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Adoption of in-field rainwater harvesting: Insights from smallholder farmers in Raymond Mhlaba Local Municipality, Eastern Cape Province, South Africa

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ABSTRACT

The in-field rainwater harvesting technique (IRWHT) has been widely promoted for the sustainability of crop production, particularly in naturally water-stressed regions. It is a technology developed to harvest rainwater that could be put into efficient use for farming. The technology was a product of collaborative efforts of the *Institute for Soil, Climate and Water (ISCW) of the Agricultural Research Council (ARC) and University of Fort Hare (UFH). The technology was piloted in several villages under Raymond Mhlaba Local Municipality (RMLM) from 2004 to 2012. Sixteen years after the introduction of the technology, the study examined the sustainability use of the technology amongst the adopters from the Tyhume valley* area. *The quantitative methodological approach was used for this study and simple random sampling technique was used to select 150 project respondents for the survey. Data was collected and analysed using Statistical Package for Social Science. Descriptive statistical analysis, frequency count, percentages, means and standard deviation were used for quantitative data analysis. Findings revealed that 96% of smallholder farmers discontinued the use of IRWHT, with the majority abandoning the technology 5 to 8 years post adoption. Amongst the reasons adduced by the respondents include complexity of the technology, space taking up by the technology for water retention/ storage and time to construct the basins. The*

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technology was labour intensive, time consuming and requires lots of inputs. Findings also indicate that farmers experienced poor support after the pilot stage. The study recommends efficient and effective monitoring and evaluation of projects post pilot stage to consolidates adoption process.

KEYWORDS: Post-adoption; Dis-adoption; Perception; Technology attributes; Extension support

1. INTRODUCTION

South Africa has continued to be a drought prone and water stressed region (Department of Agriculture Forestry and Fisheries [DAFF], 2015). The average rainfall in the country is 450 mm per annum, which is well below the world average of 860 mm per annum (Department of Water and Sanitation [DWS], 2015). In the Eastern Cape (EC) province, the water crisis has been found to be deepening as the dam levels across the province are dropping drastically (Spies, 2018). According to Ndhleve, Nakin and Longo-Mbenza (2017), the EC has been regarded as both an arid and a semi-arid climate zone, receiving 550-700 mm of rainfall per year. As a result, water scarcity is profound in the province; and, these water shortages directly affect the agricultural sector (El Chami & El Moujabber, 2016). The largest water consumer in South Africa is the agricultural sector, which consumes 70% of rainwater to produce food (Baiyegunhi, 2015). The majority of smallholder farmers in the EC province of the country are resource-poor and largely dependent on rain-fed agriculture (Shange, 2015); and, rain-fed agriculture is one of the sectors most vulnerable to climate change (McCosh et al., 2017). As such, smallholder production is primarily characterised by high on-farm losses and low productivity (Kijine, Randolph & Molden, 2007; Christian, Obi & Agbugba, 2019). The continuous heavy reliance on rain-fed agriculture indicates that sustainable production in the region may be threatened especially as recent climate change events have further heightened production threats. Increasing inconsistent rainfall patterns induced by climate change could exacerbate the production practices of smallholder farmers. Irrigation practices could therefore be critical to their sustainable production (Njoko & Mudhara, 2017).

Water shortage is a prevalent production shortfall in the EC province with little or no back-up irrigation (Khapayi & Celliers, 2016). Smallholder irrigation would imply increase for on-farm water availability and reservoirs for rainwater harvesting for farmers in remote areas (El Chami

& El Moujabber, 2016). However, the majority of the smallholder farmers are poor and unable to pay for more advanced agricultural tools to extract and conserve water (Ngaka, 2012; Khapayi & Celliers, 2016). In an attempt to address the water scarcity affecting the province, the Institute for Soil, Climate and Water (ISCW) of the Agricultural Research Council (ARC) and University of Fort Hare (UFH) implemented the IRWHTs (Hlanganise, 2010; Welderufael, Woyessa & Edossa, 2013). Khayalethu, Guquka, Giltton, Sompondo, and Mpundu villages in Raymond Mhlaba Local Municipality, which has an average rainfall of 571.01 mm, benefited from the IRWHT project funded by the Water Research Commission (Hlanganise, 2010). According to Shange (2015), the project was birthed as a solution to water scarcity impeding smallholder farmers' production in the region. It was a five-year phased project implemented between 2004 and 2012 (Hlanganise, 2010; Monde *et al.*, 2012; Shange, 2015). Execution of the project was done with the support of the Department of Rural Development of Agrarian Reform (DRDAR) which provided diverse extension support services for the project (Botha et al., 2014).

