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ASSESSMENT OF ACCESS AND UTILISATION OF TREADLE AND HIP PUMP TECHNOLOGY AMONG WOMEN FARMERS IN MACHAKOS COUNTY, KENYA

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Abstract

The study purpose was to assess the access and utilization of the treadle and hip pump technology among women and low resource producer farmers in Machakos County, Kenya. The study was guided by Social Relations Framework of analysis by Naila Kabeer complemented by Diffusion of Innovations Theory. Experimental and descriptive research designs were used for qualitative and quantitave data. The study had 70 respondents comprising 42 pump buyers purposively selected and 28 pump non-buyers identified via snowball sampling. Convenience sampling was used for key informants. Data collection was done using questionnaires, interviews and focus group discussions. Quantitative data was analyzed using descriptive statistics and presented in tables and graphics as percentages and frequencies while qualitative data was collected through narratives, analysed and put into themes. Findings revealed majority of respondents used hand tools that were powered by human and or animals. The most preferred pump among buyers was the hip pump. Pump financing option preferred were cash at 24(58%), credit 15(36%) and savings at 3(6%). Lack of finances and poor rainfall identified as major challenges. The study recommends multi stakeholder financing strategies and water harvesting and storage strategies to enable the farmers acquire the pumps and benefit from their use.

Keywords: *Treadle and hip pump, Women access and utilization, Agriculture technologies*

INTRODUCTION

1.1 Background of the study

Globally, farming is perceived as a lucrative venture in regions with sustained fertility and water resources. For arid and semi-arid region, farming has been a difficult and expensive venture as irrigation projects are required to enable food security for both domestic and commercial use. For this reason, the need to develop more approaches that will improve farming in arid and semi- arid areas became a necessity for NGOs and government stakeholders (Ivers & Cullen, 2011). Regardless of this provision, the need to develop small-scale farmers required cheap farming technology that they could use in smallholder farms. This led to embracing of technology in the sector. One of the technologies is the treadle pump, which was developed in 1979 by a team working with the Rangpur Dinajpur Rural Service (RDRS). RDRS was an NGO working in northwest Bangladesh to meet what they perceived as a large, unsatisfied demand for manual irrigation pumps. The

treadle pump extracted larger volumes of water more than the existing hand-operated pumps. The design of the pumps targets the poor and those in remote areas with limited access to diesel and technical support (Purcell, 1997).

The use of technology, however, came in stages as initial ventures did not create a sustainable solution. For instance, the first treadle hip pump was operated manually. This made it hard for smallholder farmers to irrigate their farms frequently and effectively. It in turn led to the creation of more automatic means of irrigation. Global projects funded by NGOs majorly focus on equipping women with the knowledge and equipment to take on farming. This is influenced by the fact that women in arid and semi-arid areas are the worst affected by low food production and low economic status. In an argument by Ivers and Cullen (2011), women in arid areas have a major responsibility as home keepers as well as breadwinners and equipping them with advanced farming tool elevates their ability to play their domestic role.

Asia was the birthplace of the treadle pump. For this reason, the demand of the technology in rural Bangladesh was significant. Its popularity then increased its supply across neighboring nations including India and Pakistan. In these regions, the number of rural farmers was massive as they solely depended on agriculture for their livelihood. Both men and women in the regions were provided with treadle water pumps. NGO's involved wanted to increase the buying power of the consumer thus launching a purchasing plan that would fit the financial comfort of the farmers. The NGO's would provide pumps for irrigation projects as well as provide the pumps on credit to farmers prior to agreeing to a payment plan. Since the creation of the treadle pump in Bangladesh, 1.4 million pumps have been sold to the local farmers (Alistair, Islam and Gunnar, 1991). This depicts the importance of the affordable irrigation option.

In Europe, the number of small-scale farmer was slightly lower than that in Asia or Africa. For this reason, accessing the treadle pumps was not a desired mode for irrigation. However, small-scale farmers in Hungary and Poland realized the affordable irrigation option offered by the technology. Postel (2012) asserts that rural Hungary was highly populated with small-scale farmers who also supplied their products as well as retain some for domestic use. The use of diesel pumps made their irrigation cost massive thus minimized profits and production. After the introduction of the treadle pump, the demand was huge as both women and men opted for the affordable mode of irrigation. Postel (2012) points out that NGO's rarely focus on developing food programs in Europe due to the financial comfort of most of its dwellers compared to those in Africa and Asia. Therefore, the use of the treadle pump in the region was not massively embraced.

The hip pump is a Kickstart international (KSI) innovation of the small-scale irrigation pump in terms of improvement of terms body parts used to operate it, lighter weight and lower cost than the treadle pump. The use of the treadle and hip pump in Africa is massive as the continent is one of the greatest consumers of the product. The technology is mostly used in sub-Saharan Africa where there is availability of water for irrigation. In 1998, the International Development Enterprises began the marketing of the treadle pump in Africa citing the advantages of using the technology for small-scale farmers (Sijali & Mwago, 2009). The response was promising as both men and women enrolled in groups to access the pumps. The response was then boosted by the involvement of NGOs to increase food security in rural Africa. (KSI) mainly influenced the popularity of the technology in sub-Saharan Africa. The organization was born in Kenya, which increased the use of pumps in the country as well in East Africa. In the region, Tanzania and Kenya have fully embraced the opportunity presented by the technology. KSI has mostly focused on empowering women groups and increasing their financial security. From these efforts, the treadle and hip pump technology is being used majorly in Kenya, Tanzania, Malawi, Zambia, Mali, Burundi, Sudan, Burkina Faso, Uganda and Rwanda (Sijali & Mwago, 2009).

