods. Most households report to control sufficient land for their subsistence needs, even if they also report scarcity of food in periods of the year. Market conditions are not favourable, with expensive inputs (fertilizers), low output prices and only access to local markets with particularly low prices. The extension service is present in the areas. Natural vagaries, in particular recurrent drought and severe erratic rainfalls constitute a general and lasting challenge for the farmers, who stated that rains had been inadequate for the five last consecutive years. Population growth is substantial, with 44% of the respondents reporting to migrate in, for marriage (36%), for accessing land (6%) and for employment seeking (2%).

5.1.2 Livelihood strategies

People report incomes of less than 1780 USD/hh and year or an average of USD 0.86/person and day. People are thus generally very poor. They depend solely on agriculture for cash and subsistence needs (Table 3). Crop production is beyond any comparison the main source of livelihood. The income figures for off-farm and non-farm activities are almost suspiciously low in our study; with reported less than 3% of incomes from such activities, compared to 50% reported by Ellis (2003) and to findings of other rural economy studies in Malawi. We do believe that our figures for off-farm employment could be under-reported to some extent as many households may not like to reveal working for others. But our study is also in an area with larger farms and from a year of rather good production conditions, compared to the following famine year of 2004-2005, where agricultural incomes from the same district were actually reported negative (Takane, 2006). In Ellis' (2003) study, Zomba and Dedza Districts are situated closer to major urban centres than our study villages in Kasungu District, and with better options for other types of employment combined with much less access to land.

Table 3. Total household incomes, Kasungu District, Malawi 2003*

Sources of income	Poor group (N=56)	Less poor group (N= 34)	Total sample*	%
Food crops	97 456	120 705	106 846	52.1

Cash crops	48 479	139 522	82, 873	40.4
Remittances	500	1 956	1 050	0.5
Off/non-farm	2 410	174	958	0.5
Private business	179	6 905	2 720	1.3
Livestock	1 131	25 841	10 466	5.1
SUM	**150 155**	**295 103**	**204 913**	**100**

** All values are given in MAK.* ***112.5 MAK=1 USD***

Livestock is reported used not only for food, but as source for cash incomes, for manure and as symbols of wealth. It also has a safety net function in times of trouble.

> "*During the 2001/2002 famines, all of us who had some form of livestock survived, as we were able to sell in exchange for maize or cash."*
>
> Woman, 52; Mnduka village

5.1.3 Constraints for improved livelihoods

A multiple linear regression model was used to estimate effects of potential constraints to increased total household income (Table 4).

Table 4. Constraints to increased total household income, Kasungu District, 2003

Predictor	Coefficients	P-values
Land size (ha)	40271	**0.013**
Labour (worker units)	93343	**0.029**
High input prices (yes/no)	-272315	**0.006**
Access to credit (yes/no)	-122619	**0.051**
Drought (yes/no)	1344	0.982

$R^2 = 0.21$; F= 4.71 N=90

The major constraints are land size and perceived high input prices, availability of labour, and access to credit. The perceived high input prices are results of policy reforms that among others included the removal of input subsidies.

"In spite of all the efforts, we still produce less because fertilizer prices have gone up so much. Only few people can now afford to buy."

Man, 23; Chikankheni village.

Drought was expected to be significant as Kasungu District receives quite erratic rains, but was not at the time of interview perceived by respondents to constrain production,, maybe also due to access to *dimba* land.

5.1.4 Distribution of livelihood outcomes

Using a Lorenz curve, and estimating Gini-coefficient we find that there is a highly skewed distribution of THI (Figure 1). The Gini-coefficient was 0.61, implying high income inequalities. We see that 11% of the population access 41% of incomes while the poorest 40% only control 22 % of overall incomes.

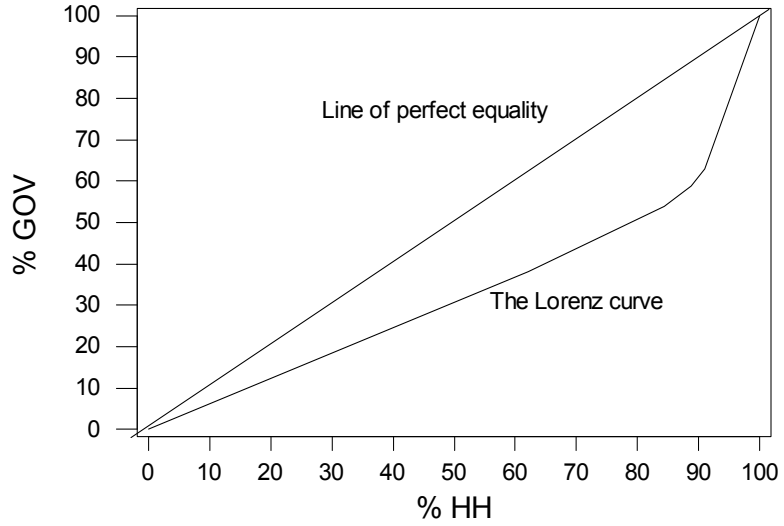


Figure 1. Lorenz curve for total household income of sample, Kasungu, Malawi, 2003