A variety of literature (Joseph & Botha, 2012; Binyam & Desale, 2015) has noted the gains in using IRWTH, particularly increased productivity, household income and food security. Therefore, the adoption of IRWTH is critical. Smallholder farmers, however, tend to adopt an innovation but later discontinue the use of it (Anaeto, 2016). The general aim of this study is to determine the smallholder farmers' perception of the adoption or dis-adoption of the in-field rainwater harvesting technology in Raymond Mhlaba Local Municipality (RMLM). Specifically, this study aimed to assess (1) the rate of use of IRWTH amongst smallholder farmers in the study area; (2) perceived attributes of the technology; and, (3) level of extension support provided for effective adoption

2. METHODOLOGY

2.1 Study area and research design

The study was conducted in Tyhume valley which is in Raymond Mhlaba Local Municipality (RMLM). RMLM is a category B municipality (Area: 6 357 km^2) situated in the Winterland of the Eastern Cape under the jurisdiction of the Amathole District (Raymond Mhlaba Local Municipality [RMLM], 2017). Raymond Mhlaba is a rural municipality whose economy is largely driven by the agricultural sector (RMLM, 2017). The quantitative methodological approach was used for this study. Kothari (2004) argued that descriptive research design refers to a design suitable for describing information, data, events perception, and issues

2.2 Sampling procedure and sample size

The purposive selection of Khayalethu, Gilton, Guquka, Sompondo and Mpundu villages in the Tyhume valley of the RML Municipality was done on account of the implementation of the IRWHT project for smallholder farmers in these localities. The population of study comprised smallholder farmers who had participated in the implementation of the IRWHT project. A list of the project beneficiaries was obtained from DRDAR from which the sample size for the survey was drawn. A total of 238 smallholder farmers were listed as adopters of IRWHT in the study area. Yamane's (1973: 258) statistical formula $n = \frac{N}{1+(e)2}$ Where: n = required responses; e^2 = error limit; N = population size; Error Limit = ± 5% was then used to determine the study's sample size $n = \frac{288}{1+(0.05)2}$ = 150

Therefore, 150 participants were sampled. A simple random sampling technique was then used to select 150 project participants for the survey.

2.3 Data collection and analysis

Data was collected using semi-structured questionnaires consisting of closed and open-ended questions. The statements in questionnaires were reviewed using face validity while a pre-test for reliability was carried out in Krwakrwa village, which also benefited from the IRWHT initiative but was not included in the study. The Cronbach internal consistency coefficient was used to measure the reliability of the survey instrument. The derived score (α = 0.78) showed that the instrument was fit enough to be used as an instrument for the main data collection. Primary data was coded and imported from excel to the IBM Statistical Package for Social Science (SPSS), software version 23 for data analysis. Simple descriptive statistical tools were used to describe the demographic profiles of the respondents, the use of IRWHT and level of extension support provided for effective adoption. Mean scores were used to present results of the perception of respondents to the attributes of IRWHT on a five-directional Likert scale of 'Strongly Disagree' = 1, 'Disagree' = 2, 'Uncertain' = 3, 'Agree' = 4 and 'Strongly Agree' = 5. A computation of individual and overall mean scores was determined [(1+2+3+4+5) /5+0.5)] = 3.05. Therefore, smallholder farmers' perceptions with mean scores greater than or equal to (≥) 3.05 were considered to have positive perceptions towards the technology, while those with mean scores lower than (<) 3.05 were adjudged to have negative perceptions towards the technology.

3. RESULTS

3.1 Demographic profile of respondents

The majority (66.7%) of the respondents were females; about 44% of respondents had obtained secondary education and 36.7% were dependent on an old age pension.

3.2 Rate of use of IRWTH amongst smallholder farmers

Results showed that 96.0% had discontinued using IRWHT to irrigate their farmlands while only 4.0% indicated they still used the technology, albeit sometimes. The period of use indicated that the majority (58%) had discontinued its use after 5 to 8 years while just about 3.3% had the technology running for more than 12 years. While an analysis of the reasons for discontinuing the use of IRHWT in study area revealed that 23% of the respondents cited land as the key reason for discontinuance (Table 2).