Machakos County is one of the 47 counties in Kenya and formerly part of the Eastern province where the climate is semi arid and the hip and treadle pump technology was marketed KSI/WSU team in 2014 to 2016, thus of interest to this study. The county experiences food shortage due to low production of food and low uptake of technologies. The goal of KSI/WSU was to offer the technology and purchasing plan fit to the financial comfort of women and low resource small-scale farmers and to do comprehensive marketing of the pumps to assure as many sales as possible. WSU/KSI study engaged farmers eligible to receive pumps using a criteria where a farmer was required to have access to appropriate land and water to irrigate their crops. The farmers were to purchase the pumps either on cash , credit or savings. The treadle pump cost Kshs.14950 while the hip pump cost Kshs. 9500 which farmers were expected to pay back within six months. Pumps were provided to individuals but on the basis of a group loan and repayment. Once pumps were distributed to the group members, the farmers were further taught how to use and maintain the technology.

This study sought to unveil how the farmers were accessing the KSI/WSU technology as well as utilizing the treadle and hip pump technology in their farms in Machakos County. The researcher engaged with women and low resource producer farmers who took up the KSI/WSU pump technology and those women and low resource producer farmers who did not take up the technology yet they had water available to irrigate their crops i.e. the non -buyers in the study. Key informants such as area chiefs, extension officers and KSI/WSU representative were also engaged in the study.

1.2 Statement of the problem

Like most parts of arid and semi areas in Kenya, scarcity of water for irrigating crops in Machakos County is a major problem yet agriculture is the backbone of Machakos County economy. Smallholder irrigation by subsistence farmers is mostly practiced using tools such as buckets and watering cans. The use of traditional tools is not only laborious but also in the semi-arid climate leads to hunger menace making residents to depend on '*mwolyo*' i.e. relief food. This also leads to a lot of suffering to women and children since Machakos County women, like the rest of rural Kenya play a major role in farming and act as household food managers.

Efforts by NGO's such Kenya Rainwater Association on the ground has taught the farmers on water harvesting and storage techniques. Other contributions by NGO's and the government include offering relief food when drought strikes or certified seeds and fertilizer subsidies. Despite these efforts, women continue suffering from hunger. Therefore, new technologies to address food shortage have become necessary to improve food security and economic status since the primitive tools and relief food is inadequate as it is applied only in times of emergencies. In addition, despite expansive land terrain and closeness to the various rivers, streams and rain harvested water; many female and low resource producer small-scale farmers in Machakos County remain poor and lack food security. Part of this problem could be attributed to lack of appropriate technologies for farming.

To address this problem, KSI/WSU introduced new irrigation technologies that would support them to irrigate crops better than with the use of traditional irrigation tools. These technologies introduced in 2014 are the treadle and hip pumps for small-scale irrigation for Machakos women and low resource producer farmers to be paid using 3 financial options; one was savings also known as mobile layaway, the second was credit also known as rent- to- own and the third was cash option. This is the reason why the researcher was interested in finding out how the women and low resource producer farmers have accessed and utilized the treadle and hip pump in Machakos County. The indicators and measurements for access of the pump were done through assessing the preferred type of pump, the finance option used to purchase the pump and the number of pump buyers against the number of people that the pump was marketed to in groups. Utilization of the pump was

measured by asking pump buyers whether they had used the pump and who used it since they bought their pump.

1.3 Objectives of the study

1.) The study established the technologies that were being used before introduction of hip and treadle pumps among women and low resource producer farmers in Machakos County.

2.) The study examined how women and low resource producer farmers are accessing and utilizing the treadle and hip pumps in Machakos County.

3.) The study identified the challenges facing women and low resource producer farmers when accessing and utilizing the treadle and hip pumps among women farmers in Machakos County.

4.) The study identified the best strategies that will enhance access and utilization of treadle and hip pump among women and low resource producer farmers in Machakos County.

LITERATURE REVIEW

2.1 Women and low resource producer farmers access and utilization of the treadle and hip pumps technology

According to Shah et al., (2000), the treadle pump developed in 1979 by a team working with the Rangpur Dinajpur Rural Service (RDRS), an NGO working in northwest Bangladesh ensured access of the pump through providing a 50% subsidy to farmers on the purchase price. However, further increases were limited by production capacity, the lack of a nationwide sales network, and the fact that a short supply chain from the manufacturer to the customer did not use the promotion potential of retailers. This study seeks to establish whether the network created by KSI/WSU marketing network of salespersons and dealer networks retailers improved the access to and utilization of the treadle and hip pump technology.

Farrington & Lewis (2014) cited that in Asia, NGOs have pioneered many of the initiatives subsequently incorporated in public sector extension services. NGOs continue to play a lead role in ensuring that women farmers and women on the farm receive training, information, and improved technologies. Their services often are increasing in scope and scale, either as complementary support to government efforts or to fill the gaps created as government expenditures and capabilities decline. An important emphasis highlighted in NGO programmes is their support for membership-based community and farmer organizations (Lwoga and Stilwell, 2011). Women as well as men benefit from the expanding opportunities to develop farmer-to-farmer extension and training networks and to form partnerships with agricultural researchers and development agencies in Tanzania. In Kenya and largely Africa, poor women in rural areas have widely benefited from NGOs projects.

A similar study by Adeoti et.al (2007) on access and utilization among adopters and non-adopters of treadle pump (TP) in the Volta and Ashanti regions of Ghana showed that some farmers, stopped the use of the TP, mostly because it broke down and could not be used over large extents of time. Almost all the adopters in this study were men, with less than 2 percent being women. This study sought to unveil how the program directed to women and with a dealer network to repair the pumps would turn out.