Less poor households report access to more assets and acquire higher incomes of all types compared to poorer households. These households are younger, have more education, less dependents, much more land, use more farm inputs, have more access to credit and produce more outputs and report higher on-farm and livestock incomes (see also Table 2 and 3).

5.1.5 Patterns for livelihood adaptations

People in the area are completely dependent on crop production for survival and livelihoods. The key constraints to improved livelihoods were found to be land size,

labour, access to credit, and the high costs of inputs relative to outputs. Respondents are aware of how to increase their production, but face these particular constraints.

5.2. WHO ADOPTS AND WHY?

5.2.1 Who are adopters?

As we see from Table 5, major differences relate to the fact that adopters have more access to land, labour and credit, have somewhat higher incomes, especially on-farm, they are more organised and they are generally better off. One could argue that the higher access to assets is a result of the adoption, but given that adoption is fairly recent and on scale does not constitute a major share of the income generation for most households in the area, we believe that our causal direction is more reasonable.

Table 5. Household characteristics and adoption, Kasungu District, Malawi, 2003

Aspects	Adopters (N=45)	Non-adopters (N=45)
Land		
-Upland	5.33 ha	4.24 ha
- Dimba	0.87 ha	0.16 ha
Labour		
- Worker units	2.4	2.2
- HHsize	5.7	5.8
Credit access	42%	13%
Entitlements		
Total hh income	210 654	199 172
Working on the farm	Dimbas during dry season	More leisure activities in dry season
Production purpose	Both food and cash crops	Mainly food crops
Organisation	Often belong to farmers' groups	Often not belong to farmers' groups
Wealth status	More often less poor	More often poor

Running a logistic regression model of adoption against various socio-economic household variables gave a similar result; asset holdings at household level, different social relations, institutional credit constraints and also livelihood outcomes all correlate positively with adoption (Table 6).

Younger household-heads may often be more open-minded and tend to adopt innovations easier than older people, and there is a weak non-significant trend in that direction. The access to labour, measured through worker units, also contributed significantly to adoption of treadle pumps.

The farm size is found to contribute significantly to adoption, and households with larger holdings have potentials of higher production, enabling them to invest and gain more from new technology.

Table 6. Household factors affecting treadle pump adoption rates, Kasungu District, Central Malawi, 2004

Independent variables	Estimated coefficient (SE)	P values	Adopters Average values	Non- adopters Average values
Age	-0.048 (0.06764)	0.479	38.9	43.4
Sex	-1.009 (1.529)	0.509	47.3% male	35.6% male
Worker units	0.617 (0.3990)	0.041*	2.4	2.2
Education	0.193 (0.1894)	0.309	5.9	4.6
Farm size	0.715 (0.3160)	0.024*	6.2	4.4
Total household income	$12.1*10^{-6}$ ($14{,}6*10^{-6}$)	0.409	***210 654 MAK/yr***	***199 172 MAK/yr***
Extension services	6.601 (2.081)	0.004**	87 % visited	19% visited
Credit	4.033 (1.610)	0.012*	42% access	13.3%
Market distance	-0.136 (0.1456)	0.351	5.7	9.3
Dimba area	0.754 (0.4152)	0.541	0.87 ha	0.16 ha

Logistic model; Loglikelihood= - 11.26 * P< 0.05 ** P<0.01 Pearson Goodness of fit test: Chisquare 41.7 DF=80, P=1

Access to information from extension services is highly significant where 87% of the adopters report to get information while only 19% of non-adopters report the same. We will discuss this further, but extension service seems to be an important factor for adoption and maintained use of treadle pumps.

The easier access households have to credit, the higher the probability to invest in treadle pumps. The pumps cost about 8,500-10,000 MAK and are thus expensive for smallholder farmers. Adopters had to pay in cash for the treadle pumps, mainly bought at ADMARC or through the Irrigation Department. However, when comparing with motorized pumps, most respondents commend the treadle pump for its low costs.