Table 1: Period (years) of use of IRWHT (n = 150)

Period of use	**F**	**%**
1-4 years	33	22.0
5-8 years	87	58.0
9-12 years	25	16.7
Above 12 years	5	3.3
Total	**150**	**100**

Source: Field survey 2019

Table 2: Reasons for discontinued use (n=150)

Reasons for discontinued use of IRWHT	**F**	**(%)**
Small farmland size	50	23
Dearth of reliable water sources during dry seasons	41	18
Insufficient extension service support post adoption	38	17
IRWHT takes up much space	28	13
Lack of output markets	24	11

Challenges with input supply and work tools	20	9
Lack of infrastructure	12	5
Group conflicts	9	4
Total		**100**

Source: Field survey 2019

3.3 Perceived attributes of IRWHT

The perception of the respondents about the relative advantage of IRWHT indicated that the majority had a positive perception of IRWHT as effective for increasing farm yields ($\bar{x}$ = 4. 38), water availability for production ($\bar{x}$ = 4.30) and household food security ($\bar{x}$ = 3.05), (Table 3). A majority of the respondents also rated the compatibility attribute of IRWHT high as it can be implemented using local resources ($\bar{x}$ = 3. 54), fits into their cultural and social system ($\bar{x}$ = 3. 37), and is also applicable in all seasons ($\bar{x}$ = 3. 32), (Table 3). All perception statements regarding the complexity in the use of IRWHT had mean values that were less than 3.05. The majority (60%) of the farmers agreed that using the IRWHT was labour intensive while about 39.3% strongly agreed that operating the technology was time consuming. About 44.7% also agreed that it was difficult to understand how to operate the technology (Table 4). More than 60% of the farmers either agreed or strongly agreed that they had tested IRWHT prior to adoption and at different seasons, which minimised any uncertainties they had about adopting the technology. As such, all perception statements were significant, with mean scores above 3.05 (Table 4). The majority (68. 7%, $\bar{x}$ = 3.81) of the respondents agreed that the yield grown under IRWHT could be easily observed. Other observability traits were also significant with their mean scores above 3.05 (Table 4).

Table 3: Smallholder farmers' perception about the relative advantage and compatibility of IRWH (n=150)

Relative advantage of IRWHT	**N**	**Strongly Agree (%)**	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly Disagree (%)**	**Total (%)**	**Mean score $\bar{x}$**
Adoption of IRWHT has a positive effect on water availability for crop production.	150	43.3	51.3	3.3	1.3	0.8	100	4.30*
Through the adoption of IRWHTs, I was able to supply my family with food.	150	44.0	50.7	3.3	1.3	0.7	100	3.05*
Through the Adoption of IRWHTs, I was able to sell the surplus for income.	150	16.0	20.0	25.3	30.0	8.7	100	2.95
The adoption of IRWHTs led to a better yield than conventional tillage.	150	52.0	38.0	6.0	4.0	0	100	4.38*
Compatibility of IRWHT	**N**	**Strongly Agree (%)**	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly Disagree (%)**	**Total (%)**	**Mean score $\bar{x}$**
The use of IRWHTs is practicable in all seasons.	150	15.3	32.0	36.0	16.0	0.7	100	3.32*
IRWHTs fit well in the cultural aspects of a social system.	150	8.7	25.3	60.7	5.3	0	100	3.37*
Smallholder farmers can implement IRWHTs using the local resources.	150	10.7	54.7	14.0	19.3	1.3	100	3.54*

Source: field survey 2019 * = *Significant relative advantage if mean score is* ≥ 3.05

Table 4: Smallholder farmers' perception about the complexity of use, trialability and observability of IRWHT (n=150)