During utilization, men are responsible for the procurement, operation and maintenance of the pumps. They pedal while women assist with water distribution. Kamara et al., (2004) observed that the difficulty for women to operate the pumps has cultural dimensions. Pedaling the pump with an up-and-down leg motion while being elevated above the ground makes women feel uncomfortable and undignified, particularly in the presence of

men. This however contrasted with the situation in Kenya where pumps are purchased by men but are mostly managed by women who hire young men to operate them Brabben & Kay (2000). This study sought to establish whether there was a cultural dimension that would hinder the access and use of the pump technology in Machakos county since the project was mainly for women.

A similar study in Malawi by Kamwamba-Mtethiwa (2012) as part of their irrigation strategy, the government and non-governmental organizations (NGOs) in Malawi actively promoted the use of treadle pumps in smallholder irrigation. Analysis of the adoption dynamics and dissemination approaches of treadle pumps showed indicated differences between male and female adopters. Female adopters were more likely to pay for subsidized treadle pumps in cash. Male adopters mostly acquired their pumps through a loan. This study sought to unveil how women farmers would utilise the 3 financial options among the study participants.

In most parts of sub-Saharan Africa, farming for economic income is determined by the ease at which credit and finance is made available for farmers. In an argument by Ivers & Cullen (2011) the poverty level in the region is mostly influenced by the inability of emerging entrepreneurs to access finance and credit. The same problem could be said to be affecting poor women in rural semi-arid areas. In these regions, the access to banking services in rural areas is limited thus the poor financial and credit access for women. Financial structures in rural regions are weak thus banks neglect the areas due to the high risks involved.

The illiteracy level in women in rural Sub-Saharan region is high which minimizes their ability to be able to seek finance from banks. Ivers & Cullen (2011) assert that women tend to be less attracted to credit and finance due to poor education in the field as well as their overreliance to the traditional approaches to farming. The authors further assert that this has limited the entrepreneurial abilities for women in rural areas (Ivers & Cullen, 2011). With proper education, the tendency by women to access finance and credit would increase significantly. The education strategy should include giving women education on the benefits of increasing their investment in farming. McComb et al., (2014) in a study found out that finance was also a key constraint: a motorised pump of $250 may be relatively 'low cost' but is still unaffordable to many farmers. Microfinance services are either unavailable in rural areas or have been unwilling to provide agricultural loans.

To evade the problem on financial constraints, women in Kenya, especially in rural regions, come together into groups in which they can access loans or get sponsorships. Women in these groups face a less complicated task of coming up with capital to launch their farming ventures. This is because they share the investment cost and it becomes less demanding for individual women. NGO findings and projects are also attracted towards women groups more than individuals. For instance, the Kick-start project across Africa target women in groups because they can easily contribute to the required capital within the desired period of time. KSI has been significant in providing women with the treadle and hip pump tools. The tools are not expensive for women in a group. In addition, accessing financial aid from institutions has also become easier as the investment is more secure. Women in groups also provide different ideas on how to approach their farming desires. The pool allows for the division of labor and specialization within the group. In this structure, other leadership position such as the treasury and sourcing can be created without minimizing the input on the farm (KSI 2015). This study sought to assess how women and low resource producer farmers in groups were accessing and utilizing the pump technology that KSI/WSU was marketing in Machakos County and whether being in groups relieved individual financial burden.

The greatest challenge for accessing the treadle and hip pumps in rural Machakos in Kenya is the lack of finance for emerging women small-scale farmers. In an argument by Olielo (2013) the implementation on new farming technique is costly especially for women in no income. The treadle hip pumps are in great demand for

poor women in rural areas. The cost of each pump is too expensive for these women. The financial problem is further worsened by the fact that financial institution fail to provide these women with loans to service their farming needs. Most financial institutions demand for security in form of property, amenities that poor women lack. For this reason, women have to rely on sponsorship or NGO related programs in order to acquire the treadle pumps. For instance, KSI provides a financial solution when women form a group. The group is then provided with financial assistance as well a structure loan repayment method (KSI 2012). Considering that KSI/WSU had provided financial arrangements for the women farmers in the study area. This study sought to unveil whether with the education and finance options to purchase the pump given to women and low resource producer farmers by KSI/WSU improved their access to and use of the treadle and hip pump technology in Machakos County.

2.2 Theoretical framework

The study was guided by two theories namely; Social Relations Framework by Naila Kabeer (1994) and Diffusion of Innovations Theory by Rogers (1983).

2.2.1 Social Relations Framework

The study was guided by Social Relations Framework by Naila Kabeer (1994). The key tenets of the framework include an analysis of how existing gender discriminations and inequalities are created, maintained and reproduced in institutions (i.e. the state, the market, the community and family/kinship) with the aim to involve women in their own development solutions. The framework uses five concepts to analyse gender inequality these are; development as increasing human well being, social relations, institutional analysis, institutional gender policies, and immediate, underlying and structural causes.

In this study, the framework analyzed the 5 concepts in the light of distribution of resources such as water, availability of labour and financial services in relation to pump access and utilization. The study also analyzed the relationships between people in pump access and utilization and how the relationships were reworked through the four institutions of the state, the market, the community and family/kinship for overall outcome of human well-being as the final goal of development from use of the pump technology. The theoretical framework therefore entailed looking at how these institutions create, maintain and reproduce inequalities in the access and utilization of treadle and hip pump technology among women and low resource producer farmers in Machakos County.