Most treadle pump derived products are horticultural crops that need to be sold immediately after harvest. The further output markets are from the farmers, the less the likelihood of adoption. Most markets were located at an average of 7.2 kilometres away

from people's homes. Poor transport services were, however, a constraint to all farmers to transporting produce to markets and short market distance only indicates a non-significant trend in favour of adoption.

Access to *dimba* land was expected to contribute significantly to adoption. This is due to the fact that most treadle pumps users cultivate in *dimbas,* which are mostly located near water sources. The average access figure for adopters (0.87 ha) versus non-adopters (0.16 ha) is high, but the variation is so substantial that this difference is not found significant in this multiple regression model, even if a trend is there.

5.3 IMPACTS OF ADOPTION

We investigated if the adoption of treadle pumps may have impacts on yield levels, number of crops and production per year, land under cultivation, income levels and food security throughout the year and also if we can identify particular socio-cultural, health and environmental effects of the adoption.

5.3.1 Impact on maize yields

Treadle pump adoption had significant impacts on maize yields. For the overall sample, the yield average is 820 kg maize/ha. We find that non-adopters on average report 628.6 kg of maize/ha while adopters report 1105.5 kg/ha. The adopting households have on average 15.7% higher gross household income as a result of the higher average maize production. If we look only at the areas under treadle pump for maize; the reported yield per ha is substantially higher; 2 376 kg of maize/ha (3.8 times higher than for non-adopters). But this high yield is only achieved for 0.25 ha of land per household. We may thus state that the effect of treadle pump is more pronounced for land productivity than for total household production or total incomes.

5.3.2 Impact of adoption on land under cultivation

We found that treadle pumps seem to have a dynamic effect in that farmers do increase their total land under cultivation (Table 7).

Table 7. Determinants of size of irrigated land. Kasungu, Malawi, 2003

Predictors	Coefficients	P-values
Livestock units	0.1591	**0.002**
Access to credit	0.6596	0.382
Worker units	0.4370	**0.010**
Consumer worker ratio	0.7961	0.453
Adoption	1.4834	**0.030**

R^2 =0.231; F = 7.69 N=90

Adoption contributes significantly to increased total area (1.8 ha) under cultivation. The treadle pump farmers themselves state to have increased their land under cultivation in general and their irrigated land fourfold in response to the adoption (see also Table 5). The fact that treadle pumps reduce labour requirements compared to watering cans also enables adopters to expand their *dimba* areas substantially. The adoption itself thus seems to trigger a positive production spiral; the availability of the pump triggers willingness to use and increase labour inputs on the farm.

With the treadle pumps, farmers are able to cultivate at least two crops per year. This further contributes to increased food production. The average land size used by treadle pump farmers was 0.87 hectares. The pump cannot effectively irrigate larger pieces of land related to land availability and its proximity to water. Labour access at farm level also constrains the amount of land irrigated. We see that households with more productive workers access more labour and can also increase total land under cultivation.

Increased livestock holdings are also found to contribute significantly to increased land size under irrigation. This could be related to higher access to capital to buy the pumps, but also to increased access to manure, making farmers more willing to expand their irrigated land in order to utilize the organic fertiliser.

5.3.3 Adoption and overall income

Use of treadle pumps increases household incomes; not only from maize, but for all incremental crops grown and yields achieved. Incomes from *dimba* production are also used to buy inputs for upland fields, securing possibilities for better harvests in the subsequent year and potentially even higher incomes over time. Total household income was used to compare levels of income between adopters and non-adopters (Table 8).

Adopters have higher average household income than non-adopters (significant at 5% level, Chi-square P= 0.001). However, around 38% of the adopting households still have incomes of less than 100,000 MAK/year, while 13.3% of the adopters report incomes of more than MAK 400,000. The majority (86.7%) of non-adopters have incomes less than MAK 100,000. If we remove the two non-adopting households responsible for some 25% of total incomes among non-adopters, the differences in mean incomes becomes substantially higher. Also, looking at the 86.7% poorest non-adopters they have an average income/cap and day that is 30% lower than the sample average.