Complexity of use of IRWHT	**N**	**Strongly Agree (%)**	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly Disagree (%)**	**Total (%)**	**Mean Score $\bar{x}$**
There is difficulty in understanding how to use the IRWHT.	150	10.0	44.7	25.3	15.3	4.7	100	2.60
There is high certainty about the adoption of IRWHT.	150	12.7	39.3	32.0	12.7	3.3	100	2.55
IRWHT is labour intensive.	150	13.3	60.0	11.4	14.0	1.3	100	2.30
IRWHTs takes time to operate.	150	39.3	31.3	17.4	9.3	2.7	100	2.37
Trialability of IRWHT	**N**	**Strongly Agree (%)**	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly Disagree (%)**	**Total (%)**	**Mean Score $\bar{x}$**
I was able to try out IRWHT prior to adoption.	150	22.0	46.0	22.0	10.0	0	100	3.20*
Trying out IRWHT prior to adoption reduced my uncertainties.	150	22.7	41.3	30.0	6.0	0	100	3.80*
I tried IRWHT during different seasons.	150	28.7	38.6	28.0	4.0	0.7	100	3.81*
Observability of benefits of using IRWHT	**N**	**Strongly Agree (%)**	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly Disagree (%)**	**Total (%)**	**Mean Score $\bar{x}$**

IRWHT decreases weeds and pests.	150	8.7	28.7	30.7	30.7	1.2	100	3.15*
IRWHT decreases the use of herbicides.	150	4.7	34.0	36.6	24.0	0.7	100	3.79*
Under IRWHT, increased crop yield is observable.	150	20.0	68.6	8.7	2.7	0	100	3.81*

Source: Field survey 2019 * = Significant perceived complexity if mean score is ≥ 3.05

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3.3 Level of extension support provided for effective adoption

The majority (98.7%) indicated that extension service support was provided while the project implementation lasted; while about 94% noted that extension officers continued to frequently visit their farmlands to monitor the adoption process. About 60.4% and 37.67% of the respondents indicated that extension officers demonstrated the practice of IRWHT and also organised training sessions respectively. More than 65% of the farmers either agreed or strongly agreed that there was extensive extension support for the adoption of the IRWHT. As such, all perception statements were significant, with mean scores above 3.05% (Table 5).

Table 5: Smallholder farmers' perception about extension support (n = 150)

Extension support	N	Strongly Agree %	Agree %	Neutral %	Disagree %	Strongly Disagree %	Total %	Mean score $\bar{x}$
Extension officers provided applicable knowledge on IRWHT.	150	31.5	41.6	17.4	9.5	0	100	3.94*
Extension training sessions were more practical than theoretical.	150	28.2	39.6	24.2	7.3	0.7	100	3.87*
With extension support, I could easily apply IRWHT knowledge on my farm.	150	37.6	40.9	19.5	2.0	0	100	4.14*
Extension officers had good knowledge of IRWHT.	150	36.9	44.3	16.1	2.7	0	100	4.13*

Source: Field survey 2019 * = Significant perceived extension support if mean score is ≥ 3.05

4. DISCUSSION

4.1 Demographic profile of respondents

The majority (66.7%) of the respondents were females. One of the reasons for the female domination is that homestead gardening has been used as a tool to empower women. According to Galhena, Freed and Maredia (2013), the concept of home gardens is associated with women. About 44% of respondents had obtained secondary education and 36.7% were dependent on an old age pension. Esabu and Ngwenya (2019) stated that a large number of farmers with secondary education implies a likelihood of technology adoption; this is because farmers can

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read and write. What this means is that if farmers can read and write, the technicalities of innovations could be easily understood.

4.2 Rate of use of IRWTH amongst smallholder farmers

Results showed that 96.0% had discontinued using IRWHT to irrigate their farmlands while only 4.0% indicated they still used the technology, albeit sometimes. The period of use indicated that the majority (58%) had discontinued its use after 5 to 8 years while just about 3.3% had the technology running for more than 12 years (Table 1). This indicates that most of the respondents discontinued IRWHT after the project promoters (UFH, ARC and WRC) had withdrawn their support. According to Monde *et al.* (2012), the IRWHT project promoters pulled out of the project after the slated 5-year period; this was to promote smallholder farmers' self-reliance on the use of the technology. However, literature has demonstrated that long-term and sustained innovation utilisation is a challenge (Laurie et al., 2017; Habanyati, Nyanga & Umar, 2018; Souza & Mishra, 2018), especially for resource poor smallholder farmers. This view is supported by several studies (Badisa 2011; Gao *et al.,* 2019; Grabowski *et al*., 2016; Kebebe, 2019) on post-adoption behaviour of farmers which shows that smallholder farmers normally drop out of a project as soon as the project donors' or government support is withdrawn. For instance, a study by Lwiza *et al.* (2017) in Central Uganda found that a biogas technology introduced to the farmers was dis-adopted within a period of 4 years after its installation even though its lifespan was estimated to be about 25 years. Therefore, the adoption of a technology must not be regarded as an outcome, as many adoption studies have presumed. Oladele and Wakatsuki (2011) argued that over time, adoption makes a distinct quality of an innovation to fade; hence, farmers adopt, and later dis-adopt once their interest in the technology wanes. As such, programmes that focus on one-time adoption can be re-strategised in preventing dis-adoption of innovations. Many studies have attributed the concept of dis-adoption to a variety of reasons, such as institutional, socio-economic and technical factors (McCosh et al., 2017; Souza & Mishra, 2018; Gedikoglu, 2019)