2.2.2 Diffusion of Innovations Theory

The study also employed the Diffusion of Innovations Theory by Rogers (1983). This second theory was important since it complemented the Social Relations Framework by Naila Kabeer (1994) which gives a political rather than a technical or informational solution. Diffusion of innovations theory key tenets of the theory are the five stages of an innovation life cycle that a product undergoes upon introduction to a new market. The theory explains how, why, and at what rate in the 5 stages a product spread in the influence of four main elements i.e. the innovation itself, communication channels, time and social system. In his theory on Diffusion of Innovations, Rodgers the distinguishes the five stages of an innovation life cycle in which the product might find itself with five different user groups i.e. the innovators, early adopters, early majority, late majority or laggards that accept the product or idea. Depending on the stage of the product, several adjustments take place e.g. much or little promotion or a high or low sales price.

In this study the treadle and hip pump technologies and the financial options of payment were innovations to be adopted and was used by KSI/WSU to market their product to women and low resource producer farmers

in Machakos county between 2014 to 2016. Rogers argues that diffusion is the process by which an innovation is communicated over time among the participants in a social system. In this study, the innovation was implemented among women and low resource producer farmers in Machakos over a period of 18 months through KSI/WSU sales person. This study sought to explain how, why, and at what rate the pump technology innovation was adopted with regard to the stage of the innovation itself, communication channels, time and social system among women and low resource producer farmers in Machakos county.

3.0 RESEARCH METHODOLOGY

The study used experimental and descriptive research designs for both qualitative and quantitave data. The target population for the study was the buyers and non-buyer women and low resource producer farmers in 132 farmer groups which had been marketed to sale of the treadle and hip pump by KSI/WSU representatives between 2014 and 2016 in Machakos County. The study had 70 respondents comprising 42 women and low resource producer farmers who were pump buyers purposively selected for the study and 28 pump non-buyers identified via snowball sampling method. Convenience sampling was used to sample the key informants i.e. chiefs, extension officers from various wards and KSI/WSU representative in the county. The study's data collection was done using guided questionnaires, interview schedules and focus group discussions. The study's quantitative data was analyzed using descriptive statistics and presented in tables and graphics as percentages and frequencies while qualitative data was collected through narratives during interviews, analysed and accordingly put into themes.

4.0 FINDINGS AND DISCUSSION

4.1 Access and utilization of treadle and hip pump technology

The study sought to find out how farmers in Machakos County are accessing and utilizing the treadle and hip pump technology. Study participants were asked to give responses in relation to systems required to enable access and utilization of the treadle and hip pump technology. The systems required for access and utilization of the pump are buyers of pump, type of pump, mode of payment, access to M-Pesa and other financial services, adoption rate and source of information of the treadle and hip pump, average distance to where the farmer can get the pump, water and labour.

4.1.1 Buyers and non buyers of the treadle and hip pump by farmers

The first question on the access to and utilization of treadle and hip pump technology sought to determine how many were buyers and non -buyers of the treadle and hip pump in the study. The findings are as illustrated in Figure 4.1 below;

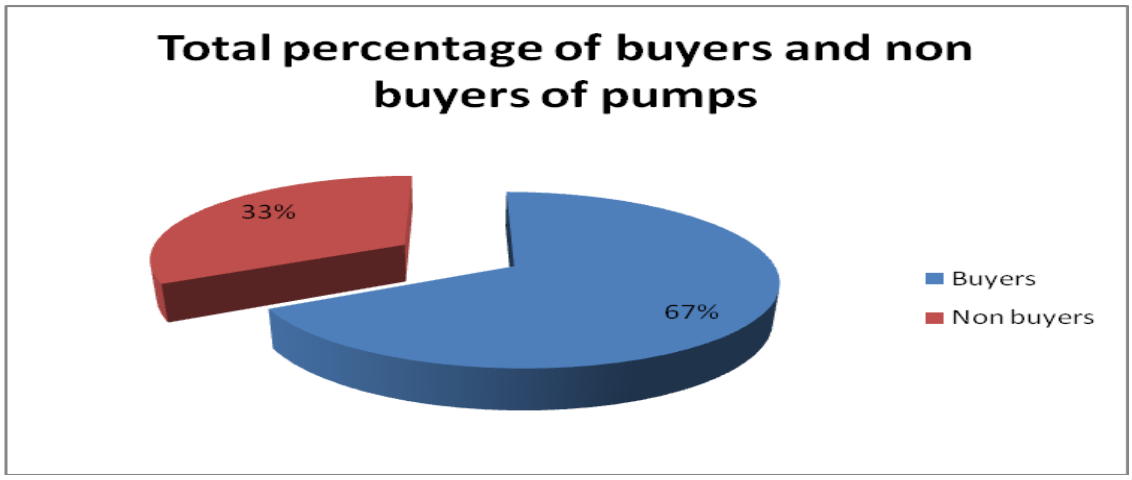

Figure 4.1: Pump buyers vs non buyers

It was established that most participants were buyers represented by 42(**60%**) response level while 28(**40%**) were non-buyers of the pumps. The large number of buyers and low number of non-buyers can be attributed to lack of water for irrigating their crops and for some non-buyers, they had other forms of pumps as given in some interview responses;

"Our type of soil is poor and does not retain water for long. This year it was worse since there was hardly enough rain" (Interview with a pump non buyer in Kabaa area. 8/02/2017)

"The pump cannot draw water more than 7 metres deep and mine is always lower than that'(Interview with a pump non buyer in Mwala area. 8/04/2017)

'I have a gas pump and did not see the need to buy a manual pump' (Interview with a pump non buyer in Kabaa area. 8/02/2017)

4.1.2 Type of pump preference

The second question on access to and utilization of treadle and hip pump technology sought to determine which type of pump between the treadle and hip pump was preferred among the pump buyers. Figure 4.2 below demonstrates the outcome.