Table 8. Total household income and adoption by income classes, Kasungu, Malawi 2003

Adopters (N=45)					Non-adopters (N=45)			
THI (MAK)	**Total THI**	**% THI**	**No HH**	**% HH**	**THI**	**% of THI**	**No HH**	**% HH**
0-100,000	1,300,771	13.7	17	37.8	5,917,977	66.0	39	86.7
100,001-200,000	2,643,277	27.9	18	40.0	264,622	3.0	2	4.4
200,001-300,000	432,220	4.6	2	4.4	465,555	5.2	2	4.4
300,001-400,000	746,623	7.9	2	4.4	0	0	0	0
400,000+	4,356,539	46.0	6	13.3	2,314,597	25.8	2	4.4
Total	**9,479,430**	**100**	**45**	**≈100**	**8,962,751**	**100**	**45**	**≈100**

As we have seen, the additional incomes from the treadle pump for the maize yield increase alone enhances the total incomes some 15%. In total, incomes from agriculture are much higher among adopters than non-adopters.

The fact that more than 1/3 of all households in the villages have adopted also indicates that farmers assess the adoption to be profitable - or at least desirable.

5.3.4 Impact on household consumption

Treadle pump farmers sustain a significant proportion of the *dimba* crops for household consumption for most of the year, increasing food access and security and improving the nutritional status of household members.

Most non-adopters report to deplete their food stocks within three months of harvest. The rest of the year they resort to *ganyu,* selling their labour to various informal activities. Most treadle pump farmers reported to have food supplies throughout the year in

particular due to supplements from the *dimba* maize. Few adopters report to have run short of food even one month before the new harvest.

"Before I started using the treadle pump my children used to be underweight and often fell sick. This time all my kids, as you can see, have gained weight and are very healthy"

Woman; Chioza village.

They also report to use additional incomes to pay school fees, buy farm inputs and purchase consumer goods. Cash from treadle pump product sales is also used to buy food in times of shortages.

5.3.5 Socio cultural impacts

Most treadle pump users own the pump in groups. This spreads risks of the investment and can promote social cohesion within the local communities. Irrigation has traditionally been perceived to be a woman's task and men would typically not irrigate when using the watering cans. With the advent of treadle pumps, time spent on watering crops is reduced and men also treadle together with their families. The workload of women has thus been reduced. Men rest less in the dry season. Women also operate the treadle pumps without much traditional or religious restrictions.

The treadle pump adoption has spill-over effects to communities. People with higher incomes as a result of the treadle pumps may be more able and willing to help others through informal credit services. Treadle pumps also create employment opportunities to those who sell labour during peak periods of production and to local artisans repairing pumps.

5.4. REASONS FOR ADOPTION

5.4.1 Revealed and reported reasons

Treadle pumps contribute in positive, significant ways to household livelihoods. Yield levels increase, number of crops, land size under cultivation and production per year increase, income levels are higher and food security throughout the year is improved for adopters. There are also positive socio-cultural and health impacts. We thus see that a

rather simple and inexpensive technological innovation improves household livelihoods. We have also seen that after less than 5 years, one third of the households in the study area have adopted the pump. In the following we look at what we can learn from this; in looking at the role of the extension system and approaches used working with the farmers.

Studying the impacts, as also most farmers have done, may help us explain why people adopt. We also asked farmers themselves directly why or why not they adopted (Table 9).

Table 9. Reported reasons for adoption choice among respondents, Kasungu District, Malawi, 2003

Reasons for non-adoption	Non-adopters (%)	Main Reason for adoption	Adopters (%)
Lack of knowledge	17 (38%)	**Reduced time for irrigating**	17 (38%)
Expensive	3 (6%)	**Easier to use**	1 (2%)
Do not have dimba land	2 (4%)	**Increases food base**	13 (28%)
Lack of water resources	11 (24%)	**The pump was a gift**	6 (14%)
Not practical technology	3 (6%)	**It supplements rainfall**	5 (12%)
Lack of labour	3 (6%)	**Others**	3 (6%)
Do not believe in it	6 (14%)		
Others	-		

Most reasons for adopting relate to the fact that farmers save time and increase their food production. In some of the cases, farmers also got the pump for free, making it much easier to adopt! Among the non-adopters reasons are more varied, both relating to lack of access to resources, and to a lack of knowledge about the pump and a general scepticism.

5.4.2 Groups and individual adoption

In our sample, 60% of the adopters have adopted the pump as part of a group and not as individuals, partly related to efforts by the extension system, but also reflecting local preferences and choices. Group adoption obviously reduces cash outlays and the risks of the rather substantial investment, but also constrains the ability to fully utilize the adoption.