4.3 Motives for discontinued use of IRHWT

An analysis of the reasons for discontinuing the use of IRHWT in the study area revealed that 23% of the respondents cited small size of land as a key reason for discontinuance (Table 2). Empirical studies have shown that land is the main contributor to adoption of agricultural technologies. Lwiza *et al.* (2017) pointed out that there is a positive relationship between the size of the land and technology adoption. Badisa (2011) and Label *et al*. (2015) also noted that small land size implies a likelihood of dis-adoption since farmers are reluctant to invest in technology adoption for small land size, considering profitability and sustainability as crucial factors. About 18% of the farmers also indicated water scarcity during dry seasons as a reason for dis-adoption. Respondents in the study area expressed the opinion that the lack of rain in dry seasons inhibited their continued use of IRWHT. According to Durga and Kumar (2016), IRWHT only promotes water conservation and efficiency, which implies that if there is lack of water supply, IRWHT will be ineffective. Botha *et al.* (2014) affirmed that IRWHTs were designed to use rainwater; therefore, insufficient rainfall may affect the use of the technology.

4.4 Perceived attributes of IRWHT

The perception of the respondents about the relative advantage of IRWHT indicated that the majority had a positive perception of IRWHT as effective for increasing farm yields ($\bar{x}$ = 4. 38) (Table 4). This benefit in particular has drawn a number of countries into practising the use of IRWHT. Nyamadzawo *et al*. (2013) pointed to several African regions like Tanzania, Burkina Faso, Ethiopia, Niger, Kenya and Mali, implementing numerous forms of IRWHT conservation practices. In Zimbabwe, smallholder farmers who adopted in-field rainwater harvesting techniques indicated that there was an observable increase in the yields of crops like sorghum, maize, millets, cowpeas, groundnuts and sweet potatoes, among other crops (Ndlovu et al., 2020). In Malawi, the adoption of IRWHTs was found to have had a positive impact on smallholder farmers' food security, farm income and that more 80% of its farmers make use of the in-situ technologies because of the relative advantage of having a greater in-field water retention efficiency (Mangisoni *et al*., 2019). IRWHTs were also credited for increasing food availability for smallholder farmers in Zimbabwe (Ndlovu *et al.,* 2020). However, Velasco-muñoz, Aznar-s and Batlles-delafuente (2019) noted that IRWHT could be damaged by storms and therefore requires regular maintenance, regardless of the fact that it facilitates the increase in crop yields and other added benefits.

A majority of the respondents also rated the compatibility attribute of IRWHT high as it can be implemented using local resources ($\bar{x}$ = 3. 54) (Table 4). IRWHT plot preparation could be done using available garden working tools. This emphasises the view that during an innovation development or technology design, the availability or ease of access to farming tools for the technology must be taken into consideration, as it is significant in the adoption process. Further

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analyses revealed that smallholder farmers perceived IRWHT as complex with regards to usage (Table 4). All perception statements regarding the complexity in the use of IRWHT had mean values that were less than 3.05. The majority (60%) of the farmers agreed that using the IRWHT was labour intensive while about 39.3% strongly agreed that operating the technology was time consuming. More than 70% of the respondents indicated that IRWHT was labour intensive and time consuming; consequently, participants were encouraged to work together and render assistance to each other. In Zimbabwe, for instance, the intensity of labour was found to be a critical factor influencing the adoption of IRWHT as the majority of smallholder farmers' in the study area expressed how labour intensive it was to implement the technology; as such, all techniques that required recurrent use of labour were not adopted by farming households with limited access to sufficient labour (Ndlovu *et al.,* 2020). Agholor (2019), in his critical analysis of gender-blind technologies, argued that an innovation would remain relevant only if the innovation increases productivity without extra labour and with minimal time commitment.