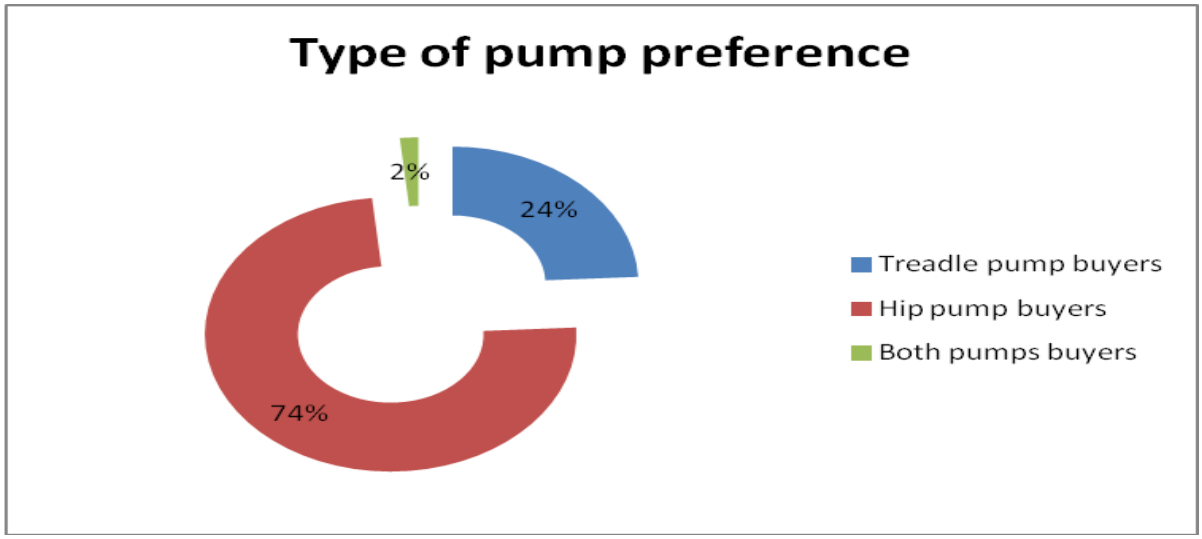

Figure 4.2: Type of pump preference

As from the Figure 4.2 above, majority of respondents bought the hip pump 31(**74%)** whereby the pump was cheaper than the treadle pump. 10(**24%**) chose a treadle pump and only 1(**2%**) had both pumps. In comparison, there was statistically significant relationship between the choice of treadle pumps and the less expensive hip pumps by gender. More women bought a hip pump than men among the pump buyers. The results are in line with diffusion of innovations theory where an innovation is required to be easily affordable for it to be adopted. The pump marketer should therefore consider making a cheaper but effective pump.

'We preferred the hip pump since it was cheaper than the treadle one' (FGD discussion response with a pump buyer at Kithimani 15/4/2017).

4.1.3 Mode of pump payment preference

Question three on access to and utilization of treadle and hip pump technology sought to find out the mode of pump payment preferred by the pump buyers in the study. The findings are as illustrated in Figure 4.3 below;

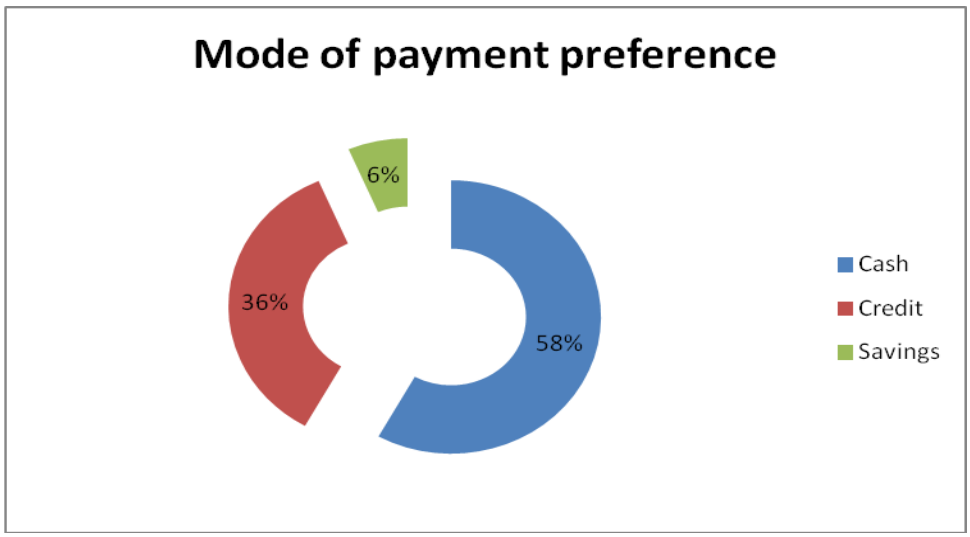

Figure 4.3: Pump payment plan

On the mode of payment for the pump technology, majority of the respondents purchased their pump through cash payment 24(**58%**), while credit and savings mode of payment were at 15(**36%**) and 3(**6%**) as shown in the response rate. The above trend could be attributed to the immediate benefits of acquiring the pump. On one hand, purchasing the pump on cash and on credit ensured the farmer had the pump at hand hence the motivation to use it. On the other hand, opting to purchase the pump through saving towards owning it made the benefit of having the pump not being immediate and visible which lead to some farmers who had registered to purchase the pump using saving option to pull out at some point.