Table 10. Socioeconomic characteristics of group and individual treadle pump adopters, Kasungu District, Malawi, 2003

Characteristics	Group Adopters (60%)	Individual adopters (40%)
Endowment	More access	Little or restricted access
Land		
-Upland	2.1 ha	4.1 ha
- Dimba	0.34 ha	0.53 ha
Labour		
- Worker units	0.8	1.6
- HH size	3.6	2.1
Entitlement access		
- Total income	171 922	249 387
- Agricultural income	146 599	211 402
- Other incomes	25 323	37 985
Organisation	Often mobilise and belong to some kind of farmers' groups	Often do not belong to some kind of farmers' groups

From Table 10 we see that the individual adopters are more wealthy, have more land, more access to labour and have higher incomes both from agriculture and from other sources.

Group ownership was still preferred or at least selected by a majority of farmers because the group would act as a source of collateral when accessing formal credit from sources such as commercial banks or suppliers of treadle pumps. Groups also function as an investment in human capital that can reduce temporary labour shortages. The greater interaction among farmers in the group also provides opportunities for exchange of beneficial experiences and practical work and may help improve pump and irrigation management and efficiency.

Group membership is a joint mobilisation to purchase a pump. Purchasing costs were shared equally among the members. Each group commonly comprised two to five people (male and female). Members were relatively homogenous in terms of wealth status. A leader was elected by the members to facilitate the group. A member was allowed to leave a group and all members could agree how much to compensate the exiting member. New members were allowed to join the group and were usually asked to contribute the same amount that the old members had paid for the pump.

The group set rules guiding use of the pump. Members were jointly responsible for management and maintenance. All contributed equally to maintenance costs if needed. Non-members were not allowed to use the pump without consent of all members. The latter had the right to use the pump at any time.

Group members also enforced sanctions applied to non-compliant members. A fine of an average of MAK 300 was charged if a member misappropriated pump parts and she/he could be evicted immediately. However, expulsion was rarely reported.

> *"We prefer to charge a fine to a non-compliant member compared to eviction as the latter would ruin the image of the member to the society."*
>
> Member; Mnkhota group.

Conflicts among group members were not commonly reported. If and when conflicts arose, members would resolve them. Conflicts could arise between leaders and members, or also among members. The cause of conflicts could be disagreements regarding time used by a member or regarding eventual sanctions.

The groups were locally initiated. However, they were often organized and recognized by government authorities such as extension workers. One important lesson learned is that one has been able to use local institutions; values, norms and networks in the adoption processes and in ways that created a rather substantial rate of adoption.

5.4.3 Summary on reasons for adoption

Around 1/3 of farmers in the study area have adopted the pumps. That is a substantial achievement. We also see a pattern that households with higher incomes, more *dimba* land, more family labour, more access to credit etc. tend to adopt. It is also reported that farmers modify and improve pumps, repair and maintain them and start to experiment and innovate. These are indicators that the adoption is becoming internalised and part of their repertoire as farmers which is important in long term sustainability of the adoption. The pronounced group adoption reflects social cohesion and indicates that socio-economic constraints can be overcome through joint efforts.

5.5. THE ROLE OF THE EXTENSION SERVICE

5.5.1 The adoption process itself

The advocacy process for treadle pumps in Kasungu District shot pace in 1996-97 through a programme supported by MoA, Department of Irrigation, Danida (donors) executed by ADMARC, NASFAM and NGOs (Concern Universal, World Vision). From our sample of 45 adopters, we find that 3 adopted in 2000, 35 in 2001, 5 in 2002 and 2 in 2004. We do not have the annual adoption rate figures for *all* adopters in the villages.

Government employed extension officers used a "block extension service delivery" approach, meeting on individual farmers' land demonstrating the technology. 75% of the adopters learned about the treadle pump through extension officers. Some adopters were provided with credits to buy the pumps, but most of them bought it cash from ADMARC and the Irrigation department, at a cost of MAK 10,000 (5% of reported average household incomes). The different supplying actors provided local people with pumps under different conditions concerning price and credits.

Respondents had used the pump for 2.5 years on average; most of them (52%) previously used the water-cane system. Some 36% had also used a motorized system. A majority of farmers had substantial previous irrigation experience. Of the 298 households found in the three villages, some 100 or about 1/3 of the households had now adopted the treadle pump (2003) within a time span of 4 years, which is a high adoption rate. Looking at Malawi in total, it is estimated that somewhere between 70,000 and 130, 000 pumps have been adopted since the start in 1994, and the rate of adoption seems to have increased up to some 30,000 new pumps/year from 2002 (Mangisoni, 2006).

5.5.2 The role and performance of the extension system

Contrary to similar investigations elsewhere in Africa, many farmers do report to have contact with the extension system. The extension services have contributed significantly to adoption rates. However, sixty percent of the farmers still report that extension workers are not providing so much technical assistance as they used to do about ten years ago.