More than 60% of the farmers either agreed or strongly agreed that they had tested IRWHT prior to adoption and at different seasons, which minimised any uncertainties they had about adopting the technology. As such, all perception statements were significant, with mean scores above 3.05 (Table 4). This study's findings suggest that IRWHT is trialable (Table 4). The majority of the farmers had a positive perception towards the technology's trialability attribute as they had tested it prior to adoption at different seasons, which minimised unwillingness to adopting the technology. This, however, is contrary to Noga's *et al.* (2015) view that trialability is not significant in the adoption of an innovation. However, Aggey, Ghartey and Brown (2012) had a different opinion and noted that trying an innovation before adopting it, minimises the unexpected consequences, thus increasing chances of adoption.The majority (68. 7%, $\bar{x}$ = 3.81) of the respondents agreed that the yield grown under IRWHT could be easily observed. Gedikoglu (2019) stressed the significance of observing the benefits of innovations to encourage sustainable use of such innovations. Observability complements trialability on the basis that it also minimises uncertainties of IRWHT adoption.

4.5 Level of extension support provided for effective adoption of IRWHT

Majority (98.7%) of the respondents indicated that extension service support was provided while the project implementation lasted. As validated by various authors (Aremu et al., 2015; Kaur & Kaur, 2018; Melisse, 2018; Lendel, Harder & Roberts, 2019), extension service takes centre stage with regards to agricultural innovation dissemination and adoption. This suggests that availability of extension officers remains a precondition to promoting agricultural technologies. Consistent with this finding, Esabu and Ngwenya (2019) indicated that access to extension service was a significant factor that contributed to adoption of conservation agriculture in Uganda. Mangisoni's et al. (2019) research outcome in Malawi validates the central role extension advisory services play in the adoption, placement and continuous use of technologies, and also, in realising the best possible results from using such technologies.

More than 65% of the farmers either agreed or strongly agreed that there was extensive extension support for the adoption of the IRWHT. As such, all perception statements were significant, with mean scores above 3.05% (Table 5). Smallholder farmers' perception of extension service support indicated a positive perception ($\bar{x}$ = 4.14) of the view that with extension support, they could easily apply IRWHT knowledge on their farm plots (Table 5). However, insufficient extension service support post adoption was given as a major reason why a majority of the respondents discontinued the use of IRWHT (Table 2).Yadav and Kumar (2018) explained that access to reliable and easily applicable agricultural information shapes a positive decision for innovation adoption. Bentley *et al.* (2018), in their study of farmers' responses to technical advice, stressed that a dearth of adequate information from relevant sources limits adoption of technologies. The cessation of extension visits to the smallholder farmers post adoption may have contributed in part to many of the farmers' decision to discontinue using IRWHT. The respondents opined that there was no need for the institution in charge to withdraw extension support post adoption of IRWHT because they still required further guidance and advisory services to deal with the challenges of using the technology post adoption.

5. CONCLUSION AND RECOMMENDATIONS

Rural smallholder farming households in the RML Municipality are specifically vulnerable as the majority of the farmers depend heavily on rain-fed agriculture. IRWHT is therefore important for the region as it promotes plant water avalability, increased yields, and also enables sustainable food production. This study has shown that despite its relative advantage, compatibility, trialability and observability, the use of IRWHT was discontinued by a majority of the projects' beneficiaries in the study area. The period of use indicated that the majority of the project's beneficiaries had discontinued its use after 5 to 8 years. The termination of extension visits to the smallholder farmers post adoption of IRWHT is among many of the contributory factors affecting the sustainable use of the technology. This implies that rain-fed agriculture in RML Municipality may remain threatened, consequently affecting sustainbale agricultural production and ultimately impacting on the economic development in the region. In conclusion, success of projects like the IRWHTs should not be measured by the high rates of initial adoption as evidence from this study, which indicates that though there was an initial high adoption rate, the majority of the farmers eventually discontinued its use in the long run.

This study suggests a continued support of technical assistance to the farmers by the extension officers to consolidate the adoption process post pilot trial. Mentoring and monitoring of the farmers and the project are key to adoption, the agricultural extension personnel should thus be up todate on these. This study also recommends proper monitoring and evaluation by extension and research institutions to allow for continous assessment of the projects.

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