This also concurs with study in Malawi by Kamwamba-Mtethiwa (2012) where female adopters were more likely to pay for subsidized treadle pumps in cash and male adopters mostly acquire their pumps through a loan.

"*I opted out since it was taking too long to get the pump and I had problems with money. I decide to be refunded what I had contributed and wait until I get enough money to buy a pump"*(Interview with a pump non-buyer at Masinga 18/3/2017).

"*There was no rains and those who enrolled resorted to hunger first resolution'(*Questionnaire guide with KSI/WSU representative 20/4/2017).

The pump payment plan was in itself an innovation, diffusion of innovations theory recommends that an innovation should give options to its access. In this study, the respondents preferred cash option compared to savings and credit options in acquiring the pump. Social relations framework is also reflected in the choice in mode of payment, those with available cash were able to pay and have the pump while those without even pulled out of the pump ownership process. This was also heightened by the period of lack of rains which made farmers opt to deal with hunger situation first as justified by KSI/WSU key informant above.

4.1.4 Access to M-Pesa and other financial services opportunities

The fourth question on the access to and utilization of treadle and hip pump technology sought to determine how many respondents had access to M-Pesa and other financial services opportunities. Table 4.1 below illustrates the outcome.

Table 1: Access to and utilization of MPESA and other financial services

Response		
	Yes (%)	**No (%)**
M-Pesa used to purchase your pump	28(**66.7**)	14(**33.3**)
Household members took loans, borrowed cash or received in-kind transfers	38(**54.3**)	32(**45.7**)
Member of "Merry-Go-Round" savings club	62(**88.6**)	8(**11.4**)

Use of M-Pesa and experience with Merry-go-round savings groups was an important aspect to study in this research. The farmers were expected to use M-Pesa to make payments towards their pump purchase. Their saving trends were also to play part in the process of acquiring the pump since they were key determinants of how much debt they can access through financial service institutions.

28(**66.7%**) of the respondents answering this question said they used M-Pesa to purchase their pump while 14(**33.3%**) used cash to purchase their pump. Informal discussions with respondents revealed that many of them used 'Merry-Go-Round" savings clubs 62(**88.6%**) to purchase some of their most expensive assets such as water tanks.

"I used merry go round to buy a water tank and household goods" (FGD response by a pump buyer in Masinga 18/4/2017).

Asked whether any household members took loans, borrowed cash or received in-kind transfers, 38(**54.3%**) of participants responded with a 'yes' while 32(**45.7%**) said 'no'. In most parts of sub-Saharan Africa, farming for economic income is determined by the ease at which credit and finance is made available for farmers. The study confirmed an argument by Ivers & Cullen (2011) that the poverty level in the region is mostly influenced by the inability of emerging entrepreneurs to access finance and credit. The same problem could be said to be affecting poor women in rural semi-arid areas. In these regions, the access to banking services in rural areas is limited thus the poor financial and credit access for women. Financial structures in rural regions are weak thus banks neglect the areas due to the high risks involved. These was also found by McComb et.al., (2014) in a study where he found out that finance was also a key constraint: a motorised pump of $250 may be relatively 'low cost' but is still unaffordable to many farmers. Microfinance services are either unavailable in rural areas or have been unwilling to provide agricultural loans.

However, commenting on the illiteracy level in women in rural Sub-Saharan region is high which minimizes their ability to be able to seek finance from banks. The study concurred with Ivers & Cullen (2011) assertion that with an education strategy giving women education on the benefits of increasing their investment in farming would increase their access and utilization of technology. Participants in this study had undergone intense education about the pump technology. However, there were other challenges to their access and utilization of the technology other than education about it. The major one being source of funds to purchase considering their income level and lack of knowledge on how to finance a loan.

'The reason why I have never taken a loan is because I fear debts and my property to be auctioned, I have seen this happen with KWFT' (Interview with Kyalo a non-buyer from Mwala 8/4/2017)

Respondent's ability to use M-pesa services and access to financial services reflect on the social relations framework aspect where inequalities in access to resources at family level are reflected in institutions such as the market. In this case, access to financial services was a platform that seemed to lack. Use of merry go round group only means one gets the same amount of cash they have contributed to the kitty over a period of time.

4.1.5 Adoption rate and source of information of the treadle and hip pump.

The fifth question on the access to and utilization of treadle and hip pump technology sought to determine the adoption rate and source of information of the treadle and hip pump among the respondents.

Ninety six percent 67 (**96%**) of farmers reported that they would want to be the first to use a technology as compared to 3(**4%**)who would want to wait until they see another person use it first so that they can use it. Diffusion of innovations theory by Rogers (1983) proposes that four main elements influence the spread of a new idea; the innovation itself, communication channels, time and social system. In this study, the treadle and hip pump irrigation tools, by far the most important source for information among both buyers and non buyers of the pump was the vendor at 50(72%) response rate. This result identified a major challenge to acceptance of credit and savings mode of payment for the pumps. Cash sales are made directly from a vendor but this is not the case for credit or savings sales which are the result of interaction between a marketer and the potential buyer. 50(72%) of the owners rely on the vendor as their most useful information source but neither credit nor savings buyers have a direct seller/buyer relationship with a vendor at purchase. It was therefore difficult for the latter to access important information on product improvement, operation and maintenance. New technology information which could improve utilization of the pump may therefore not be available to the credit and savings buyer if there is no formal link with the vendor until a challenge arises.