The frequency of extension workers' visits to farmers is important in maintaining and improving trust and confidence. Forty percent of the extension workers report that they tried to visit farmers once every fortnight, the rest visited farmers once in a month. On the other hand, 51% of all farmers in the total sample reported that extension workers have not visited them over the last three years.

The extension services provided information mainly on agronomic practices and on the treadle pumps themselves. About 18% of the adopting farmers reported that extension workers visit them once in a month. 52% indicated that they are visited at least once in two months. Few female-headed households (13%) report to access extension information. Farmers expressed dissatisfaction with the frequency of the visits;

"*We want extension workers to visit us at least once a week, but it has never been the case. The worst thing is that when they visit us, they always tell us they are busy and hardly take more than 15 minutes."*

Respondent 54; Chikankheni village

5.5.3 Approaches in service delivery

Government extension workers as the main agents used both individual and group approaches. Group methods were used to reach more farmers, to reduce costs of meeting farmers and to facilitate farmers to share experiences and encourage one another. Farmers, however, stated that extension first of all reached local leaders and the affluent individually, while the rest of the farmers were met on a group basis only:

"Extension workers prefer visiting the well to-do-people on individual basis; we, the poor, are totally ignored even if there is a pressing need for their services"

Respondent 61; Mnduka village.

The 'block extension' service delivery calls farmers to meet on a particular farm. Demonstrations and advisory services are carried out and attendants both practice and spread information to other farmers. The content would be scheduled to coincide with seasonal farm operations. Extension workers would typically dominate the discussions.

Farmers were expected to listen in a centralised, supply driven approach typical of the 'training and visit approach'.

This approach was preferred because it made farmers aware of the new technologies. The approach also allowed preplanning of extension messages and facilitated monitoring and evaluation of the progress among farmers.

However, farmers reported that the 'block meeting' created inequalities in accessing information. For example, women do not mix easily with men and often opt to stay at home waiting for men to inform them. Time was also reported to be a constraint for women, due to their multiple roles at home, and as one woman reported:

"It is not easy to mix with men, even if you take the courage to do so, you would not easily ask a question in front of men. You would be thought of being a woman without manners."

Woman 18; Chikankheni village.

Young farmers would not easily ask questions in the presence of older people. The 'block' meetings also created other conflicts in the society. This is because meetings were often held on particular individuals' farms. One respondent angrily said:

"Can you imagine, each time there is an extension meeting, the extension worker always wants some particular individuals' farm to be chosen. If you argue, you end up being criticised by fellow farmers."

Respondent 41; Chioza village.

Forty percent of the extension workers report that 'demand driven' approaches are used in service delivery together with the 'block' extension system. The 'demand driven' approach is more responsive as farmers are asked to present their needs to the extension officers while the 'Block extension' brings in messages from outside and above without the consideration of particular needs of the farmer and his resource endowments. The 'demand driven' service is furthermore pluralistic and accommodates the multifarious

needs of farmers. The 'block system' has a more narrow focus and does not fully take local heterogeneity into consideration.

Many of the extension workers thus report to use both 'demand driven' and 'block extension' approaches for the treadle pump adoption process. Farmers expressed their needs related to irrigation activities. Extension workers responded by providing technologies for irrigation in the 'block' meetings. Seventy eight percent of the farmers responded that they got information about treadle pumps from extension workers, while the rest got information from fellow farmers.

5.5.4 Launching the treadle pump

Extension workers issued information about treadle pumps in their areas through meetings and through spreading information materials. Some farmers thought at first that it was an impractical technology and ignored the meetings. A few farmers were selected to attend a field show in a different district to be exposed to the technology. Demonstrations were carried out on the pioneers' plots. This included mounting of the pump, plot layout and plant spacing. Farmers were mostly passive participants in these demonstrations. Extension agents stated that food production levels among adopters increased after starting to use the pumps. Most households were now having at least two meals per day. The nutritional status of children below five years improved. Food stocks became available for most of the year. Adopters started to own assets like oxcarts, radios and bicycles. There were more ceremonial activities like weddings during the dry season. Farmers also stated that treadle pumps enabled them to increase both food production and cash income levels. Extension workers reported that most non-adopters were food insecure, the most vulnerable groups being the elderly, children under five and the female-headed households. The adoption process was spreading in light of visible results delivered.

5.5.5 Perceptions on typical adopters

Experienced extension officers often have an intuitive impression about what farmers that are likely to adopt a particular innovation. According to the extension agents in our case, it would be *properties of the farmer more than the farm*; farmers with more education, the right age and attitudes, and also farmers with more land and access to *dimba* land

would be more likely to adopt treadle pumps. 81% indicated that typical adopters would have higher education levels. 78% indicated that the middle aged from 25 to 45 were the most likely adopters. Farmers with average land holdings of more that 2 hectares are also more likely adopters.

Farmers, on the other hand, would argue more from an asset base point of view; 82% of the farmers responded that those who access formal credit are the typical adopters while 68% stated that those having *dimbas* are more likely to adopt.

5.5.6 Key constraints facing extension workers

Extension workers reported that there has been a contraction of financial and human resources for public extension services that adversely affect their operational services to farmers and especially adequate transport facilities to meet farmers. With the advent of the 'demand driven' approaches, this situation would aggravate. Extension workers also stated that there are few workers; one extension agent reported to be responsible for more than 1,000 farmers.

Extension workers also reported that lack of in-service training hinders their delivery of services capacity. No respondent had been trained for the last five years:

"I have not been trained since I started this profession. Yet I am expected to effectively carry out my services. The demand driven approach is very challenging and needs a lot of improved professional skills to tackle farmers' problems."

Extension worker 2; Chulu EPA.

Extension workers furthermore state that many farmers are less productive due to diseases and high malnutrition levels and that many agricultural activities are not effectively taken up. Low literacy levels of farmers have also been impeding the scope of production, as farming is less perceived as an entrepreneurship activity. Few farmers participate very actively in the market economy and often direct their production to subsistence oriented goals.

6. STEP BY STEP

Malawi is among the poorest countries in the world, as reflected in this study. The average household has a per capita income of USD 0.84/cap and day. Not all are extremely poor; 11% of the population control 41% of all incomes, while the poorest 40% only control 22% of all incomes. However, the least poor 11% still has less than USD 2/cap and day. The Gini coefficient is 0.61, implying a very skewed distribution. Agriculture is more or less the sole source of income, apart from some environmental resources, not directly valued in this study. The major constraints to improved livelihood relate to lack of land, especially irrigated land, labour and the access to reasonable credit and capital is almost non-existent.

Some 33% of the rural households in the study area have adopted the treadle pump; in groups (60%) or as single households (40%). Adopting households control more land and labour and have more access to credit, they have higher education levels, they are younger, they have higher incomes, especially on-farm and they are more organised. They are generally better off.

Treadle pumps will not solve the problems of food security and secure household livelihoods among rural poor dwellers in Malawi. But it can constitute important complimentary incomes and food supply in particular times of the year and it can contribute as much as a crucial 15-20% share of income to households. We find that maize yields on the now irrigated land are almost 4 times higher, and we find that the purchase of a treadle pump has a dynamic price effect in that adopters report to increase their land under cultivation as a result of the investment. The study documents that adopting households cultivate 5 times more *dimba*-land than non-adopters. They also take more crops per year, higher yields/ha and provide more production in the critical dry season, thus improving food security through the "safety net function" of the pump.

The adoption process is and has been a process of gradual social change, where sceptical farmers have become convinced through trial and errors that this technology seems to

carry merit. An interesting feature is that a majority of farmers has adopted as groups, most likely caused by the rather high investment for them, but also because it has been promoted by the extension system. The intervention provides tangible, but not revolutionary results in terms of productivity increases, increased yields and production in the precarious dry season, and delivers through an interface in ways that have proved to be compatible with farmers' lifeworlds. High costs and increased use of labour is a challenge, and we also find a general scepticism among the non-adopters against the new technology as an alien to their present lifeworld and production system. In this context, it seems that the use of local institutions with its values, norms and networks in the adoption processes has enhanced adoption. The adoption is also becoming more internalised and part of their repertoire as farmers, they report to maintain and repair the innovation themselves, which is important in a long term sustainability of the adoption; preventing disadoption. The pronounced group adoption reflects social cohesion in the area and that various types of socio-economic constraints can be overcome through joint efforts. "Step by step" we see that rural households are able to improve livelihoods through this kind of innovations.

REFERENCES

Devereux, S. 1999: Making Less Last Longer. Informal Safety Nets in Malawi. IDS Discussion Paper. No 373. Brighton.

Dougherty, T. and Hall, A. 1995: *Environmental Impact Assessment of Irrigation and Drainage Projects.* FAO Irrigation and Drainage Paper 53. FAO, Rome.

Douthwaite, B., N. de Haan,V. Manyong, and D. Keatinge. 2001: Blending Hard and Soft Science. The "Follow the Technology" Approach to Catalyzing and Evaluating Technology Change. Conservation Ecology. Vol 5,(2).No.13.(online).