According to FGD response;

'*Payment time for the pump to some farmers was too short, again KSI/WSU did not follow up, they came, left and never came back'* (FGD participant response at Kyumvi 15/2/2017)

The above confirmed that communication channel partly contributed to poor adoption of the pump technology. It also deduced that contrary to Ragasa (2014) in her study that examined the experience of programs and projects that aim to increase women's access to extension services through use of digital devices as a source of information and education on farming practices. In her study technology such as radio and television channels broadcast farming programs that are guided by professionals in the field were used, however, small-scale women and low resource producer farmers in Machakos county were expected to use mobile phones to pay towards their pump purchase. The platform was not interactive. For instance in Western Kenya, one extension agent has to cater to farming needs more than 20 women (World Bank, 2011). With short messages, they could able to help the women without their physical presence.

'*Lack of real time interaction between the payment channel and the pump purchase did not give a personal feel to the buyers. Pump marketers should therefore consider blending various media channels such as radio and television together with an interactive short message platform.' (*Interview with a communication student and pump buyer in Mwala 8/4/2017).

4.1.7 Average distance from home to pump access location

The seventh question on the access to and utilization of treadle and hip pump technology sought to determine the average distance from the home of respondents to treadle and hip pump access location among the respondents. Table 4.2 demonstrates the responses.

Table 4.2 Average distance in kilometers from respondents' home to pump access location

Average distance in kilometers from respondents' home to pump access location	**Buyer**
To town market	65.8 Km
To local market	56.7 Km
To pump owner	39 Km
To pump vendor	92 Km
Total average distance	87.6 Km

The average distance from farmers location to the town and local market, pump vendor and owner was 87.6 km. The above average shows that the distribution of pumps is not even. The above information also confirms Naila Kabeer's Framework on how the market community and state synergy can bring disparities for women to access and utilize the technology. Distance from one pump owner to the other also showed how hard it was for a farmer to access a pump in the community even if they decided to share. This was further aggravated by the experimental part of the research where WSU/KSI ensured that there was a 15 km distance between the 3 different treatments of cash, credit or savings mode of pump purchase. The researcher in this study encourages development strategies that would reduce the distance and improve on even distribution of the pumps among women and low resource producer farmers in Machakos County. This is because traveling is difficult due to inaccessive roads, poor means of transport which challenges the access to pumps. The strategies include but are not limited to creating a model that will encourage purchase and sharing of pump among farmers who are near each other, including more pump vendors and encouraging sales people to increase contact time with the farmers.

4.1.8 Access to water for utilization with treadle and hip pump

The eighth question on the access to and utilization of treadle and hip pump technology sought to determine the accessibility of water for use with the treadle and hip pump the respondents. Table 4.3 demonstrates the responses.

Table 4.3: Rainfall status in 2015 to 2016

Rainfall	**2015 % of Respondents**	**2016 % of Respondents**
Normal	17(**24.2**)	30(**42.9***)*
Above Normal	2(**2.9**)	25(**35.7**)
Below Normal	51*(***72.9***)*	15(**21.4**)
N	70	70

Access to water is part of infrastructure required to determine whether a farmer could utilize the pump since use of the pump goes hand in hand with availability of water. During the period of the KSI/WSU study, buyers and non-buyers were experiencing difficult rainfall conditions with 51(**72.9%**) of participants responding that rainfall was below normal until the short rains of 2016 when normal or above normal rainfall patterns predominated. This, without question, resulted in low adoption of the pump technology since there was no enough water for irrigation and people resorted to dealing with hunger first. In addition, the poor rainfall conditions and short period for the famers to use their newly acquired irrigation equipment had an impact on data generated during the study period since there was no enough water to irrigate their crops.

4.1.9 Utilization of the pump and availability of labour

The ninth question on the access to and utilization of treadle and hip pump technology sought to determine the availability of labour to operate the treadle and hip pump among the respondents. Figure 4.4 demonstrates the outcome in percentage of time used physically by gender as given in terms of the respondent's perception.

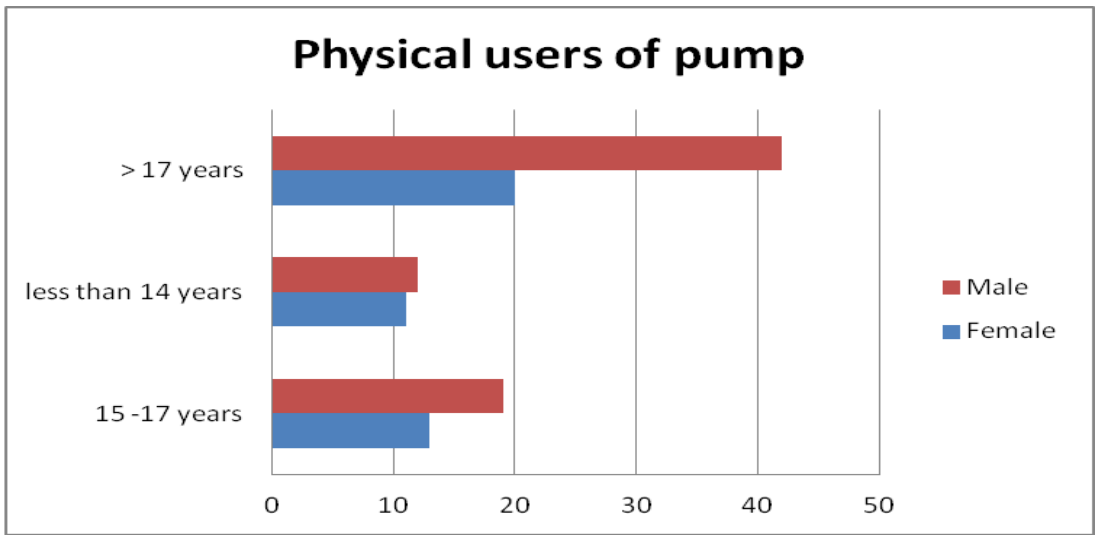

Figure 4.4: Physical users of pump

All pump buyers reported to have used their pump for at least one time. Although both female and a male might have used the pump at once, it was perceived that men used the pump more than women since men are involved in operation and maintenance as they pedal while women distribute water using pipes. It was evident from the above table that more males than females were involved physically when utilising the pump.