Ellis, F. 2000: Rural Livelihoods and Diversity in Developing Countries. Oxford University Press.

Ellis, F., M. Kutengule and A. Nyasulu: 2003: Livelihoods and Rural Poverty Reduction in Malawi. *World Development*. Vol 31. pp 1495-1510. Pergamon Press.

GOM, 2002a: Malawi Poverty Reduction Strategy Paper. Office of the President and Cabinet, Lilongwe, Malawi.

GOM 2002b: National Development Plan.Lilongwe, Malawi.

GOM, 2000: National Irrigation Policy and Development Strategy. Lilongwe, Malawi.

Gujarati, D. 2003: *Basic Econometrics.* McGraw-Hill International Editions. New York.

Kay, M. and Brabben, T. 2000: *Treadle Pumps for Irrigation in Africa*. *International Programme for Technology and Research in Irrigation and Drainage*. FAO, Rome.

Kutengule, M. 2000: Farm and Non-farm Sources of Income: Rural Livelihood Diversification in Malawi. Ph.D. Thesis. School of Development Studies. University of East Anglia. UK.

Long, N. 1989: Encounters at the Interface: a Perspective on Social Discontinuities in Rural Development. Wageningen Agricultural University. Wageningen, The Netherlands.

Long, N. 1992: Battlefields of Knowledge. The Interlocking of Theory and Practice in Social Science Research and Development. Routledge. New York.

Mangisoni, J.H. 2006: Impact of Treadle Pump Irrigation Technology on Smallholder Poverty and Food Security in Malawi: A case study of Blantyre and Mchinji Districts. Report to IWMI, Southern Africa Sub-regional office. Pretoria, South Africa.

March, J.G.1994: A Primer in Decision-making Theory. Wiley. New York.

Negatu, W. and A. Parikh. 1999: The Impact of Perception and Other Factors on the Adoption of Agricultural Technology in the Moret and Jiru Woreda (district) of Ethiopia. *Agricultural Economics*. Vol 21. pp. 205-216.

Orr, A., and B. Mwale. 2001: Adapting to Adjustment. Smallholder Livelihood Strategies in Southern Malawi. *World Development*. Vol 29. pp 1325-1343.

Pannel, D.J., G. Marshall, N. Barr, A. Curtis, F. Vanclay and R. Wilkinson. 2006: Understanding and Promoting Adoption of Conservation Practices by Rural Landholders. *Australian Journal of Experimental Agriculture*. 46. 1407-1424.

Rogers, E. 1995: *Diffusion of Innovations.* Free Press, New York

Scoones, I., 1998: Sustainable Rural Livelihoods: A Framework for Analysis, IDS Working Paper No. 72. Brighton.

Scoones, I. and Thompson, J. 1994: *Beyond Farmer First. Rural People's Knowledge, Agricultural Research and Extension Practice.* Intermediate Technology Publications. London.

Shah T., Alam M., Kumar M., Nagar R.K. and Singh M. 2000: *Pedalling Out of Poverty: Socio Impact of Manual Irrigation Technology in South Asia.* Research Report 45. Colombo, Sri Lanka

Sijm, J. 1997: *Food Security and Policy Interventions in Sub-Saharan Africa. Lessons from the Past Two Decades.* Thesis publishers, Amsterdam.

Takane, T. 2006: Risky Business: Smallholder Tobacco Production and Rural Livelihoods in Malawi. In: Takane, T. (ed): Current issues of Rural Development in Malawi. IDE. Chiba, Japan.

UNDP 2001: Development Report 1999. Oxford University Press: New York.

USAID 2006: Malawi Food Security Update, FEWSNET. Malawi.

Vedeld, P. 1990: *Household Viability and Change Among the Tugens - A case study of Household Resource Allocation in the Semi-Arid Baringo District*. *Nomadic Peoples*: No.25-27: pp.133-151.

Vedeld, P., E. Krogh, A. Vatn, 2003: Good Agronomy. A Social Institution among Norwegian Farmers. Paper presented at the XX Congress of the European Society for Rural Sociology. 18-22.8.2003. Sligo, Ireland. 29 pp.

Wiyo, K.A., R. Lunduka and P.C. Nalivata. 2002: *Impact Assessment of Treadle Pumps in Malawi*. Bunda College of Agriculture, Malawi.

World Bank 2006: Malawi. Country brief and Malawi Data Profile. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/MALAWIEXTN/0,,menuPK:355882~pagePK:141132~piPK:141107~theSitePK:355870,00.html