This also implies that the innovation itself i.e. the treadle and hip pump is likely to be suitable where there are males with physical energy to operate it than women.

'It is tough using the pump' (Interview with Ann a buyer from Maavuni17/4/17)

Although during a study by Kamara et al., (2004) on pump utilization saw men responsible for the procurement, operation and maintenance of the pumps, there was no cultural dimensions in use of the pump in Machakos county.

Despite having economically productive persons from the demographic characteristics of study respondents, 45(**64.3%**) also reported to have no enough labour in their homes for use of the pump and had to hire a person to help thereby adding cost of using the pump while 25(**36%**) reported they had enough labour. This however

concurred with (Brabben and Kay 2000) study in Kenya where pumps are purchased by men but are mostly managed by women who hire young men to operate them.

This posed an inequality in distribution of labour as in the social relations framework where people and their responsibilities in the activity of use of pump technology was not only unequal at family level but also in the market in form of pump innovation.

"KSI needs to come up with a high performance gender neutral pump that can be used without maintenance irrespective of intensity of use and terrain it is operated" (Questionnaire guide with an extension officer at Mathingau 15/3/2017).

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

This section contains the summary of key findings of the study on access and utilisation of treadle and hip pump technology among women and low resource producer farmers in Machakos County.

The study sought to find out the access and utilization of the treadle and hip pump among women and low resource producer farmers in Machakos. Although there was education and intensive marketing and education among the farmers by KSIWSU team, the study found out that;

- Pump buyers were represented by 42(**60%**) of respondents in the study while 28(**40%**) represented non-buyers of the pump in the study.
- The most preferred type of pump among pump buyers was the hip pump over the treadle pump. 31(**74%**) of buyers bought the hip pump, 10(**24%**) of pump buyers bought the treadle pump while 1(**2%**) bought both pumps. The hip pump was preferred to the treadle pump since it costs cheaper.
- The mode of payment preferred by study participants was cash at 24(**58%**), credit 15(**36%**) and savings at 3(**6%**). Cash and credit modes of payment were preferred more than savings mode of payment since the former guaranteed immediate use and benefits of the pump compared to the latter where one had to wait until payment is done to possess the pump. This also concurs with study in Malawi by Kamwamba-Mtethiwa (2012) where female adopters were more likely to pay for subsidized treadle pumps in cash and male adopters mostly acquire their pumps through a loan.
- Poor rainfall and lack of food made some study participants to withdraw from paying for the pump and opted to pull out and deal with hunger issues first.
- Out of the 70 respondents, 62(**88.6%**) were members of merry go round. Above half of the study respondents 38(**54.3%**) had taken loans, borrowed cash or received in-kind transfers while slightly below half 32(**45.7%**) had never taken loans, borrowed cash or received in-kind transfers. This was due to their economic status and inability to do so since they were required to have collateral that they did not have.
- 67(**96%**) of the respondents said they preferred to be the first to use the pump while 3(**4%**) preferred to be the last to use the pump. This proved the point that most respondents were either early or late majority in the five stages of diffusion of innovation theory.
- The main source of information about pumps was the vendor with 50(**72%**) responding that they got information from vendors. The average distance from a farmers land to the point where they could

buy a pump or its spare parts was 87.9 kilometres. Findings also showed that distribution of pumps among farmers was uneven and the roads were inaccessible especially when it rained.

- Adequate and accessible water availability was a problem during the study period since 51(**72.9%**) of respondents reported that rainfall in 2015, 2016 was below normal until late 2016 when there were short rains.
- 38(**54%**) of respondents had rivers or stream as a source of water while the others depended on dams and wells which were seasonal and would go dry after a short period when the rains stop.
- 45**(64.3%**) gave labour as a challenge to them where some had to hire someone to help them use the pump hence incurring another cost.

5.2 Conclusion

From the findings above, this study concludes that access and utilization of the treadle and hip pump technology among women and low resource producer farmers fell short of the intended results of having the technology adopted to a level that would accelerate to a near tipping point in Machakos county. Access and utilization of the treadle and hip pump technology among women and low resource producer farmers was also expected to be high considering the education and financial innovations given to enable purchase of the pumps among women and low resource farmers in Machakos county to purchase and use them. However, other barriers abound the pump technology adoption using the financial innovation. The infrastructure that comes with it i.e. water, finances, labour, time of pump repayment, priorities in a family, source of information about the pumps and distance to point of purchase of the pump were also critical.

5.3 Recommendations

From the foregoing conclusions above this study recommends the following to support women and low resource producer farmers in arid and semi arid areas to access and utilize treadle and hip pump technology. Both buyers and sellers of the pump innovation to consider of all aspects that come with the pump for it to work effectively. These include water harvesting and storage points, avenues of accessing loans, information source about the pump and labour to operate for it to be successfully adopted. Pump marketers can also find a solution through working with other stakeholders and adjustment of pumps to a high performance gender-neutral pump.

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